APPEL A PROJETS LABEX/ CALL FOR PROPOSALS

2010

Acronyme du projet / Acronym

DOCUMENT SCIENTIFIQUE B / SCIENTIFIC SUBMISSION FORM B

Acronyme du projet/ Acronym of the project	**SYMMECOM**
Titre du projet en français	Systèmes moléculaires et matériaux sous environnements complexes
Project title in English	Molecular systems and materials under complex environments
Coordinateur du projet/Coordinator of the project	Nom / Name : LEROUX Hugues Etablissement / Institution : PRES ULNF Laboratoire / Laboratory : Unité matériaux et transformations Numéro d'unité/Unit number : UMR 8207
Aide demandée/ Requested funding	**11.47 M€**
Champs disciplinaires (SNRI) / Disciplinary field	X Santé, bien-être, alimentation et biotechnologies / Health, well-being, nutrition and biotechnologies X Urgence environnementale et écotechnologies / Environnemental urgency, ecotechnologies □ Information, communication et nanotechnologies / Information, communication and nantechnologies □ Sciences humaines et sociales / Social sciences X Autre champ disciplinaire / Other disciplinary scope
Domaines scientifiques/ scientific areas	Energie, environnement, santé, géoscience, matériaux sous pression, matériaux architecturés, systèmes moléculaires, polymères, sécurité-feu, transition de phase, combustible nucléaire, électrolyse à haute température, réactivité-sélectivité
Participation à un ou plusieurs projet(s) « Initiatives d'excellence » (IDEX) / Participation in an « Initiatives d'excellence » project	X oui ☐ non

Affiliation(s) du partenaire coordinateur de projet/ Organisation of the coordinating partner

Laboratoire(s)/Etablissement(s) Laboratory/Institution(s)	Numéro(s) d'unité/ Unit number	Tutelle(s) /Research Organisation reference
PRES Université Lille Nord de France (ULNF)		

Affiliations des partenaires au projet/Organization of the partner(s)

Laboratoire(s)/Etablissement(s) Laboratory/Institution(s)	Numéro(s) d'unité/ Unit number	Tutelle(s)/Research Organisation reference
Unité Matériaux et Transformations	UMR 8207	PRES ULNF/Lille 1, CNRS, ENSCL
Unité de Catalyse et de Chimie du Solide	UMR 8181	PRES ULNF/Lille 1, CNRS, ENSCL, ECLille, Univ Artois
Laboratoire de Spectrochimie Infrarouge et Raman	UMR 8516	PRES ULNF/Lille 1, CNRS
Miniaturisation pour la Synthèse, l'Analyse & la Protéomique	USR 3290	PRES ULNF/ Lille 1, CNRS
Chimie Moléculaire et Formulation	EA 4478	PRES ULNF/Lille 1, ENSCL
Institut Michel Eugène Chevreul	FR 2638	PRES ULNF/Lille 1, CNRS, ENSCL, ECLille, Univ Artois
Laboratoire de Mécanique de Lille	UMR 8107	PRES ULNF/ Lille 1, CNRS, ECLille, ENSAM
Polymers and Composites Technology & Mechanical Engineering Department / UR MPE /	Non concerné	PRES ULNF/Ecole des Mines de Douai

1. RESUME / SUMMARY

The **SYMMECOM project** grew out of researchers from the Lille area (North of France), in laboratories and teams rated A+ and A by AERES which have demonstrated expertise in the field of processing, transformation and characterization of molecular, polymeric and inorganic materials for applications in the field of **energy and environment for a sustainable future**. With different backgrounds, all the researchers involved in this project have a common objective: the development of **molecular systems or materials** for acquiring basic knowledge on the behavior of matter under complex and extreme environments together with the development of innovative systems that answer the functionality requirements for targeted applications. This diversity is nonetheless based on a **unique set of technical characterization platforms** of international level. Above all, the project benefits from past collaborations between researchers from various disciplines (chemists, physicists and mechanical researchers), leading to the **multidisciplinary** configuration required to challenge scientific, technological and societal issues.

With the awareness of the environmental impact, it is urgent to develop new concepts of atom economy, better reactivity and selectivity, sustainable energies keeping in mind security, a better understanding of our planet and better health. These are main concerns of the French SNRI (National Research and Innovation Strategy) and it is the ambition of the SYMMECOM project to tackle these issues.

Research: Our scientific project is based on solid ground skills and achievements. It is mainly based on concepts for which we are recognized internationally. They include the behavior of materials and molecular systems **under extreme conditions** (pressure, temperature, dynamic loading), **controlled architectures and microstructures with functional properties,** the **reactivity-selectivity** at the molecular scale. It comes in the form of **challenges** for which we expect to make significant progress. They are mostly interdisciplinary, involving chemists, physicists and mechanical engineering researchers whose partners have proven expertise in the field of development and transformation of molecular and polymeric or inorganic materials. They target various application fields (Earth sciences, materials against fire, materials for future energies, chemical reactivity for sustainable applications, valorization of the biomass, materials for health). They are divided into **6 Work Packages**:

WP-1- Multiscale plastic behavior under high pressure whose challenge aims to design a new approach in Earth's mantle rheology by integrating laboratory experiments under extreme conditions and numerical multiscale modelling.

WP-2- Driven microstructures against fire: new polymeric systems whose project addresses the issue of optimizing innovative polymeric and composite materials in terms of processing conditions, microstructure development and durability.

WP-3-Design of novel architectured materials for future energies which concerns the elaboration of functional compounds with tailored properties, more specifically the design and production of novel iono-covalent structural architectures through the rational association of patterns, each of them bringing its own specific functionality for application in the field of nuclear fuels and hydrogen production by electrolysis of water vapor at high temperature.

WP-4- Smart nano reactors: towards optimized activity and selectivity whose objective is here to challenge the development of smart micro-nanoscale reactors for sustainable chemical applications integrating atom economy and lower energy consumption.

WP-5- Biomass for an integrated Biorefinery based on the development of new catalysts for (1) the valorisation of the alcohols produced by this sector, (2) the capacity of valorization of the various by-products, and (3) the capacity of purification of the obtained primary products as well as the treatment of the secondary pollutions generated by the chemical and/or biological conversion processes.

WP-6 Material Science for Health whose objective is here to establish a pharmaceutical material science platform providing experimental and numerical tools of physical analysis. The project also aims to acquire a transversal skill in the functionalization of medical devices.

These WP will rely on the **analytical platforms of international stature (WP7)** currently supervised by the partners. These platforms gather latest generation equipments which have reached an outstanding level of quality and performance, which will contribute to the success of the SYMMECOM project. They will be developed, both on hardware and skill levels and we aspire to optimize their current organization by combining them under a single operational structure. In addition, in order to strengthen and amplify industrial and international partnerships, we aim to develop **high level synthesis platforms**. These platforms are the core of the implementation of the project and constitute an important part of the funding request. Moreover, they should be an important factor in attracting high level students and researchers.

Higher education: SYMMECOM is based on an environment which has a solid experience in higher education. Most of the participants are academics involved in teaching and several of them manage **masters** in material science and chemistry (ranked A and A+ by AERES), in addition to a strong involvement in three **engineering Schools**. They also manage an international **ERASMUS MUNDUS** master "Advanced Spectroscopy in Chemistry", a network composed by 7 universities. The objective associate to SYMMECOM is to consolidate this exceptional training offer and to develop new ones to attract the best students, in particular foreigner students. One flagship project is to build a new ERASMUS MUNDUS master in Materials Science covering the border area (France-Lille, the Netherlands and Belgium), a project strongly supported by the University Lille 1 for which this North axis is strategic and of high priority. Since the second years of the master degree is

the pivotal period between training and a first research experience, SYMMECOM plans to set up grants to attract best students from all over the world in our training courses with the aim to recruit the best as PhDs. The training courses we manage are included in a wide program developed by the college doctoral under the responsibility of the PRES ULNF. PRES ULNF and its doctoral colleges develops lifelong learning offer, which is nationally well recognized as one of the best. SYMMECOM and its associated master degrees are already involved in this lifelong learning scheme. We will challenge to go deeper in this direction in coordination and support of the experience of the institutions within the PRES ULNF.

Exploitation of results and scientific communication: The project has strong industrial applications and we intent to consolidate and extend collaborations with our industrial partners (i.e. Sanofi Aventis, Total, Areva, CEA, EDF). In this scheme, the "transfer center" included in SYMMECOM, firstly focused on our analytical platform but with a possible evolution toward the synthesis technological platforms which are the core of the SYMMECOM project, will be a master tool to extend our partnership, mainly with SMI-SMEs. For the patent policy we intend to work with the research exploitation department and the incubator "cré-innov" of University Lille 1 and possibly latter with "Nord de France Valo", since the PRES ULNF has decided to group together the existing research exploitation departments. Once arrangements have been made to protect any commercially significant intellectual property arising from the project, results will be published in refereed international journals and in proceedings of appropriate international conferences. In addition to the specialized scientific publications, our project has good potential to communicate with a wider audience, for which we have some experience. Indeed the majority of subjects are at the heart of important topics of our changing society (materials for health, future energies, energy consumption, biomass…) which are well adapted to strengthen a public dialogue and exchanges with elected officials.

Governance: A key objective of SYMMECOM is to strengthen links between seven Research Units in order to improve their research productivity, their higher education offer and results exploitation. SYMMECOM, supervised by PRES ULNF, has no legal autonomy. It doesn't manage staff members and research equipments which come under joint reseach units and higher education institutions responsibility. Yet, it has full scientific autonomy and approves project that will be carried out by the SYMMECOM partners. The governance scheme, similar to the project governance framework, will be made up of an Executive Board, a Scientific Advisory Board and a steering committee. SYMMECOM shall also be represented and managed by a Director assisted by three Deputy Directors.

University strategy: University Lille1/PRES largely supports SYMMECOM. In addition to the actual human resources, scientific equipment and building infrastructure, the university is committed to providing subnational additional support for this LABEX, in particular in

Human resources support, building and scientific infrastructure as well as in administrative and logistic support and current expenses .

2. CANDIDATURE AUX ACTIONS DU PROGRAMME INVESTISSEMENTS D'AVENIR/ APPLICATION TO THE ACTIONS OF THE PROGRAMME « INVESTISSEMENTS D'AVENIR »

Several EQUIPEX have been submitted in September. Two of them were driven by staff members of SYMMECOM. These are EQUIPEX META (PI P. Raterron - UMET) and EQUIPEX REALCAT (F. Dumeignil - UCCS). For the others (ROCK, PharmaR3, FT-ICR), units which participate to SYMMECOM are partners.

EQUIPEX META: The project aims the creation of a **Center for Analytical Transmission Electron Microscopy** hosted in the new building of the Chevreul institute. The required equipment includes analytical transmission electron microscope and an environmental transmission electron microscope. The project regroups scientific programs in Materials-chemistry, Earth and Space science, Communication and Information Science and Technology (STIC), environment and biology-healthcare.

EQUIPEX REALCAT: The aim of this platform is to build a versatile High Throughput Technologies (HTT) platform in order to accelerate the development of innovative catalysts used for biomass valorisation. The objective is to divide the time of development of a catalyst by, at least, a factor 10.

Staff members of SYMMECOM are also involved in the IEED IFMAS ("Institut Français des Matériaux Agro-Sourcés") and in the IEED PIVERT. IEED means *"Instituts d'excellence dans le domaine des énergies décarbonées"*

Nom de l'action	*Acronyme du projet (préciser si le projet est déposé ou envisagé)*	*Nom du coordinateur*	*Consortium /partenariat impliqué*
EQUIPEX	META	P. Raterron	PRES ULNF/Lille 1/Chevreul federation (10 laboratories), ArcelorMittal, Roquette, Saint-Gobain
EQUIPEX	REALCAT	F. Dumeignil	PRES ULNF-Lille 1/ Chevreul federation/Unit of Catalysis and Solid State Chemistry (UCCS)
EQUIPEX	ROCK	V. Briois	SOLEIL (PI), including UCCS as partner)"
EQUIPEX	PharmaR3	B. Desprez	Lille1, Lille2, INSERM

EQUIPEX	FT-ICR	Chamot-Rooke (National), Tokarski (Loc.)	CNRS, Consortium National : École Polytechnique, Paris 6, U. Aix-Marseille, U. Rennes, U. Metz, U. Lille
IEED	IFMAS	Non déterminé	PRES ULNF (Lille 1, ENSCL, U. Artois, Ecole des Mines de Douai) ; INRA Nantes, CREPIB, Société Roquette, Pôle MAUD, ARMINES
IEED	PIVERT	Thomas/Santini	Sofiproteol / Univ. Amiens / Univ. Compiègne / Pôle IAR, UCCS-Lille1, etc…

3. ORGANISATION DU PARTENARIAT/ MANAGEMENT OF THE PARTNERSHIP

3.1. COMPOSITION DU PARTENARIAT/ COMPOSITION OF THE PARTNERSHIP

Nom du partenaire	*Affiliation*	*Effectifs / Catégorie de personnel (chercheurs, ingénieurs, doctorant …)*
Unité matériaux et Transformations UMR 8207	Univ Lille 1 PRES ULNF	11chercheurs, 57EC, 7 ITA, 11 IATOS, 42 Doctorants, 7 Postdoc
Unité de catalyse et de chimie du solide UMR 8181	Univ Lille 1 PRES ULNF	13 chercheurs, 83 EC, 10 ITA, 20 IATOS, 86 Doctorants, 18 Post-Doc, total 230
Laboratoire de Spectrochimie Infrarouge et Raman UMR 8516	Univ Lille 1 PRES ULNF	13 Chercheurs, 18 EC, 9 ITA, 5 IATOS,, 18 doctorants, 4 Postdoc
Miniaturisation pour la Synthèse, l'Analyse & la Protéomique USR 3290	Univ Lille 1 PRES ULNF	2 EC, 1 ingénieur (sur un effectif total de 6 personnes)
Chimie Moléculaire et Formulation (CMF EA 4478)	Univ Lille 1 PRES ULNF	3 EC et 1 IE (sur effectif total de 32 personnes)
Laboratoire de mécanique de Lille UMR 8107	Univ Lille 1 PRES ULNF	2 CR, 5 EC, 1 ITA
Polymers and Composites Technology & Mechanical Engineering Department / UR MPE /	Ecole des mines de Douai - PRES ULNF	Effectif impliqué dans le projet : 11 Enseignants chercheurs (sur un effectif total de 78 personnes)

3.2. QUALIFICATION DU COORDINATEUR DE PROJET /RELEVANT EXPERIENCE OF THE PROJECT COORDINATOR

Projet coordinator : Hugues Leroux, professor, 43 years

Hugues Leroux is Professor at University of Lille 1. He obtained first a tenured position in 1995 as assistant-professor and became professor in 2002. He was appointed to Polytech'Lille, an engineering school, in the Material Science Department and conducts his research activity at the UMET laboratory (partner of the SYMMECOM Labex), in the Mineral Physics team. His expertise concerns electron microscopy, phase transformation, defects in minerals. His research topic is actually positioned at the interface of *material science* and *Earth and Planetary Sciences*. Key elements of his scientific career and experience in management are given below:

Key elements of his scientific career (60 publications, 1500 citations, h-index = 18):

1995-1999: Shock metamorphism in minerals - The research activities were focused mainly on the metal-silicate interaction and shock metamorphism in meteorites, using a microstructural approach.

1998-2000: European programme TMR « Mineral Transformations » - The European research program "Training and Mobility Research (TMR) Network" Mineral Transformations "comprised seven European laboratories. The main objective of the network was to work on the mechanisms and kinetics of phase transformations in materials of geological origin. His contribution was to quantify the effects of irradiation and post-irradiation annealing on the evolution of a model silicate, zircon.

2000-2005: Silicate evolution under irradiation - Around 2000, he created a new theme on the evolution of silicates under irradiation in an astrophysical context (in collaboration with astrophysicists). This research was an experimental approach to understand the behavior of silicates under irradiation, which aimed to assess the role of irradiation on the life cycle of silicates in space.

2006-2010: Stardust mission - Since 2006, he is involved in the study of cometary samples reported by the Stardust mission, in collaboration with NASA. This mission is a major space program and is the second sample return after the Apollo missions in the 1970s. During the same period, he develops experimental approaches to understand the evolution of dust material in protoplanetary disks.

Experience of project coordination and management

- Vice director of the UMET laboratory (Chevreul federation, Lille 1, PRES-NDF). UMET is a new laboratory which gathers the essential expertise from the university on material science. The UMET gathers 140 persons including post-doc and PhD.
- He leads a French consortium on the study of samples from the Stardust mission (since 2007). This consortium includes 6 laboratories and is funded by CNES (French space agency). His role is to coordinate the expertise performed on advanced characterization

tools (X-ray-synchrotron, electron microscopy and ion nano-beam analysis) and to assume the connection with NASA.
- He was PI of several CNRS grants, and in this context animator of research programs including several French laboratories.
- Member of the committee of the CNRS French programme of planetology (since 2004). His role consists in the expertise of projects and coordination of the national research strategy, in particular for micro-beam analysis and experimental works.

Awards : Bronze Medal of the CNRS, 2002

4. DESCRIPTION DE L'EXISTANT/ DESCRIPTION OF THE EXISTING

4.1. PRESENTATION DES PARTENAIRES

4.1.1 PARTENAIRE 1/ PARTNER 1 : PRES ULNF

"Lille Nord de France University - Research and Higher Education Cluster" (later named *PRES ULNF*) was founded in January 2009 in order to increase regional academic potential, promote its visibility and enhance its international standing. With 17 higher education institutions (Universities and engineering schools), 130 000 students, 4 600 researchers and research fellows, 3 000 doctoral students in 6 doctoral schools, Lille Nord de France University focuses largely on public research in the Nord-Pas de Calais region. It also supports the academic community to work in close collaboration with national research organisations and business and techno clusters. All of its activities lead to development in regional research and higher education.

4.1.1.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

See following partners

4.1.1.2 VALORISATION / EXPLOITATION OF RESULTS

The exploitation of results is actually conducted thought the *Lille Nord de France Valo Centre*, which is composed by the research exploitation subdivision of each partner (University Lille 1 for us). The PRES ULNL will answer to the proposal SATT project (see the corresponding section 5.2.2) in order to construct an unified exploitation, research and expertise department. In the following we describe the exploitation research department of University Lille 1.

University Lille 1 participates to the strategy of local collectivities and is involved scientifically and in the management of the 7 competitiveness clusters of the Nord Pas de Calais Region. Lille 1 also contributes with others parties (urban communities, regional and general councils ...) to innovation and to the economic development. It offers technological platforms to test techniques, innovative technologies, provisions of services and researches to the companies.

University Lille 1has a research exploitation department which contributes to i) the transfer of scientific knowledge, of technologies, of processes and of known how towards companies, thus participating to the **social and economic development** and ii) increase the number of submitted research projects and especially European projects to reinforce the **Lille 1 international visibility and excellence** as well as to develop **new collaborations with public and private partners**. In collaboration with research institutions (CNRS, INSERM, INRIA, INRA) and the PRES ULNF, University Lille 1 encourages and facilitates innovation. The research exploitation department which hires 17 persons (financial managers, jurists, and scientist) includes 3 units: project engineering unit, industrial and commercial activities unit (Service des Activités Industriels et Commerciales - SAIC) and an enterprise incubator (Cré-innov).

The research exploitation department helps researchers to take up national, European and international projects. A new **project engineering unit** (Ingénierie de projets) has been created in September 2009 to boost especially submissions of European projects. As an example, **29 European projects** (FP7, Interreg, DG research,..) have been submitted **within 1 year**, **8 of them have been awarded** (among which **4 are coordinated by Lille 1**) and have a total **EC contribution** of about **4 000 000 euros.** The department also manages industrial and commercial contract via the Industrial and commercial activities unit **(SAIC)**). About **200 new contracts are negotiated and signed each year** with the help of jurists. Lille 1 owns about **70 families of patents** among which **12 are exploited** by companies and **20 softwares with half of them exploited**.

University Lille 1 has got an incubator (Cré-innov) which helps to the emergence of new companies in collaboration with laboratories and Lille 1 is thus indirectly creating jobs. The university directly creates jobs (PhD, post doc, technicians, engineers, secretaries,...) when national or European projects are accepted and then indirectly when results of these projects are further exploited by companies at the end of projects. SAIC sells patents licensing, negotiates technological transfer and provisions of services to companies which help companies to acquire and develop new technologies and which thus involves indirectly the creation of new and usually high qualify jobs.

4.1.1.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

See following partners

4.1.1.4 ORGANISATION / ORGANISATION

PRES ULNF is a scientific cooperation establisment of the region Nord Pas de Calais (Northe of France). Each establisment has its own organisation. Partners of the project are Research Unit of University Lille 1 and Ecole des Mines de Douai.

4.1.2 PARTENAIRE 2/ PARTNER 2 : UNITE MATERIAUX ET TRANSFORMATIONS

4.1.2.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

The laboratory UMET focuses its research activity on material science, within the federation Michel-Eugène Chevreul (FR 2638) at University Lille 1. The UMET teams develop most aspects related to material science. They concern synthesis, functionalization, characterization of structures and properties in relation with their condition of use. The objectives are diverse: the understanding of fundamental processes that determine a given behavior may seek a direct application with industrial partners or more fundamental studies. Areas of study include the mechanical behavior of materials eventually submitted to high pressure and/or detrimental environment, therapeutic and biocompatible materials, processing and surface functionalization, behavior under irradiation, behavior under fire …

The laboratory has 57 researchers – teachers and 12 CNRS researchers corresponding to 41 full time researchers. It is organized into four teams, three of which participate to the SYMMECOM project and are briefly presented below. The AERES notation of the laboratory is A, the recent report by AERES is readable at the following link: http://www.aeres-evaluation.fr/content/download/11455/170882/file/EVAL-0593559Y-S2100012108-UR-RAPPORT.pdf

Matériaux Moléculaires et Thérapeutiques/Molecular and Therapeutic Materials, headed by M. Descamps **(AERES notation = A)**. The research field of the team focuses on the physical behavior (structure, dynamics, phase transitions) of macromolecular compounds subjected to various disturbances: changes in temperature, pressure, but also grinding and dehydration. The overall objective is to analyze metastabilities, the glassy state, phase transformations and nonequilibrium transitions induced by the external perturbation. The materials studied are those of the pharmaceutical and agro-food sectors.

Physique des Minéraux/Mineral Physics, headed by P. Cordier **(AERES notation = A+)**. The Mineral physics team aims to apply the concepts and methods of materials science to topics in Earth and Planetary Science. Two main directions of research are developed: "Plasticity of mantle minerals" and "Astromineralogy". The main activity of the team concerns the development of deformation setups under high pressure which represents a technological challenge. The team also develops numerical modeling of plastic deformation under pressure.

Ingénierie des systèmes polymères/Polymer engineering, headed by J.M. Lefèbvre **(AERES notation = A)**. The team produce innovative materials including multifunctional biomaterials, assemblages with controlled architectures, biobased polymers systems, polymers against fire, ... The team combines skills and expertises in polymer physico-chemistry, controlled radical polymerization, multi-responsive macromolecular assemblies, supramolecular chemistry, and surface functionalization. It develops elaboration of smart self-assembled systems (micelles, supramolecular polymers) and smart (bio)surfaces that have the propensity to present a bioactive functionality. One other main topic is devoted to the 'Reaction and Resistance to Fire'. It develops new halogen-free formulations that do not evolve toxic and corrosive smoke in the conditions of fire. The team has many industrial partners and is strongly concerned in exploitation of results (patents).

Staff members of high level and high potential:

Patrick Cordier : PR, 49 years old, h-index: 21, 100 publications, citation index: 1800, Past president of the french Mineralogical Society, Fellow of the Mineralogical Society of America.

Serge Bourbigot: PR at ENSCL, 46 years old, h-index=31, 220 publications (including chapter in books), number of citations=2900, invited Professor at the University of Hefei (China) for 3 years (2010 – 2012)

Sébastien Merkel: PR, 36 years old, h-index=15, 31 publications, number of citations = 600, awards, prizes: Outstanding student award, American Geophysical Union, Mineral and Rock Physics Focus Group, 2002. High International experience (total 7 years): Carnegie Institution of Washington, University of Tokyo - Japan, University of California - Berkeley, USA

The **activities report** of the laboratory was presented at the last AERES evaluation in January 2009. The **publication rate** is about 100 publications per year for about 41 full time researchers. Full and selected lists of publications are given in the annex 7.2 for researchers of UMET involved in SYMMECOM.

The UMET laboratory is involved in number of research programs on former and ongoing projects at the national and European levels (ANR, FUI, Interreg IV, FP7). Without being exhaustive, we can mention the Interreg IV IDEA (on pharmaceutics materials, 2010 – 2013), Interreg IV Nanolac (on fire resistant biopolymers, 2008-2012). Number of ANR projects are in direct relation with SYMMECOM, for instance the ANR Blanche Internationale with China "ARCHIFLAME" (fire resistance 2011-2014), two ANR « Dislocations under pressure » (2008-2011) - « Mantle Rheology » (2009-2012) and ANR JC Electrotunepoly (2009-2012).

Private collaborations have been agreed between different industries: Akzo Nobel (UK), Lanxess (Germany), BASF (Germany), Hunstman (Belgium), Schneider Electric, Sanofi Aventis, Astra-Zeneca, Ets Roquette Frères, EDF, CEA.

Equipements : The major equipments of the laboratory are those of the federation Chevreul (see the description in the corresponding section, partner 7). Indeed, these facilities are now shared through common analytical platforms at different laboratories. The laboratory is strongly involved in the electron microscopy platform, the instruments (TEMs, SEMs) are all gathered in its building. Staff of the laboratory is responsible for the management and maintenance of instruments. The laboratory deposited an EQUIPEX project about electron microscopy (project META, headed Paul Raterron). The project aims to develop the analytical and environmental transmission electron microscopy.

4.1.2.2 VALORISATION / EXPLOITATION OF RESULTS

The UMET laboratory did not have its own research exploitation structure. The laboratory uses the facilities of the University-PRES and occasionally those of the CNRS. The structure of the research exploitation department and its results are given in the section “partner 1”. The results (patents) obtained by the laboratory are given in annexe 7.1 for the recent period.

4.1.2.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

Members of UMET are involved in the doctoral school Sciences de la Matière du Rayonnement et de l'Environnement (SMRE) of the PRES ULNF.

P. Cordier (Prof), leader of the PM group of UMET is responsible of the Materials option (M2 spécialité Matériaux) of the second year of the Master of Physics of the university. This option gathers between ten and fifteen students per year and proposes general materials science (physics of polymers, metals, minerals) courses with the possibility of specialization in the area of materials for the nuclear industry and materials for pharmaceutics applications. **M. Bacquet** (Prof), member of the ISP group of UMET, is responsible of the Polymers option (M2 spécialité Ingéniérie des Systèmes Polymères) of the master of Chemistry of the university. This master gives solid tools to ten to fifteen students per year to create and characterize functional polymers and composites for packaging, health cosmetics and environment applications. Both masters provide a substantial number of students (between five to ten per year) that perform doctoral studies at UMET. These two master degrees have been marked A by the AERES.

Besides these master degrees, members of UMET participate actively in the Materials Science Department of Polytech'Lille, an engineer school of University Lille 1 (more than 70% of the

educational staff of the department belongs to UMET, including the directors of the department between 2002 and 2010 Prof G. Reumont and A. Legris). The MS Department graduates around thirty engineers per year and 5 to 15 % may pursue their studies with a PhD, often in the UMET laboratory. Various members of UMET have important responsibilities at the ENSCL - Ecole Nationale Supérieure de Chimie de Lille (Pr, S. Bourbigot, Research Director, Prof; J.B. Vogt responsible of the materials option of the second and third year of the engineer training). Around eighty engineers are graduated at the ENSCL each year and the Material option attracts twenty students a year. Two or three graduate students a year perform a PhD in UMET.

4.1.2.4 ORGANISATION / ORGANISATION

UMET is a member of the research federation Michel-Eugène Chevreul, the heart of the SYMMECOM project. Chevreul is a research institute of University Lille 1 which is member of the PRES ULNF. The CNRS is also partner of the laboratory leading to a double laboratory management. UMET is also associated with the engineering school ENSCL. The governance of UMET is based on a management board (Director, A. Legris and vice-director, H Leroux) for the day to day life of the laboratory. The laboratory has a scientific committee composed by members of research teams and responsible for the management of research actions.

4.1.3 PARTENAIRE 3/ PARTNER 3 : UNITE DE CATALYSE ET CHIMIE DU SOLIDE

4.1.3.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

UCCS Catalysis and Solid-State Chemistry Unit.

The **research activities of the UCCS** are oriented towards **Energy and Sustainable Development**, with strong expertise in **solid-state chemistry and homogeneous/heterogeneous catalysis**. Our research projects are involved in the fields of biomass valorisation, green chemistry, fine chemistry, vegetal chemistry, pollution treatment, new and clean fuels, nuclear fuels and wastes, fuel cells and high-temperature electrolysers.

The UCCS is organized into 3 research departments that include 13 project-teams. Its particularity is to develop an integrated approach of the scientific objectives, viz:

i) the synthesis of molecular and iono-covalent compounds with tailored properties, including supramolecular catalysts, organometallic catalysts, nanostructured catalysts, organic intermediates, ionic conducting ceramics, self-healing glasses, magnetic ceramics, ferroelectric thin-films;

ii) the development of advanced characterization methods such as Solid-State NMR, XRD, AFM, XPS. Most of these methods are used in *Operando* or *in situ* mode, and are completed by *ab-initio* calculations;
iii) the implementation and characterization of catalytic processes with applications in the fields of pollution treatment, production of new fuels and biomass valorisation. These processes are developed from lab to semi-pilot scales.
The UCCS is composed of **127 permanent members** and *ca.* **90 contractual staff** (PhD, Post-doc). The UCCS produces each year *ca.* **145 publications in peer-reviewed international journals**, and its skills are recognized through numerous collaborations with industrial and academic partners in France and abroad. The UCCS was **rated "A" by the AERES in 2009, as well as its 3 research departments (Solid-state chemistry, Heterogeneous chemistry, Catalysis and molecular chemistry)**.

The AERES report can be downloaded via the following link.
http://www.aeres-evaluation.fr/content/download/11452/170861/file/EVAL-0593559Y-S2100012107-UR-RAPPORT.pdf

The UCCS research activities are funded by public institutions, including the European Community (FEDER, PCRD6, PCRD7), the Agence Nationale de la Recherche (ANR), the Région Nord-Pas de Calais, the Ademe, as well as by research contracts with companies (Total, IFP, Air-liquide, Arkema, Adisseo, Axens, Rhodia, Oril, Cellial, Lvm sa, Roquette, Sanofi-Aventis, Snecma, Messier-Bugatti, Bruker, PSA, Areva, CEA, EDF,…). The UCCS is currently involved in 18 ANR projects and is the coordinator of 14 of them.
It is also the coordinator of the PCRD7 European Programme EuroBioRef *'EUROpean Multilevel Integrated BIOREFinery Design for Sustainable Biomass Processing'*, gathering 28 partners of 14 different nationalities for a global budget of 38 M€ (23 M€ of subvention) during 4 years (01/03/2010 - 29/02/2014; Coordinator: F. Dumeignil).
In terms of **international collaborations**, in addition to the EUROBIOREF programme, the UCCS is currently involved in **2 INTERREG** programs with Belgium dealing with reduction of air pollutants, **1 ECOS-Sud** action with the University La Plata, Argentine dealing with catalyst for fuel desulfuration, **1 ECOS-Nord** action with The University of Bogota, Colombie, dealing with the oxidation of VOC, **1 PHC** program with the University of St-Andrews on fuel cells, **2 IFCPAR exchange programs with India** dealing with the glass sealing for SOFC, and catalyst for the oxidation of VOC. The UCCS is also involved in networking actions such as: The **International associated Laboratory UCCS/NCL/Pune (Inde)** « *Catalysis for Sustainable and Environmental Chemistry* » 2009 – 2013, the IDECAT Excellence Network, 2006-2010 « *Integrated Design of Catalyst Nanomaterials for a Sustainable Production* », The **International French-Polish research group** « *Catalysis for environment : Depollution, Renewable, Energy and Clean Fuels* » 2007-2010, The **International Research France/Japan** group on « *Environmental Catalysis for Sustaining Clean Air and Water – ECSAW* » France/Japon 2008-2011, The **French-Chinese LIA**.

Researchers of high level and high potential

Among the researchers of high level and high potential at UCCS, one can mentioned:

- **Thierry Loiseau**, DR CNRS, 42 years old, who joined the CS department in April 2009, with a h index of 31 and 122 papers published in international journals with more than 4500 citations, he was awarded the SCF "division Chimie du Solide" price in 2007. At UCCS, he will develop a new project on the preparation of carbides materials under inert atmosphere as new nuclear fuels.

- **Franck Dumeignil**, 38 years old, is actually professor at the University of Lille since 2006. He is among the researchers having a high potential, recently elected as Member of the Institut Universitaire de France. He is author and co-author of 42 papers. Franck Dumeignil is also the coordinator of the European contract 'Eurobioref' representing an overall budget at more than 23 Meuros for 28 academic and industrial partners.

Also promising in the CS department, but with a lower scores, are Olivier Mentré, DR CNRS, 44 years old, in charge of the Innovative oxides and derived phases team (h=14, 76 papers), Lionel Montagne, PR Lille 1, 46 years old, in charge of the glass and NMR methodology team (h=15, 82 papers, head of the UCCS), Rose-Noëlle Vannier, PR ENSCL, 44 years old, in charge of the Materials for energy group (h=21, 75 papers), she was awarded a Marie-Curie Fellowship at Imperial College in 2000-2001, and among the youngest, Houria Kabbour, 31 years old, h=8, 25 papers, specialised in simulation, Olivier Lafon, 30 years old, 30 papers, specialised in NMR methodology, Laurent Delevoye, 40 years old, 50 papers, specialised in NMR for materials characterisation, in charge of the NMR platform, Pascal Roussel, 39 years old, 101 papers, specialised in crystallography, in charge of the X-ray platform, Christophe Volkringer, 29 years old, 21 papers, specialised in the MOF preparation.

Regarding the CH department, Andréi Khodakov DR CNRS 45 years old is in charge of the Fischer-Tropsch synthesis. He is especially involved in operando spectroscopic measurements using the synchrotron radiation (h = 21, 75 papers). Pascal Granger, 46 years old is the actual manager of the CH department. He is author and co-author of 70 papers (h = 14) dealing with environmental catalysis and kinetics of heterogeneous reactions. Sylvain Cristol, 38 years old recently promoted as Professor is involved in operando spectroscopic measurements and molecular modelling. He is author and co-author of 32 publication in international journal (h = 12) Among, the youngest researchers recently recruited, Jean-Philippe Dacquin and Simon Desset 28 and 30 years old involved respectively in the synthesis of mesoporous materials for environment catalysts and the development of novel supported ionic liquid catalysts for the biomass valorisation recently joined the UCCS.

In the CCM department, Eric Monflier, PR University of Artois, 44 years old, at the head of the Supramolecular Catalysis team (h=24, 113 papers), Francine Agbossou-Niedercorn, DR CNRS, (h=23, 77 papers), at the head of the Catalysis and Molecular Chemistry department and Catalysis, Chirality and Fine Chemistry team, Sébastien Tilloy, PR University Artois, (h=20, 49 papers) specialized in biphasic catalysis, Marc Visseaux, PR Lille 1 (h=18, 57 papers), 45 years old, responsible of the Polymerization Catalysis team, Régis Gauvin, CR CNRS, 38 years old (25 papers) specialized in supported catalysis, Christophe Michon, CR CNRS (employed 2009), 36 years old (17 papers) specialized in organometallic chemistry and catalysis, Mathieu Sauthier, associate professor Lille 1, 36 years old (23 papers) specialized in carbon monoxide chemistry.

Equipment and infrastructure

In terms of equipment, the UCCS relies on the platforms of the Foundation Chevreul. It is notably in charge of:
- the X-ray platform, headed by Pascal Roussel, CR-CNRS, and Frédéric Capet, IR-CNRS, CS,
- the NMR platform, headed by Laurent Delevoye, CR-CNRS, CS department,
- the surface analysis platform, headed by Pascal Granger, PR-Lille 1, CH department.

The UCCS also applied for an equipex: the REALCAT and is involved in the META equipex, headed by Paul Raterron. UCCS also participates in the EQUIPEX project within the existing SOLEIL synchrotron facility for obtaining a new time-resolved X-ray absorption spectroscopy (XAS) beamline based on the quick-scanning energy principle, the so-called QuEXAFS. The ROCK beamline (ROCK being the acronym for Rocking Optics for Chemical Kinetics) is devoted to the study of fast kinetic processes in nanomaterials used in catalysis and batteries.

4.1.3.2 VALORISATION / EXPLOITATION OF RESULTS

The UCCS has a large set of collaborative activities with industry. 60% of its activity is funded by industrial contracts, more than 30 industrial contracts are conducted each year, and 40% of PhD theses are realized with industrial collaboration. Valorisation and patenting are done in collaboration with the CNRS and Lille 1. From 2007 to 2010, 6 patents were deposited by the UCCS.

4.1.3.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

Most of the academics at UCCS (83 teachers/researchers) belongs to University Lille 1, Artois University, Ecole Nationale Supérieure de Chimie and Ecole Centrale Lille.

The UCCS is linked to the Doctoral school Materials, Radiation and Environment Sciences (EDSMRE, ED104) and is involved in a few mater degrees:
- the master Chemistry, Energy and environment, headed by Pascal Granger, PR-Lille 1, supported by Lille 1, ENSCL, Artois and Mines de Douai.

- the Advanced Spectroscopy for Chemistry ERASMUS-MUNDUS master, headed by Sylvain Cristol, PR-Lille1. This master was set up by Jean-Pierre Wignacourt, PR-Lille 1. Lectures are given in English and about 10 people from Lille 1 and ENSCL are involved in the teaching.
- the Catalysis and Processes Master, headed by PR. Edmond Payen, PR-ENSCL, supported by the ENSCL, Centrale Lille and Centrale Paris.
- until 2010 The Organic and Macromolecular Chemistry master was headed by André Mortreux PR Lille1.

From 2002 to 2006, Rose-Noëlle Vannier (PR-ENSCL) and Nouria Fatah (PR-ENSCL) from 2006 have been the head of admissions at the ENSCL. They are both deeply involved in teaching in inorganic chemistry and chemical engineering, respectively.

In collaboration with industrial partners in the field of nuclear, UCCS with UMET are currently willing to introduce training on materials for nuclear application within a European framework. They are also involved in the creation of an ERAMSUS-MUNDUS master, focused on materials.

4.1.3.4 ORGANISATION / ORGANISATION

UCCS is a member of the research federation Chevreul which is the heart of the Labex project. It is partner of University Lille 1, The Artois University, the ENSCL, the Ecole Centrale and the CNRS. The governance at UCCS is based on a directory board composed of the Director, the two associated directors and the 3 head of departments, for day to day life in the unit. Main decisions are discussed by the scientific committee which gathers at least once a month, composed by all research teams leaders and members of the directory board. Decisions are taken by the laboratory committee, composed of elected and nominated members of the unit.

4.1.4 PARTENAIRE 4/ PARTNER 4 : LABORATOIRE DE SPECTROCHIMIE INFRAROUGE ET RAMAN

4.1.4.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

The LASIR (Laboratoire de Spectrochimie Infrarouge et Raman) is a joint research unit of CNRS and University of Lille 1 (UMR 8516) primarily related to the Institute of Chemistry and secondarily at the Institute of Ecology and Environment of CNRS. It is one of the three pillars of the UMR Research Federation Michel Eugene Chevreul (FR 2638). The laboratory is located mainly on the scientific campus of Villeneuve d'Ascq and also has an office in the Faculty of Pharmacy, University Lille 2. The LASIR initially developed his skills in the field of vibrational spectroscopies (Raman, infrared absorption, neutron scattering) and associated

instrumentation. Today the laboratory's expertise has greatly expanded and also covers electronic spectroscopies (UV-visible absorption, fluorescence), NMR and EPR. The main application field of the laboratory is Chemical Physics. All the research activities of LASIR are developed in two research teams: "photoreactivity and dynamics in condensed phase" and "Spectrochemistry in complex environments." A joint support of research involving common spectroscopic facilities, design offices, workshops and administration assists research teams. The laboratory human resources include 45 permanent people, almost equally divided among CNRS staff (12 researchers, 9 ITA) and Higher Education (18 Teacher-Researchers, 6 BIATOS). It is built around two research teams that have been rated A by AERES.

Staff members of high level and high potential:

Olivier Poizat, 55 ans, DR2, 84 publications, h-index=16
Cyril Ruckebusch, 38 ans, MCF, 36 publications, h-index = 12
Michel Sliwa, 33 ans, CR2, 39 publications, h-index = 11
Hervé Vezin, 44 ans, DR2, 105 publications, h-index = 22

The team "*Photoréactivité et Dynamique en phase condenseé*" involved in SYMMECOM is centered on the photoreactivity around three main thematic axes:

- photoreactivity of new organic photoswitchable molecular materials.
- photoreactivity in nanoporous matrix.
- Basic photoreactivity of hydroxylated compounds.

Besides these main lines, a specific action developed in partnership with Hollyday Pigments is focused on the development of a new, completely clean synthetic route of ultramarine pigments. Taken together, these research axes aim to elucidate the reaction pathways and real-time characterization of the structure and dynamics of the reaction intermediates involved. Our effort is focused on determining the structural and physicochemical factors that contribute to the responsiveness of the systems studied. Although characterized by a rather fundamental approach, these projects have, overall, the ambition to turn more toward the understanding of functionality of chemical systems developed for specific applications. This commitment is manifested in certain aspects of the ambitious and innovative program strongly focused on the reactivity scale of the material (eg. photoswitchable fluorescence materials for opto-electronics, photovoltaics, nanosensors).
The research program is built on the recognized expertise of the team regarding the original techniques of ultrafast time-resolved spectroscopy combining pulsed laser excitation and transient UV-visible and Raman detection (pump-probe method). It implies also the development of new techniques such as femtosecond IR absorption whose implementation is nearing completion, time-resolved EPR and NMR, and original transient spectroscopic methods such as "pump-pump-probe". The elaboration of new analytical tools based on chemometrics for the processing of complex spectro-kinetic data, already initiated in LASIR,

will be reinforced and more systematically associated with experimental time-resolved spectroscopic measurements for a more reliable and rigorous analysis of the data. Finally, the interpretation of experimental data is supported by the approach of molecular modeling using sophisticated methods of calculation from molecular dynamics and quantum chemistry. The team is running 8 ANR projects and is involved in many PHC and Marie Curie international exchange programs. It also runs a PIR CNRS program and has collaborations with industrial partners.
LASIR gathers CNRS staff and academics involved in teaching, the average production is 40 journal papers in peer reviews per year and about 6 invited conference a year.

Equipements : See partners Chevreul

4.1.4.2 VALORISATION / EXPLOITATION OF RESULTS

Exploitation of results and patenting are done in collaboration with the CNRS and Lille 1.

4.1.4.3 ORGANISATION / ORGANISATION

The governance is based on a directory board composed of the Director and vice-director for day to day life in the unit. Main decisions are discussed by the scientific committee composed by all research team leaders and members of the directory board..

4.1.5 PARTENAIRE 5/ PARTNER 5 : MINIATURIZATION FOR SYNTHESIS, ANALYSIS AND PROTEOMICS

4.1.5.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

MSAP (Miniaturization for Synthesis, Analysis and Proteomics) is a joint Service and Research Unit (USR 3290) between the CNRS and the Université de Lille 1, Sciences and Technologies created for four years in January 2010. The Unit was evaluated as a team in the aborted project fusion between the former LCOM UMR CNRS 8009 (Organic and Macromolecular Chemistry Laboratory) and the LASIR (UMR 8516) (see http://www.aeres-evaluation.fr/content/download/11453/170868/file/EVAL-0593559Y-S2100012109-UR-RAPPORT.pdf). The team was rated A on the overal (with A grades for science production, organization and A+ grade for the research project). After the AERES committee CNRS and USTL decided that the best solution was to create an independent structure, shared between Chemistry (Institut Chevreul) and Biology Institutes (IFR 147) of the USTL emphasing the service part of the team. MSAP is a pretty small structure (1DR, 2 MCF, 1 Pr, 4.5 Engineers and technicians) which is organized in three teams:

- Proteomics (research activities), headed by Dr Caroline TOKARSKI
- Microfluidics, surface chemistry and reactivity, headed by Dr Maël PENHOAT

- Proteomics methodological developments and service, headed by Dr Christian Rolando

The strength of the Unit is the interplay between organic chemistry whose aim is to create new molecules or devices for the proteomics team, to bring its expertise in micro/nanofluidics, for the analytical team and to handle small quantities for the synthesis team.

Staff members of high level and high potential:
Christian ROLANDO, 56 years old, 150 papers, 2250 citations (without self-citations), h_{Index} = 29, Deputy director of the CNRS Institute of Chemistry, in charge of Platforms and Research infrastructures, President of the Analytical Division of the French Chemical Society (Société Chimique de France)
Maël PENHOAT, 32 years old, 15 papers, 300 citations, h_{Index} = 9

Publications: See reference liste in section 7.2

Equipements: MSAP (Miniaturization for Synthesis, Analysis and Proteomics) is participating in many contracts both public and private :

- IBISA label and contract for the Proteomics Platform (head Christian ROLANDO), « Open » ANR FT-ICR 2D (2010-2013, head Christian ROLANDO), « Young researcher » ANR Proteomics for Art (2009-2011, head Caroline TOKARSKI)
- OSEO Safe synthesis of polymerisation catalyst in microreactors (2009-2010, head Maël PENHOAT), Ph D student grant and Research contract by the Etablissement Français du Sang Nord de France, Post-doc grant and Research contract by Biosynthech company an SME involved in « safer smoking »,

4.1.5.2 VALORISATION / EXPLOITATION OF RESULTS

Valorisation and patenting are done in collaboration with the CNRS and University Lille 1. From 2007 to 2010, 3 patents from MSAP were granted in foreign countries.

4.1.5.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

Pr Didier BARBRY head of the USR 3290, MSAP created a new Master (Master 1 and 2) dedicated to Organic Chemistry and Biology which started in September 2010 involving the Universities Lille1, Lille 2, Artois and the ENSCL. More than 30 students choose this Master 1 this year. The Master includes two specialities for the second year Organic chemistry (headed by Pr Didier BARBRY) and Bioanalytical Chemistry (headed by Caroline

TOKARSKI) attended respectively by 15 and 10 students. MSAP has strong tradition to form PhD students. On the average they are 5 PhD students in the Unit.

4.1.5.4 ORGANISATION / ORGANISATION

MSAP is a Service and Research Unit belonging both to the Chemistry and Biology Instititutes of University Lille 1. MSAP is the main partner of the Proteomics platfom which has the IbiSA label.

4.1.6 PARTENAIRE 6/ PARTNER 6 : MOLECULAR CHEMISTRY AND FORMULATION

4.1.6.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

The EA-4478 "Molecular Chemistry and Formulation", consisting of 15 researchers – teachers, 1 CNRS researcher and 14 PhD/post-doc, focuses its research activity on organic chemistry and colloidal chemistry, within the Federation Chevreul. It includes three teams with recognized expertise in their respective fields: "**Methodological developments in synthesis and applications**" (A. Couture) develops new concepts for the assembling of structurally complex molecules emphasized by the synthesis of natural or bioactive synthetic products. "**Organic and Medicinal Chemistry**" (P. Cotelle) designs heterocyclic or phenolic molecules with biological activity. "**Oxidation and physical chemistry of formulation**" (J.M. Aubry) studies new catalytic oxidizing systems and forge conceptual tools applicable to formulation chemistry

Only the 3rd team, graded A in the AERES evaluation [http://www.aeres-evaluation.fr/content/download/11455/170882/file/EVAL-0593559Y-S2100012108-UR-RAPPORT.pdf], participates in the SYMMECOM project by bringing its expertise in designing non-conventional reaction media (water, triphasic oxidizing microemulsions, catalytic Pickering emulsions) and in the use of activated forms of oxygen (H_2O_2, organic peroxides, peroxometallates, singlet oxygen) to oxidize selectively various organic substrates.

The team has for a long time experience in the formulation of oxidizing monophasic microemulsions [JACS **1997** 5286, JACS **2004** 10692]. Recently, it has developed a new concept, based on "balanced catalytic surfactant" leading to water/microemulsion/solvent systems [JACS **2008** 14914]. Such three-phase systems combine the advantages of phase transfer catalysis (ease of formulation, processing and work-up) and of microemulsions (huge water/solvent interface, compartmentalization of reactants). As part of an ANR project (CATASURF) starting in 2010, with our group as the leader, we seek to extend this concept to oxidation catalysts belonging to the family of POMs (polyoxometalates). SYMMECOM will be an opportunity to generalize this concept to other catalytic reactions mastered by other teams involved in the project. One of the challenges is to apply the concept to catalytic reactions involving ground state oxygen ($^3O_2$) as an oxidant instead of H_2O_2 or ROOH.

Staff members of high level and high potential:
Jean-Marie Aubry : 58 years-old, h-index: 20, 136 publications, citation index: 1500, Past-president of the French Formulation Group, Member of the CNU 32nd section, Founder of the Master, both vocational and research dedicated, in "Formulation Chemistry and Engineering" graded A+ in the AERES evaluation.

Publications: The activities report of the EA-4478 was presented at the last AERES evaluation in January 2009. The publication rate is about 20 by year (the laboratory has 15 R-T and 1 CNRS corresponding to **8.5 full time researchers**). The full list of the publications is given in the annex 7.2 for researchers of the EA involved in the Labex project (7 R-T).

The EA-4478 is involved in several research programs on former and ongoing projects at the national and European levels (2 ANR, 1 FUI, 1 PICS).

ANR Catasurf (2010-2013), ANR InBioSynSolv (2010-2013),
FUI Delta3 (2010-2013)
PICS with the University of Regensburg (2007-2010)

Private collaborations have been agreed between different industries: Givaudan China (Shanghai Chine – 2005-2008), International Flavors & Fragrances (New Jersey, USA – 2006-2013), Anios (Hellemes, France – 2006-2010), Roquette (Lestrem, France – 2006-2010), Arkema (Colombes, France – 2008-2009), Unilever (Port Sunlight, France – 2008-2013). ARD (Pomacle, France – 2008-2011).

Equipements: The major equipments of the laboratory are related to our work in oxidation (flash photolysis and ultra sensitive IR-luminescence detector for singlet oxygen) and in colloidal chemistry (4 different types of tensiometers, DLS, zetameter, rheometer).

4.1.6.2 VALORISATION / EXPLOITATION OF RESULTS

Valorisation and patenting are done in collaboration with Lille 1.

4.1.6.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

The team « Oxidation and Formulation Science » founded 20 years ago a master M2 both vocational and research dedicated, in "Formulation Chemistry and Engineering" (co-authorized Univ. Lille 1 - ENSCL). It has the distinctive feature to be the centre of a national (Paris, Rennes, Mulhouse, Rouen, Lyon) and an international (Merida, Regensburg, Barcelone, Potsdam, Cologne) network of academic partners. Students acquire a solid and transverse background in interfacial physical chemistry required to understand and

characterize complex mixtures found in the various fields of formulation (cosmetics, detergents, paints, food…). It has been graded A+ in the AERES evaluation.

4.1.6.4 ORGANISATION / ORGANISATION

The management of the team is done by J. M. Aubry for the day to day life of the laboratory. He is member of the Executive Board of Chevreul federation (see partner #7).

4.1.7 PARTENAIRE 7/ PARTNER 7 : MICHEL EUGENE CHEVREUL FEDERATION

4.1.7.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

Chevreul Institute federates research and innovation efforts in the field of chemistry and materials science at University Lille 1, with the ambition to become a center of excellence in the euro-region. In the context of CPER 2007-2013, it operates the project "Chemistry and Materials for a Sustainable Development". Research is conducted by over 400 collaborators including 220 lecturers and researchers. Multidisciplinary programs under concern are at the heart of the key priorities at National and European levels, comprising - Solid-state chemistry, metallurgy and materials under complex environments - Biomass valorization, cleaner processes and products - Functional materials - The perimeter of Chevreul Institute relates to the partner laboratories 2 - 6. It supports mutualized platforms of advanced characterization, from molecules to materials, and provides financial support to emerging interdisciplinary research projects carried by young researchers. Chevreul Institute is fully engaged in industrial collaboration, with specific support to competitiveness clusters, and apart from contributing to the SYMMECOM project, it takes part in the IEED project IFMAS (French institute for agro-based materials).

Analytical plateform overview :

The Chevreul Institute ensures the share of major analytical equipments. It manages a coherent set of seven analytical Platforms:

- Nuclear Magnetic Resonance (Head: Laurent Delevoye)
- X-Ray Diffraction (Head: Pascal ROUSSEL)
- Electron spin resonance (Head: Hervé VEZIN)
- Mass Spectrometry (Head: Christian ROLANDO, Caroline TOKARSKI)
- Electron Microscopy (Head: Paul RATERRON)
- Infrared and Raman Spectroscopy (Head: Guy BUNTINX)
- Surface analysis (Head: Pascal GRANGER).

These platforms represent a total investment of 27 million euros over ten years and an average investment of over $ 2.5 million per year. These facilities pooled within the Chevreul

Institute (FR 2998) are operated by 20 highly qualified level engineers, who are specialized in an analytical field. The very high quality of the platforms recognized nationally is materialized by the national labels of four of them:

- TGIR (Very Large Research Infrastructure) as part of the "Roadmap" of the Ministry of Research for NMR spectrometers 800 and 900 MHz.
- TGE (Very large equipment) CNRS spectrometer FT-MS and label IBISA Platform for Proteomics
- TGE (Very large equipment) called RENARD (REseau NAtional de Rpe interDisciplinaire) : FT-EPR and Imaging spectrometers
- National equipment for the CNRS-INSU Microscopy plateform.

These platforms have several original characteristics: firstly, all the techniques of analysis are recovered encountered in chemistry, organic chemistry to solid until (through) surface, leading the Chevreul Institute as a preferred structure in conducting interdisciplinary research. These cross-over fields of researches are also found in each Platform: Nuclear Magnetic Resonance comprises both liquid and solid NMR. The mass spectrometry platform is managed jointly with the Institute of biology (IFR 147), and its activities are shared between chemistry and biology. Moreover, cross-over between the platforms of NMR and EPR are presents in joint action toward Dynamic Nuclear Polarization development, for which individual skills is required. Secondly, in each platform a dual activity is represented:

(i) methodological development activity in their own disciplines
(ii) advanced characterization, often combining several techniques combined with modelling and theoretical quantum calculations.

Summary sheet describing each plateform is presented in Annex 7.2, along with a brief description of the activities of methodological development and finally, some examples of advanced characterization.

Short summary of each platform managed by the Chevreul federation.

Nuclear Magnetic Resonance

The NMR platform of the Chevreul institute is composed of 7 NMR superconducting magnets ranging from 21.15 T (900 MHz proton Larmor frequency) to 2.35 T (100 MHz). This state to the art platform relies on the scientific knowledge and expertise of multidisciplinary research groups located within the institute, working with vertical integration from the development of new methods to the NMR applications in the frame of industrial collaborations. The variety of the magnetic fields, associated with a large choice of probeheads, from double to triple resonance, is one of the major advantages given by our platform providing the means to investigate most nuclei. This equipment is available on site in Lille, allowing innovative investigations in addition to our knowhow at very high fields. Through our methodological approach, we take advantage of the unique specificity of solid-state NMR to reveal the connectivities and the proximities in solids, through the use of two-

dimensional correlation experiments. The variety of research projects includes: quadrupolar and low-gamma nuclei, dynamic nuclear polarization, glasses and amorphous materials with applications in catalysis, solid chemistry, and industry. The NMR platform in Lille is also known at national and international level through its implication in the national Very Large Research Infrastructure.

X-ray Diffraction

The X-Rays technical platform is composed of 2 diffractometers for single-crystals structural characterisation, 8 diffractometers dedicated to polycrystalline materials and finally an equipment for SAXS and WAXS investigations. The different features of those equipments provide a large range of possible studies: structural investigation can be done on single-crystals, powder, massive compounds and thin films under several gaseous atmospheres at room, high or low temperatures. Some apparatus are equipped with high power X-rays sources: μ-sources for small single crystals (~100μm) and for SAXS experiments; a rotating anode generator (9kW) for high resolution, small amount of powder or thin films analysis. Thanks to this state-of-the-art equipment, it is possible to study crystal structure resolution on organic and inorganic samples, phase transitions, compounds behavior under reactive atmosphere, structural analysis on thin films, in-plane diffraction, reflectivity, pole figures, reciprocal space mapping, residual stress, texture etc… All those possibilities lead to national, international, academic and industrial collaborations.

Electron spin resonance

The activity of RPE platform is mainly devoted to the chemistry of materials and to characterize the paramagnetic centers both structurally and in terms of spatial distribution of radicals by the methods of imaging resolution of micrometer scale. These advanced techniques allow to measure precisely the nuclear environment of these centers, but thanks to the distance measurements between paramagnetic centers to trace the local order and the radicals in nanostructuring materials. The platform which is supported by Chevreul Institute is equipped with three spectrometers (E500 and E580 ELEXYS ESP300 equipped with pulsed gradient for imaging continuous) and is labeled at the national level TGE INC-CNRS.

Mass Spectrometry

Well before the so-called "proteomics" period, the Lille campus has been an historical place for the characterisation and the isolation by mass spectrometry of peptides, proteins and carbohydrates in biological samples but also of bio-sourced polymers and has a strong tradition in advanced mass spectrometry instrumentation. For instance, a 4-sector instrument with FAB source was implemented at the USTL in 1986 and the first MALDI in France was acquired in 1992. The platform which is part of both the Biology Department (IFR 147) and of the Chemistry Department (FR CNRS 2638) works for more than 500 researchers and is equipped with a complete set of mass spectrometers dedicated for proteomics (MALDI TOF, TOF/TOF, nanoESI-Q-TOF, SELDI) but also for organic analysis. In 2006 the Christian

Rolando team acquired a Bruker 9.4 FT-ICR instrument which is used mainly for the study of post-translational modifications, quantitation using stable isotope labelling and middle-down proteomics and is now entering the metabolomics field. The Christian Rolando team works with several academic teams from the Lille area but also from all France, health agencies like the French Blood Agency, SMEs and private companies.

Electron microscopy:
The « Centre Commun de Microscopie » (http://umet.univ-lille1.fr/CCM) is dedicated to the micro-characterization of metal, glasses, ceramics, polymers, minerals, materials for catalysis and microelectronics, with a renowned expertise in quantitative nano-analysis and electron diffraction. It is equipped with two transmission electron microscopes (TEM, 200 and 300 kV), two scanning electron microscopes (SEM) and an electron probe microanalyser (EPMA). These equipments allow investigating materials at the micron and sub-micron scales: imaging to the atomic resolution, microstructural characterization by electron diffraction (EBSD, LACBED, Precession, etc.), and chemical nano-analyses using the associated spectroscopy (EDS, WDS, EELS, Cathodoluminescence). 3D contrast and compositional imaging is also provided (electron tomography). The facility is regularly used by 50 trained experts, including users from the private sector (ArcelorMittal, Saint-Gobain, Nexans, etc.). It is a TEM national facility for the French INSU-CNRS. The platform has deposited an EQUIPEX project "META" focused on analytical and environmental transmission electron microscopy.

Vibrational spectroscopy
The vibrational spectroscopy plateform is equipped with 5 FTIR spectrometers and 5 Raman microprobes. The spectral range of the IR spectrometers covers the near and the mid-infrared. They are equipped with various accessories which enable the analysis of sample under different physical and chemical phases. Time-resolved (ns-ms) and space-resolved (10 μm) experiments can be performed with these spectrometers. Raman microprobes are equipped with different lasers emitting from the UV to the infrared allowing to address resonance Raman spectroscopy or to avoid fluorescence straight light. Molecular cartography showing the location and amount of different components in heterogeneous samples with a spatial resolution of about 1 μm^2 can be routinely registered with these instruments. The main application of these techniques is molecular and structural characterization of compounds in the fields of chemistry, material science, biology, polymer science, microelectronics, geology, art… Beside the vibrational platforms, the LASIR is also equipped with time-resolved spectroscopic facilities ranging from ns to fs time-scale. Time-resolved Infrared, Raman and UV-vis spectroscopies can be applied to characterize short-lived species (excited state, reactive intermediates) during photo and thermo activated reactions.

Surface analysis

The "Pole Régional d'Analyse de Surface" is dedicated to surface analysis of solid materials for various industrial and academic applications such as metallic corrosion, polymers, heterogeneous catalysis, health, lubricant, optics, microelectronics… This platform is composed of three coupled XPS/LEIS/Tof-SIMS spectrometers. Their specificity is to provide complementary information relative to the electronic structure of individual atoms and their local chemical environment at the topmost surface and in a depth of 5-10 nm. Surface and depth profile concentration is useful for explaining the specific functions of materials and their sensitivity under reactive atmosphere. *In situ* thermal treatments under controlled reactive atmosphere can be achieved through an operative cell which can be heated up to 800°C which widen the panel of applications and potential national and international partnerships (AREVA, Arkema, TOTAL, Arcelor MITTAL, Umicore, Johson Mathey,..). This platform is supported by the Institute IRENI (GIS CNRS) and Chevreul Féderation.

4.1.7.2 VALORISATION / EXPLOITATION OF RESULTS

See partners 2-6

4.1.7.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

See partners 2-6

4.1.7.4 ORGANISATION / ORGANISATION

Chevreul Institute is ruled under the supervision of a director, with an executive board which gathers all laboratory directors of the federative structure.

4.1.8 PARTENAIRE 8/ PARTNER 8 : LABORATOIRE DE MECANIQUE DE LILLE

4.1.8.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

The Lille Laboratory of Mechanics (LML – UMR 8107) is a research unit common to CNRS, University Lille 1, Ecole Centrale de Lille and ENSAM which AERES global rank is A. There are more than 60 permanent researchers, 15 people in the technical staff and more than 60 PhD students. The LML addresses fluid mechanics as well as mechanics of materials with 5 specific research topics : (i) Complex fluids and interactions (AERES Rank : A) , (ii) Rotating and turbulent flows (A), (iii) Deformation, damage and fatigue micromechanisms (A), (iv) Thermo-hydromechanical and chemical (THM-C) coupling (A+) and (v) Braking, contact, surfaces (A). In all these domains, the laboratory conducts research on theoretical, numerical

and experimental topics. This multidisciplinary panel is one of its originality in France. Some specific experimental equipments have to be mentioned: many multiaxial test set-ups (tension-compression-torsion tests in small and large strains, plane biaxial loadings for large strains, real 3D test on geomaterials and metallic structures, etc), a braking tribometer, a large wind tunnel for boundary layer, a series of original home-made set-ups for specific measurements (kinematic and thermal full-fields, permeability, 3D flow rate fields, etc) and for material characterization in coupled THM-C conditions. These equipments are mostly dedicated to the study of multiscale and multiphysics phenomena as well as complex topics as turbulence, cavitation, non-newtonian fluids or durability.

Two teams are partially involved in the Labex project. They are "deformation, damage and fatigue micromechanisms"(AERES rank = A) and "ER4: THM-C coupling" (AERES rank = A+).

The "deformation, damage and fatigue micromechanisms" team is composed of 15 permanent staff members. The research topics of this team cover experimental investigation, theoretical and numerical modelling of deformation and damage micromechanisms, in particular in fatigue. Two main research topics are developed: relations between microstructure and mechanical properties and identification and modelling of the micromechanisms. Polymers, composites and metallic materials are mainly addressed. Some key features are: the development of multiaxial tests (biaxial plane loadings with high displacements, tension-compression-torsion tests with internal pressure) associated with finest full-field measurements techniques; the analysis of the dissipative phenomena due to irreversibilities at all the scales (from macroscopic to microscopic ones) with the coupling of kinematic and thermal measurements; and the theoretical analysis of asymptotic cyclic regimes. This team is developing scientific collaborations with national and international academic partners (1 ANR) and industrial partners (MICHELIN, PSA, THALES etc.). The publication rate of the team is about 15-20 publication per years (annexe 7.2).

The "THM-C coupling" team is composed of 11 permanent staff members. The research topics of this team cover experimental investigation, theoretical and numerical modelling of thermo-hydromechanical and chemical (THM-C) coupling phenomena in various engineering materials (cement based, clay-based, materials of energy). Three main research topics are developed: multi-scale approaches for laboratory characterization and theoretical modelling; multi-scale modelling of THM-C coupling; numerical modelling of heterogeneous materials and structures in complex conditions. The team has developed high level expertise in experimental characterization of microstructure evolution due to coupled loading and chemical degradation (micro tomography, micro and nano-indentation etc.), experimental identification of mechanical, poromechanical and chemo-mechanical properties, theoretical and numerical development in multi-scale modelling using linear and non linear homogenization techniques, numerical computing algorithms for coupled

processes and structure durability analysis. This team is conducting and participating in a number of national (5 ANR projects) and European research projects (1 EU project). This team is developing scientific collaborations with national and international academic partners and industrial partners (TOTAL, ANDRA, EDF, DGA, CEA etc.). The publication rate of the team is about 15-20 publication per years (annexe 7.2).

4.1.8.2 VALORISATION / EXPLOITATION OF RESULTS

The LML laboratory did not have its own research exploitation structure. The laboratory uses the facilities of the University-PRES and occasionally those of the CNRS.

4.1.8.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

Two masters are associated with the LML "Science mécanique et Ingénierie" and "genie civil". These formations are not concerned by the perimeter of the Labex project.

4.1.8.4 ORGANISATION / ORGANISATION

University Lille 1 and the Ecole Centrale de Lille, which are members of the PRES ULNF are partners of the LML, as well as an other engineering school (ENSAM) and the CNRS. The governance of UMET is based on a management board (Director, J.F. Shao and vice-directors, P. Dufrénoy and O. Coutier-Delgosha) for the day to day life of the laboratory. The laboratory has also a management committee and a council where peoplein charge of the 5 research teams are present.

4.1.9 PARTENAIRE 8/ PARTNER 8 : MATERIALS, PROCESSES, ENVIRONMENT

4.1.9.1 RECHERCHE ET INNOVATION / RESEARCH AND INNOVATION

The MPE (Materials, Processes, Environment) research unit of the Engineering College & Research Centre EMD (Ecole des Mines Douai) is composed of 121 people including 33 faculty members (among 62 permanent staff). It is organized in two teams, GCE (Civil and Environmental Engineering) and TPCIM (Polymers and Composites Technology & Mechanical Engineering), the TPCIM group being the only one involved in the Labex projet. The AERES ranking of the laboratory is A (www.aeres-evaluation.fr/..../11405/170532/file/EVAL-0590342B-S2100001832-UR-RAPPORT-1.pdf).
The research team TPCIM is composed of 19 faculty members (i.e. 9.5 full-time researchers) among 38 permanent staff members (for a total staff of 78 people including post-docs and PhD students). The publication rate is about 25 publications/year (see annex 7.2). The expertise area covers multi-disciplinary fields: materials science, processing science, physico-chemistry, solid and fluid mechanics, rheology, non destructive testing ... Its activities are

oriented towards the analysis of the polymers, polymer systems & structural polymer composites processing technologies, the related process-induced and -tailored properties, and their optimisation taking into account the specifications of different industrial sectors (transportation, energy, packaging, health/biomedical applications ...). Its scientific expertise on the above mentioned materials, based on an integrated approach material / process / structure / properties, covers:

• Formulation of polymer systems and related compounding/processing technologies; Rheology at melt and solid states in complex environment applied to dilute and concentrated suspensions; Structure / morphology / physical-chemical characterisation; Non-destructive evaluation of structural and physical properties based on acoustic emission, infrared thermography, ultrasonic measurement and coupling of these techniques; Characterisation of thermal, hydro-mechanical and saturation properties.

Modelling and numerical simulation (FEM, XFEM) of thermo-mechanical behaviours (including damage mechanisms) under complex loadings; Modelling of phenomena governing the processing; Numerical simulation of manufacturing processes based on multi-scale and multi-physics approaches (coupling of thermal, hydro-mechanical and saturation phenomena), using advanced numerical techniques (FEM, SSFEM, Meshless (SPH, FPM), C-NEM); Stochastic mechanics applied to processing technologies and behaviour of parts; Modelling and numerical simulation of heat and mass transfer in multi-scale porous media; Numerical, asymptotic and micro-poro-mechanical homogenisation.

The contribution of the TPCIM team of the MPE research unit in the work packages 2 and 6 actually corresponds, on the one hand to the decided orientation towards living matter sciences and health related issues (polymeric systems for biomedical applications and associated processing techniques), and on the other hand to the strengthening of the EMD expertise in understanding the relationship existing between polymeric materials, their processing technologies, the induced microstructures, and the resulting tailored end-use functional properties (experimental analysis, modeling, simulation). The above-mentioned strategic priorities have led the EMD to continuously invest in this area (permanent staff, buildings and heavy equipments) for many years so as to constitute a first-class platform dedicated to compounding/forming processes of advanced polymeric systems, unique in France. In particular, to develop the above-mentioned research topics, 7 new faculty members were appointed between 2006 and 2009 within the TPCIM team, and 10 M€ investment was decided over the period 2007-2013 to support the EXTREMOM (**EXT**ension du pôle de **RE**cherche sur la **M**ise en **O**euvre des **M**ulti-matériaux) structuring project carried by TPCIM. The TPCIM building extension up to 7500m^2 (new construction already finished in 2010 and completion of the rehabilitation of the oldest workshop forecasted in 2011) now allows hosting external local, domestic or foreign academics and industrial partners, so as to amplify the multi-field interactions that EMD wishes to promote in the frame of this Labex.

The expertise of the group has been built on former and ongoing projects at the national and European levels: FP6 SuperLightCar (2005-08) following FP5 Tecabs (2000-05), FP7 Infucomp (2009-13), FP7 Mapicc3D (2011-15), Interreg IV Navare (2008-12), Interreg IV Sensoplast (2009-13), Egide Balaton (2008-09) and number of ANR and FUI programmes. Private collaborations have been agreed with different industrial companies, supporting PhD programs: Arkema (2005-08, 2006-10), Dassault Aviation (2004-06, 2006-08), EADS and Airbus (2007-10), DGA (2008-11), Hutchinson (2002-08), Saint-Gobain Vetrotex International (2002-05), Nanocyl Belgium (2006-10), DSM The Netherlands (2004-08) … In addition, a dedicated permanent scientific collaboration agreement has been signed with ESI Group (2006, ongoing).

Equipements: Unique facilities over 7500m^2 are dedicated to the research activities of this group, including: **(i)** Processing workshop with instrumented processing machines for plastics and composites (compounding, injection, extrusion, extrusion blowing, film (co-)extrusion, rotational moulding, thermoforming, filament winding, automated fiber placement, liquid composite moulding, compression) at both a laboratory and industrial scale; **(ii)** Full-scale characterization workshop for industrial parts under short- or long-term static (creep) and/or dynamic (fatigue) mechanical loading (including multi-axial and internal pressure loading) in controlled environments (temperature, relative humidity); **(iii)** Materials characterization labs including devices for thermo-mechanical, rheological, physical, thermal, structural (microscopy), dimensional (3D, contactless), non destructive (ultrasound, acoustic emission, infrared) assessment; **(iv)** Computing lab with simulation codes covering different science fields (rheology, mechanics, heat transfer).

4.1.9.2 VALORISATION / EXPLOITATION OF RESULTS

The research exploitation structure of EMD (and thus of MPE/TPCIM) is ARMINES. ARMINES is a contract-based research association operating within the framework of French Law related to Research dated April, 8th, 2006 and linked by state-approved agreements to the CARNOT MINES Institute and to the Ecoles des Mines and in particular of EMD (engineer post graduate schools). ARMINES has a central team with skills and capacity dedicated to support the efforts of the Research Centers to built up and monitor research collaborative contracts, manage the intellectual property of the Research Centers and to organize technology transfers towards industry. ARMINES through the Ecoles des MINES has international relationships with academic organizations, universities and industrials worldwide and is also very active in the European Framework programs, coordinator of around 30 projects and partners to at least 180 projects. It detains a family of around 70 patents some of them being used under license by industrial partners and has generated a large range of innovation exploited by industry. It holds at least 10 major software some of which being distributed worldwide by its subsidiary TRANSVALOR or by industrial partners.

4.1.9.3 ENSEIGNEMENT SUPERIEUR / HIGHER EDUCATION

TPCIM group is directly in charge of the teaching programs of two majors (Mechanical Engineering IM, Polymers and Composites Technology TPC) of the GEM Graduate School (Douai Campus). The TPC major was created to meet the requirements of the French Federation of the Plastics Processing Industries, and was recently awarded the label of the MAUD competitiveness cluster. Besides, this group is also involved in the ISP (polymer systems engineering) joint master program (Lille 1/EMD/ENSCL) and in the Mechanical Engineering joint master program (Lille1/EMD). EMD was also recently accredited to co-deliver the PhD degree in two Doctoral Schools (ED104 SMRE and ED72 SPI).

4.1.9.4 ORGANISATION / ORGANISATION

The governance of MPE is based on a management board (1 Director, 3 vice-directors) for the day to day life of the laboratory. The Directors of its two research teams GCE and TPCIM are members of the Executive Board of Ecole des Mines de Douai (EMD).

4.2. COLLABORATIONS EXISTANTES / EXISTING COLLABORATIONS

The SYMMECOM partners come from a variety of disciplines (mostly from chemistry, physics and mechanics). They cooperate with each other for many years, as evidenced by a significant number of joint publications.

Since several years the Chevreul federation plays an important role in its perimeter (UMET, UCCS, LASIR, MSAP and MCF) in terms of incitation of collaborations. A number of projects have been initiated and funded by the federation. These projects have two goals (1) support to young researchers with the aim that the research project turns within the two years to the deposit of a project at the ANR (2) An early identification of potential emerging projects, which are not yet formalized enough to qualify them for a response to a call of formal national or European proposals. In both cases, the projects are multidisciplinary as widely promoted by the policy of the Chevreul federation. About 7-8 projects per year are supported. By way of illustration, the synthesis control of tuned nanoparticles (size and geometry) and the introduction of micro-/nano-fluidic technologies for controlling contact time of different reagents are two disciplines in a rapid phase development (UCCS/MSAP). This interdisciplinary project was initiated within the Chevreul Federation and latter supported by a common BDI CNRS-Région, thesis (2009-2012). It is worth noticing that the PhD student, involved in this project, obtained the 2010 “Best poster” award during the last JNOEJC Conference (Journées Nord Ouest Européennes des Jeunes Chercheurs), which is organized by the local SFC entities (Societé Chimique de France) from North and Normandy,

and dedicated to young researchers, mainly PhD students. A second example is a project between UCCS and MCF on the synthesis of new agro-based surfactants via telomerisation reactions with starch derived polyols and the evaluation of their physical-chemical properties which has also led to a PhD support. A third project which is currently running is dealing with "New polytopic receptors for aqueous catalysis (UCCS/UMET)", it aims to elaborate new mass transfer additives for aqueous organometallic catalysis. These mass transfer additives are synthesized by controlled polymerization of modified cyclodextrins and exhibit molecular recognition properties. More recently, it was decided to support new projects on the development of novel catalysts on the basis of new concepts related to ionic liquid in interaction with macro-mesoporous material (MCF/UCCS). This new project will be part of WP 4 in SYMMECOM. Strong partnerships also concern collaborative projects such as operando catalysis and EPR (UCCS/LASIR) – singulet oxygen photoluminescence (LASIR/CMF) – Raman micro spectroscopy and photolumiscence materials (LASIR/UMET) – heritage object (LASIR/MSAP) and the development of Dynamic Nuclear Polarization combined with NMR and RPE (UCCS/LASIR) for which a PhD grant was allocated and an ANR (Young Researcher) project was recently accepted.

Collaborations with partners which are not member of the Chevreul federation are also active. As an example one can cite the collaboration between UMET and LML about the micromechanical behavior and modelling of polymers and polymer-particulate nanocomposites. Strong relationships also exist between UMET and the MPE team of EMD which is deeply involved in plastics processing industries.

Project partners have many national and international collaborations, with academic or industrial partners. A number of these collaborations are formal via European projects, agreement between our universities or programs managed by Egide between two countries. Frequently, exchange of researchers (PhD, postdocs and visiting professors) is promoted. Joint papers in peer reviewed journals show the quality and the complementarily of our collaborations (see reference list in section 7.2).

As shown in the description of each partner (see 4.1), all members are deeply involved in ANR programs with numerous national collaborations with academic but also industrial partners. One of the biggest programme is the PCRD7 European Programme EuroBioRef *'EUROpean Multilevel Integrated BIOREFinery Design for Sustainable Biomass Processing'*, gathering 28 partners of 14 different nationalities for a global budget of 38 M€ (23 M€ of subvention) during 4 years (01/03/2010 - 29/02/2014; Coordinator: F. Dumeignil) which involves the three UCCS teams and several French teams as IRCELyon and the LCS of Caen. One can also cites the strong implication of each partner in GDR, GNR and GDRI (PACS on Fuel cells, MATINEX and PARIS on nuclear energy, GDRI with the Polish academy of Sciences and the AIST in Japan dedicated to the development of sustainable and environmental catalytic processes, REX Idecat), the creation of an International Associate

Laboratory at the beginning of 2009 with the National Chemical Laboratory of Pune (India) under the auspices of the CNRS and CSIR in India, at least two CEFIPRA programs with India. There are also strong connections with China. In the two last years, at least 3 co-tutorial PhDs with University of China (Shanghai, Sichuan, Wuhan) were funded and recently defended. It is also worth to remind the recent award of an international ANR Blanche with China "ARCHIFLAME" on fire resistance (2011-2014).

Among the international partners, one can also cite: Imperial College, London, University College, London, Univ. of Berkeley, USA, Saporo University, Japan, Utrecht University, Univ. of Krakow, Univ. of Warsaw, Univ. of Gent, Univ. Delaware, USA, Kyoto Institute of Technology, Japan; Indian Institute of Technology Delhi, India; Univ. Louvain, Belgium; ETH Zürich, CH, Rheinisch-Westfällische-Technische-Hochschule (RWTH) Aachen, Germany ; Univ. Budapest, Hungary; Univ. Sao Paulo, Brasil; Univ. Auckland, New Zealand, . Lawrence Livermore National Laboratory, Eotvos University, Johnson Space Center, NASA, USA, National Institute of Standard and Technology, USA, Marquette University (Milwaukee, WI - USA - Prof. Wilkie), Almaty university, Kazakhstan, Mons University, Belgium, Ulster University, Irland, Univ. of Limerick, Irland, Polytechnic of Turin, Italy, Louvain University, Belgium, the university of Glasgow, the University of Massachussetts Amherst, USA, University of La Plata, Argentina, Ecole Polytechnique de Montréal, …

5. DESCRIPTION SCIENTIFIQUE ET TECHNIQUE DU PROJET / TECHNICAL AND SCIENTIFIC DESCRIPTION OF THE PROJECT

5.1. ETAT DE L'ART / STATE OF THE ART

SYMMECOM addresses the case of **molecular systems and materials under complex environments**. It is a wide field and we propose here to focus on important topics for which we have significant skills or we aim to build significant advance. These topics are **architectured media, behavior under extreme conditions, driven systems and reactivity-selectivity of molecular and iono-covalent materials**.

Architectured materials have been first demonstrated to be attractive for their specific mechanical properties. Many efforts have also been devoted to the control of the size and shapes of porous media leading to a wide range of different materials with applications in catalysis, microelectronics and medical diagnosis. In this context, multiphasic media involving **architectured molecules** like micelles when surfactants are used, have attracted much attention to prepare inorganic compounds with tailored porosity. These systems also open the possibility of catalysis in confined media for a **better reactivity and selectivity**. At the atomic scale, the **design of novel iono-covalent crystalline structures** by association of patterns, each of them bringing its specific functionality, is also a new trends in the field of

solid state chemistry to design **new architectured materials with tailored properties**. Controlled architecture of **polymer composites** are currently studied as systems **against fire**. In many cases, materials are maintained in non equilibrium conditions by some external dynamical forcing (irradiation, grinding, extrusion, application of an electrical bias, ..). In such configuration, the physical, chemical or structural properties of materials are changed and cannot be described by the usual framework of thermodynamics. The study of **driven materials** offers a wide range of challenging fields, including the study of the physical and chemical states, the **reactivity-selectivity**, **the metastability** and specific properties of driven systems. All these concepts can be applied for the **design of materials under extreme conditions** (pressure, temperature, dynamic loading, biological media) for applications in various fields such as **Earth sciences**, **polymeric systems against fire, materials for future energies,** design of new **catalysts, biomass, materials for health**,.

Most natural hazards (volcanism, earthquakes, tsunamis..) are just surface manifestations of the internal activity of the earth. Our planet is still hot (98 % of the volume of the earth is at temperatures above 1000°C) and needs to dissipate its internal heat through large-scale convective motions that affect the mantle. The mantle is an envelope which extends down to 2900 km depth and is made of solid rocks composed of high-pressure phases of magnesium silicates. Plate tectonics, that describes most geological manifestations at the surface, is in fact the boundary layer of the earth viewed as a thermal machine. One of the most challenging issues in geodynamics is to constrain the **rheology of the earth's mantle**. The requires to understand how high pressure phases flow under high-temperatures (up to 3000K), high-pressures (up to 135 GPa) and very low strain-rates (of the order of 10^{-14} s^{-1}). Solving this fundamental issue of geophysics clearly calls for a **multidisciplinary approach** involving concepts and knowledge from materials science.
Experimentally, specific machines are now available on synchrotrons; they allow deformation experiments up to 15 GPa at controlled strain rates with in-situ rheological (strain and stress) measurements[1]. At higher pressures, diamond anvil cells (DAC) can be used to investigate materials properties from which we can extract information about mechanical properties[2] The Mineral Physics team at UMET has produced pioneer contributions in those fields, with involvements in both the development of these machines and the concepts required for data interpretation. Besides experiments and observations, numerical modelling has recently emerged as a powerful approach in mineral physics. In the last few years, the team has shown that multiscale modelling of plastic deformation could contribute greatly to our understanding of the mechanical properties of mantle materials[3]

Today, the minerals physics team of UMET gathers a unique ensemble of skills in the field of high-pressure rheology, with a close interaction between experimental and numerical approaches. In this project, it will take advantage of this configuration and establish, in Lille, a world leading centre for the understanding of mantle rheology, integrating numerical modelling and cutting-edge high pressure experiments.

With also dramatic consequences, fire is undoubtedly an emotive subject, especially when it comes to scenarios that we can imagine in a "closed system" (e.g. ship or aircraft) and the possibilities to escape are restricted. So fire safety is a great concern of the industry to develop safer materials meeting the regulation. Indeed the development of science and technology provides the availability of sophisticated products but concurrently, increases the use of combustible materials (in particular organic materials such as polymers and polymer composites). **Reaction to fire** of **polymeric materials** is a key feature. Upon heating and under fire, regular polymeric material degrades and burns but when controlling the architecture and the integration of materials such as carbon, clay, ceramic, fibers, aluminum particles, the so-called flame retarded material exhibits limited thermal and mechanical degradation. The mechanism of protection takes place in the condensed phase thanks to the formation of an insulative protective layer. This layer can only be characterized after removing heating and fire and it remains completely unknown while providing its protection. Its **dynamic of formation** in **such extreme conditions** has also never been investigated and is ignored by the scientific community.

Then such a research field is very challenging because it is multidisciplinary and it needs a systemic approach gathering processing, physico-chemistry, rheology, mechanic, thermophysic and automation. The challenge is then to develop new experimental protocols and the complete modeling of the **fire behavior** of polymers and composites based on its full understanding and of its complete description, i.e. from the intrinsic properties of materials (micro scale) to their macroscopic and functional properties under extreme stresses.

Development of new energies, more sustainable and reliable, is a also real challenge in terms of materials. With possibility of fuel recycling, **nuclear energy** may play a key role in the future, mainly because of its high energy density relative to others, but also because it will allow developing **hydrogen as a vector of energy**. The level of constrains is high, **systems are complex** and rely on the **design of new architectures** able to withstand **irradiation** and **high temperature**. Most of the projects selected after the road map of the Generation IV forum for the future nuclear reactor, will use **actinide oxide** or **mixed actinides oxide** (MOX) as **combustible fuel**, but also a new type of materials such as metal carbide. The preparation of metallic carbide at high temperature (T > 2500 C) in arc furnace from a mixture of metal uranium with graphite or *via* carbothermal reduction from a mixture of uranium oxide with graphite at lower temperature (T = 1400-1600 C)[4-6] is not possible for MOX fuel (U,Pu) due to the partial volatilization of plutonium at these temperatures. As alternative routes calcination of metal oxide in the presence of carboneous gas (CH_4, C_3H_8, …) could be a promising method as it does exist for the synthesis of metal carbides as catalysts[7-12] but no experience has been reported in this domain with actinides. The other route could consist in the formation of **organic-inorganic hybrid complexes** as a basic building unit playing the role of precursor.

Another issue in the spectrum of future energy is to combine nuclear plant with the production of hydrogen which will act as an energy vector in the future. It will be produced by electrolysis of water vapor using solid-state devices connected to nuclear plant, while electricity will be recovered in fuel cells used either for transportation applications or to provide electricity in isolated places. **Electrolysis of vapor water at high temperature** will be preferred to take profit of the thermal heat produced by the new generation of reactor. However, these systems still suffer from severe degradation, mainly due to their high temperature of operation and thermal cycles. A solution would be to get ceramic cells working at a temperature as low as 650°C and resistant to thermal shocks. To achieve such low temperatures, there is still a need of new materials, mainly for the electrode at the air side and sealings[13-17] The same technological bolts prevail for the development of Solid Oxide Fuel Cells able to work in this range of temperature, since the principle of a SOFC is the reverse of an electrolyser. Up to now, most of the researches focused on structures deriving from the fluorite or the perovskite[18-20]. Recently, the team of Mentré evidenced promising properties in the thermoelectric compound $Ca_3Co_2O_9$ which can be viewed as the intergrowth of $[Co_2CoO_{3-\delta}]$ rocksalt ionic layers and $[CoO_2]$ (Co^{3+}/Co^{4+}) hexagonal electronic layers[21]. This assembly of units with complementary functions opens new perspectives in the research of materials for Solid Oxide Fuel Cells or Electrolysers.

Nowadays, the durability and the performances of chemical processes integrating low energy consumption and the minimization of side product are cost effective and represent an outstanding issue. Up to now homogeneous and heterogeneous catalytic processes compete efficiently to fulfill major requirements in terms of **selectivity and energy gain** but further improvements are probably needed in comparison with enzymatic catalytic systems exhibiting a remarkable activity/selectivity behavior. The great fundamental challenge that remains for **heterogeneous catalysts is to elaborate hierarchically ordered materials**[22,23] with controlled individual pore sizes, porous structures for subsequent functionalization by metallic and oxidic nanosized particles represent an outstanding issue to optimize nanosized catalytic reactors. Alternately, liquid-liquid multiphase enantioselective homogeneous catalysis[24] combining the typical selectivity of homogeneous catalysis with simple catalyst/product separation that characterizes heterogeneous protocols is an important issue. The development of novel methodologies such as **multiresponsive water soluble smart nanoreactors and zwitterionic metallo-organic**[25] represents a significant breakthrough. Subsequent miniaturization and multi-functionalization of devices as well as researches in **nanofluidics** are expected to deliver fully functionalized nanosized reactors capable of performing chemical reactions in complex reactive environments in which chemical processes, heat and mass transfer will be optimised. **Femtochesmitry** have brought powerful concepts for the control of the reactivity at the scale of the atomic bond and with the time-resolution of the molecular motion.[26] The challenges in this field are in the dynamical control in time and space insuch type of heterogeneous/homogeneous reactors and in the creation of new optically controlled nanofludic reactors.

In addition to these domains, the **Pharmaceutical Material Science** (PMS) is an emerging discipline which attempts to apply fundamental concepts in the physical sciences to the challenges of understanding the **behavior of soft, mostly organic, crystalline, and amorphous material**s of relevance for the pharmaceutical industry. PMS is concerned with connecting phenomena occurring on the molecular scale - such as: crystallization, polymorphism, molecular mobility and glass properties…- to metrics of macroscopic performance – such as dissolution, hydration rate, mechanical strength…- and their consequences for **drug delivery**, **control of drug form**, **manufacture and processing of nanoscopic and microscopic particle systems**, and the structure and properties of bulk powders and their assemblies for use in pharmaceutical applications. Historically concentrated in pharmacy departments, research in PMS is becoming a subject area in its own right with material scientists playing a key role in this process; Excellence in PMS clearly has both a high human value and a high economic value, and it has become a significant driving force in the global economy of the 21st century. The significant advances that have been made in experimental and computational chemistry, physics and biology in the past few years and the advent of new approaches for designing and fabricating materials create many opportunities for exploring novel pharmaceutical applications for existing materials and characterization techniques while new therapeutic materials with unique properties are being created each year. Several national centers have been established in the Americas (Center for Pharmaceutical Processing Research- Indiana U.S.), U.K.(Pfizer Institute for P.M.S. in Cambridge), and Asia. Some specialized research groups have developed, such as those at MIT, and University of Texas. It is internationally recognized that the MMT (Molecular and Therapeutic Materials) team of UMET is a leader in this area and contribute in a high degree to the promotion of this growing field.

Biomedical implants are involved in a wide range of surgical disciplines. They are made of polymers and/or metallic alloys, ceramics and assemblies thereof… Once implanted, they are exposed to a **complex environment** made of variable cellular types, blood, physiologic liquids containing salts, (glyco)proteins, enzymes etc. Historically, the first approach in the development of implants was to define biomaterials with a controlled resistance to biodegradation and whose eventual degradation products do not involve any toxicity. Then second generation consisted to apply surface treatments in order to avoid drawbacks such as thrombosis, irritation and subsequent infection. Due to the enhancing variety of implantable devices, a third generation of implants has recently appeared, with "**tailored" surface properties according to specific functionalities** that may be requested in function of their site of implantation in the body. For example, a vascular prosthesis (PTFE or textile polyester) should present antithrombogenic properties, while a hip prosthesis (titane alloy) should promote osteoblastic cells proliferation on its surface. Therefore a wide range of chemical paths are requested in order to functionalize these various surfaces with various biologically active molecules. As a consequence, a wide literature is yearly published in

materials journals concerning functionalization of surfaces for biomedical applications. In the last 5 years, the Polymer Engineering group of UMET contributed to this progress through the development of **textile implants** for the **controlled delivery of antibiotics**.

5.2. OBJECTIFS DU PROJET PAR RAPPORT À L'ÉTAT DE L'ART ET LIENS AVEC LA SNRI/ OBJECTIVES OF THE PROJECT COMPARED TO THE STATE OF THE ART AND IN RELATION TO THE SNRI

5.2.1 PRESENTATION SCIENTIFIQUE DU PROJET DE RECHERCHE/ SCIENTIFIC PROGRAMME

To meet the challenges that were presented in the previous section, we offer ambitious targeted actions for which we want to set substantial resources in the coming years. They are presented here in form of workpackages (WP), each of them explains how scientific advances can be made or scientific obstacles can be removed for the important topics presented in the state-of-the-art section. The first two WP are dealing with materials under extreme conditions, under high pressure to simulate the mantel rheology (WP1) and under fire conditions with high temperatures (WP2). (WP3) is devoted to the design of new materials for energy, mainly in the field of nuclear applications with the elaboration of new fuels and recycling, and the production of hydrogen by electrolysers connected to nuclear plant. Keeping in mind the need of economy of atoms and going towards reactions with better selectivity and reactivity, nano-reactors are developed in (WP4). Our action in biomass which is also a vector towards sustainable energy is described in (WP5) and, since materials for health are also materials under complex environment, they are the heart of (WP6). SYMMECOM is a **multidisciplinary** project which will rely on **outstanding analytical platforms** and **forthcoming platforms of syntheses**. To manage these platforms, an additional workpackage is devoted to the implementation of an "**Institute Access structure**" (WP7) for these platforms which feed the scientific challenges and will play a key role in the attraction effect, associated to the SYMMECOM project.

WP-1. Multiscale plastic behavior under high pressure (PI: Patrick Cordier)

Very significant progresses have benefited the field of deformation under high-pressure. Deformation experiments are now possible at high-pressure and high-temperature (up to 15 GPa and 1500 K). Stress and strain rate can be measured simultaneously and in-situ, from which phenomenological rheological laws are built. Applying these laws to mantle conditions involves strain rate extrapolations over six orders of magnitude. Understanding how rheological properties scale with strain rate would be a significant advance that would benefit both the earth and material sciences.

In the present project, we want to design a new approach in mantle rheology which integrates laboratory experiments under extreme conditions and numerical modelling. We expect significant progresses in three directions:

- high-pressure deformation experiments and rheological measurements (in-situ and ex-situ, including microstructure characterization)
- development of multiscale modelling of plastic deformation of minerals
- developing an integrated approach involving these two aspects.

To achieve these goals, we need to develop a world-leading high-pressure facility devoted to rheological studies under high-pressure connected to a group of numerical modelling.

WP-2. Driven microstructures against fire: new polymeric systems (P.I. Serge Bourbigot)

The project aims at investigating polymeric materials exhibiting a very well process-controlled morphology in very extreme conditions (fire and high temperature) with a systemic and multidisciplinary approach thanks of the unique expertise's combination of different groups (association of physicochemist and physicist (ISP-UMET), mechanical researcher (LML) and polymer engineering & processing science researchers (TPCIM-EMD)). It should permit the development of new experimental protocols and numerical modeling to simulate both the processing of the material and its fire behavior.

Our main objectives are described as follows:

1. Development of processes able to prepare polymeric systems with tailored nano/micro/macro structures and with the appropriate morphological and distributive parameters. It includes the development of new experimental (technologies for manufacturing structural composites, polymer nanocomposites …) and numerical (models based on multi-physics and multi-scale) methodologies
2. Development of experimental benches (including the specific design of the bench and its protocol): the purpose is to design specific set-ups able to work at high temperature and/or in fire to measure thermophysical, rheological and mechanical parameters. Those set-up will be connected to full-field measurements techniques (high resolution CCD, infrared cameras, long wavelength video image-based detection (LWVD) with luminosity-based algorithm to measure temperature of hot objects ...)
3. Chemical characterization of the degraded polymeric materials: investigating quantitative methods including the kinetic aspects and the chemical composition of the structure of the degraded materials
4. Making of general comprehensive and predictive model permitting the full understanding of polymeric material against any thermal stress: use of coupled problems based on a fully comprehensive theoretical approach and development of numerical modeling (use of coupled models including viscous terms as a function of temperature, degradation kinetic of the material, thermo-hydromechanical and chemical (THM-C) couplings and porous media).

WP-3. Design of novel architectured materials for future energies (P.I. Thierry Loiseau)

The challenge of this WP is to provide **advanced materials for energy through a rational approach (design ↔ characterisation) for a breakthrough in performances**. Elaboration of functional compounds with tailored properties will be achieved by the use of building sub-units able to combine their own properties into the final edifice or the incorporation of specific functionalities in subunits. These new advanced architectured materials will be oriented towards important breakthroughs in the field of materials for future energy in collaboration with the industrial partners in the field, …, in the frame of the generation IV nuclear reactors and hydrogen based electrochemical systems. Each individual step of this promising approach will be supported by advanced characterizations (in situ/operando studies under an electrical bias or working atmospheres using X-ray diffraction, ^{18}O isotope exchange combined with SIMS and LEIS and ^{17}O NMR) using the outstanding platforms of the Chevreul Federation, as well as validations by ab-initio calculations.
The project mainly concerns i) The **elaboration of carbines for the generation IV nuclear plant** through the design of hybrid complexes. Downstream the nuclear fuel cycle, **lanthanide recovery** is still a challenging task. As a middle term objective, we propose to design novel architectures for immobilization matrices constituted of metal-oxide frameworks. ii) The **design and elaboration of new materials for SOFC or SOEC** by **association of 2D building blocks with specific function** such as distinct anionic or electronic transport to obtain original nanocomposite phases intergrown at the atomic scale which will be used as **electrodes**, or based on **alternated 2D layers of glass and healing phases for sealing applications**. In this latter case, at middle term, bloody vessels network will be integrated within the seal to enable local repairing, to get a "bioinspired" self-healing effect. On a longer time scale, our objective will be to design new seal architecture that will enable self-detection and diagnostic of failure, followed by improved self-healing.

WP-4. Smart nano reactors: towards optimized activity and selectivity (P.I. Pascal Granger)

This topic is dedicated to a *'better understanding and control of the reactivity of meso- and molecular structure under complex media : towards atom economy and lower energy consumption'*

The development of novel micro- nanoscale reactors will be of interest to *get selective, friendly environmental and cost effective chemical processes*. Concerted approaches will be implemented focused on the following targeting challenges. (i) Aqueous/organic biphasic catalysis in organised media to address critical issues in multiphasic transformations of highly hydrophobic organic substrates. The conception and the realisation of novel multiresponsive water-soluble nano reactors will be implemented involving novel catalytic systems to obtain selectively highly functionalised products from enantioselective cascade transformations. The long term goal of this project is the development of multiphase homogeneous catalytic protocols to widen the scope of catalyzed organic transformations (ii) The development and the control of the architecture of nanostructures/nanophases stabilized on hierarchical macro-meso heterogeneous catalysts will be envisioned for monitoring the

adsorptive properties of functionalized surface and the specific reactivity of adsorbates via confinement effects in the macro-meso porous structure. The long terms goal of this project is to get optimised heterogeneous nano sized reactors minimizing heat and mass transfer in order to control and tune the catalytic properties under industrial operative conditions. (iii) Ultrafast spectroscopic investigations and operando spectroscopic studies to control and optimize the efficiency of nano heterogeneous reactors at the time scale of elementary steps. New spectroscopic techniques will be developed to address the specificity of the chemistry, by ultrafast T-jump experiments, and time-resolved nanoscopy. While femtochemistry is usually restricted to unimolecular reactions, the ultimate goal is the demonstration of the optical control of the chemistry of complex reaction schemes and to open the route for the realization of nano sized reactors.

WP-5. Biomass for an integrated biorefinery (P.I. Franck Dumeignil)

The viability of the technologies using biomass as a raw material is strongly depending on *(1)* the capacity of valorization of the alcohols produced by this sector, *(2)* the capacity of valorization of the various by-products, and *(3)* the capacity of purification of the obtained primary products as well as the treatment of the secondary pollutions generated by the chemical and/or biological conversion processes. Our activities are mainly divided in two main axes, namely *'Biomass and Clean Energy'* and *'Biomass and Chemical Intermediates'*. The developed research themes include acetalization of monoalcohols (ethanol and methanol) over novel efficient bi-functional catalysts, the low temperature steam reforming of ethanol for hydrogen production, the gas-phase glycerol conversion to acrolein over new coke-resistant catalysts, the liquid phase partial oxidation of glycerol over a new type of Au-based catalysts avoiding the addition of a base to the reaction medium, and the purification of pyrolysis oils by HDO. **Design of new catalysts with controlled architecture** is of first importance. It will rely on the REALCAT platform (equipex). The aim of this platform is to **build a versatile High Throughput Technologies (HTT) platform** in order **to accelerate the development of innovative catalysts used for biomass valorisation** The objective is **to divide the time of development of a catalyst by, at least, a factor 10**. In the short term, the REALCAT platform is intended to be used within the frame of collaborations with French or foreign laboratories involved in catalysis research. We have the potential of re-energizing the biomass production, growing the industry and achieving the original dream of biomass sustainability across the whole of Europe.

WP-6. Material Science for Health (Marc Descamps)

The objective is here to establish a Pharmaceutical Material Science platform providing experimental and numerical tools of physical analysis to optimize the formulation of pharmaceutical compounds and thus improve their bioavailability, their physical and chemical stability and to get a better control of drug release. This objective requires overcoming several bolts:

1) Increase the solubility of the many poorly water soluble drugs by manipulation of the amorphous state and by rationalization of formulations: polymers/drugs based on a rigorous physical approach.
2) master solid state transformation frequently induced by formulation process (grinding, extrusion, drying techniques…) to predict, control and manipulate the nature of the final physical states of pharmaceutical compounds. This point requires an adaptation of the fundamental physical approaches of driven materials (non-equilibrium phase transitions) to identify relevant control parameters.
3) develop amorphization routes which do not induce chemical modifications of labile drugs. This requires to understand deeply the link between physical and chemical stabilities and to develop amorphization methods which do not involve high temperature excursions.
4) master the cristallinity, the hydrophilicity, and the biodegradability of polymeric excipients which drive the drug release. This point could be addressed by catalytic copolymerization of precursors of biodegradable polyesters with hydrophilic monomers.

An other challenge to be taken up in the next 10 years will be to develop a transverse "know how" in the functionalization of polymeric, metallic and ceramic medical devices with biologically active molecules. This objective will be reached through the following strategies:

1. to attempt a preliminary preparation of the supports with "chemical anchors" in order to fix molecules or bio-macromolecules that present an intrinsic bioactivity.
2. The second planned strategy will concern targeted drug delivery from implants. Therefore different materials in use in vascular, orthopedic and visceral surgery will be functionalized with cyclodextrin, a family of compounds known for their ability to reversibly form inclusion complexes. Indeed we already obtained remarkable results in the last three years in this domain, but these promising results have to be extended to other therapeutic effects such as anti-cancer agents and also to new types of implants. This concept based on supramolecular chemistry will aim to deliver a drug in the targetted surrounding tissues of the implant.

WP-7 Analytical and synthesis platform access structure (P.I. Christian Rolando)
Until now the seven analytical platforms of the Chevreul Institute are managed independently. This structure is very fruitful for people working in define scientific field but renders more difficult interdisciplinary studies and access to external users. Indeed most of the request from SMEs are based on a "solving a problem" approach and involve the use of several platforms. On major aim of the SYMMECOM labex will be to elaborate a Chevreul Institute Access structure (including also the new synthesis platforms) which:

- will be the only entry point for external users (both academic and industrial)
- will take in charge external expertise request as a whole (from the analysis of the subject to the final report)
- will guarantee the quality of all the individual platforms

The SYMMECOM labex structure will recruit a senior PhD engineer to manage the Chevreul Institute Access and a least a junior engineer. The senior engineer will be the link between the incoming users and the platforms. He will have in charge to establish the way for solving the proposed problem, the price of the project and to ensure the follow-up with the technical staff of the platforms. The junior engineer will have in charge the sample preparation, the realization of classical analysis and the writing of the report. A secretary will ensures the accounting Chevreul Institute Access along with the accounting of the analytical and synthesis platforms altogether.
A short term objective of the SYMMECOM labex, Chevreul Institute Access structure will be to prepare the individual platforms to obtain quality labels (typically ISO 9001) and to assure "good laboratory practice" regulation enforcement. The Chevreul Institute Access structure will organize training for all Master degrees and PhD students on the platform on order to optimize the use and to maintain the quality of the platform.
A permanent action of Chevreul Institute Access will be to organize seminars for SMEs, to be present in professional fairs and congress for presenting the capacities of the platforms in order to attract new customers from Nord, Pas-de-Calais area, but also from all France and close European countries. On the other hand Chevreul Institute Access will favor the diffusion of the new techniques developed by the platforms toward the high-end industries which already user of standard research equipments. The Chevreul Institute Access will also assure the link between the SYMMECOM labex and the valorization structures of the Nord, Pas de Calais Région (NSL, Maud clusters, Eurasanté, Crée'Inov technical park…) and National (OSEO, INPI…). On the overall, Chevreul Institute Access will maximize the transfer of knowledge and expertise between the SYMMECOM labex and Chevreul Institute researchers and the academic and industrial partners.

Link with the SNRI "National Research and Inoovation Strategy".
Most of the challenge we intent to address are in good agreement with the French SNRI. First, SYMMECOM responds to the principle of **fundamental research** which is essential for our knowledge-based societies. The project has been built between researchers from various disciplines (chemists, physicists and mechanical researchers), leading to the **multidisciplinary** configuration required to challenge scientific, technological and societal issues. The challenges we propose are included within the priority areas, first dealing with **Materials Science for Health** (priority area n°1) but above all in the priority area n°2 which is "**Environmental urgency and eco-technology**". Three of our challenges are directly related to this topic (WP3 for development approach to future energy technologies, including nuclear recycling, WP4 for its sustainable chemical applications integrating atom economy and lower energy consumption, and lastly WP5 for the development of innovative catalysts for biomass valorisation).

5.2.2 VALORISATION, TRANSFERT ET EXPERTISE/ EXPLOITATION OF RESULTS, TRANSFER AND EXPERTISE

Once arrangements have been made to protect any commercially significant intellectual property arising from the project, results will be published in refereed international journals and in proceedings of appropriate international conferences. They will also be presented to a wider audience since they are dealing with societal challenges.

Scientific communication: In addition to the specialized scientific publications, our project has good potential to communicate with a wider audience. Indeed the majority of subjects are at the heart of important topics of our changing society (materials for health, future energies, energy consumption, biomass…) which are well adapted to strengthen a public dialogue and exchanges with elected officials, in particular regional ones. We plan to establish a communications policy around our Labex project. To achieve this objective, we don't plan to build our own communication department but we will work with the communication unit of University Lille 1, of associated engineering schools and of the PRES ULNF, it seems unnecessary to multiply the communications units. University Lille 1 also has an efficient cultural center (conference room, exhibition space http://culture.univ-lille1.fr/). We already have some experience of scientific communication. For example several members of this project were involved in local implementation of the UNESCO international year of physics (2005), Astronomy (2009) and are currently preparing the international of chemistry (2011), for giving conference, exhibitions in schools, or for the local organization.

Communication toward industrial, including SMI-SMEs: An important focus of the project is to make them more legible by building a "transfer center" in charge of interaction with external academics and local, national and international companies. In order to ensure attractiveness of this center, we look forward to work with competitiveness clusters which will contact companies to be regularly informed of service offers (price, type of possible works...). for instance, MAUD competitiveness cluster frequently organizes workshops to promote meeting of industrials and academics (Maud Business Lab, Thematic workshops…), and widely contributes to the implementation of research partnerships involving industries, SME-SMIs and research laboratories . Direct collaborations between our teams and industries should be also enhanced by the SYMMECOM project.

School and Workshops: Our teams have an experience for the organization of school and workshops. For instance, For instance, the UCCS partner organizes international solid-state NMR workshops since several years: Pune, India, 2005 ; Wuhan, Cina, 2006; Rio de Janeiro, brazil 2007 ; Daegu, south Korea 2007 ; Brisbane, Australia, 2008 ; Kyoto, japan, 2010. MSAP organized 2 CNRS Thematic School attended by 60 participants on Fourier Transform Mass Spectrometry (2008) and Chromatographies and Mass Spectrometries (2010) in Ambleteuse (Nord, Pas-de-Calais), LASIR organized "New horizons of photochromism: From design of

molecules to applications", October 12th – 15th, 2008 / Arras (France). Several members of the SYMMECOM were deeply involved in the organization of the 24th JIREC (Journées de l'Innovation et de la Recherche pour l'Enseignement de la Chimie) (2008) in Ambleteuse whose topic was the "Valorization and recycling of mineral matter". Lionel Montagne is heading the "GDR verre" which proposes regular workshops and the next meeting of the GDR PACS dealing with fuel cells will be co-organized by the ENSCL and Polytech-Lille on the 6-8 December 2010, about 170 attendees are expected. The next training school on electron microscopy organized by the GN-MEBA will held in Lille, next June 2012, with the help of people from SYMMECOM. It is dedicated to technicians and engineers from industry or university willing to be trained in SEM. In case of success, SYMMECOM should be a good vector to reinforce our scientific audience by organization of events in relations with our challenge or associated platforms.

Exploitation of the results (patents): Partners of the project are already involved in patent delivery policy (see description of the partners and the annex 7.2 for the list of the patents). As previously mentioned, researchers have already engaged strong and close relationships and commitments in the domain of energy with the French industrials partners in the field of nuclear for instance. The research topics and results will be directly related to the industrial issues. Thus the transfers of scientific knowledge will directly benefit to the interested industry. The new research on actinide carbides will without any doubt lead to patenting. The interface with industry is also wide with various active partnerships with Total, IFP, Arkéma, Adisséo, Renault S.A. GDF Suez, Sanofi Aventis, Servier, CNES, DGA, Hollyday Pigments. Some of them are long term collaborations which have already proven their efficiency through various patents essentially dedicated to catalyst synthesis. The challenge proposed in SYMMECOM should lead to long term repercussions and should strengthen our collaborative programs. Let us note that the REALCAT project under examination (Equipex program) has been submitted to build an integrated and versatile High Throughput Technologies (HTT) platform in order to contribute to R&D programs and to accelerate the development of innovative catalysts. The applications are centred on the rapidly growing and strategic biomass valorisation sector, but also on energy and environmental applications. Several companies have confirmed their intent for this platform and valorisation is expected.

Operational structure for exploitation of the results, transfer and expertise: At the start of the project, we intend to work with the research exploitation department and the incubator "cré-innov" of University Lille 1, both already described in the section 4.1.1.2 which is now included in the Lille Nord de France Valo Centre. In the following, we present the main lines of the strategies of these structures we plan to use for the exploitation results of our project.

Operational activities carried out by Lille Nord de France Valo Centre:

- Awareness -raising, training and information for researchers

- Detection of research results with applied economic potential, and transferable to economic actors (all kinds of companies, either already in existence or/ being created). This identification work undertakes the necessary actions to assess scientific, legal, technical and economic factors, well beyond just active monitoring of research.
- Help in project development: scientific evaluation, identification of stepping stones to cross/obstacles to clear, with means available to attain the goals;
- Protection, exploitation of viable results to include, effective industrial protection ;
- Research of opportunities, markets and industrial operators likely to follow up research results, and to develop, exploit and commercialize them through key innovation strategies;
- Negotiation of research partnerships, of transfer and concession of rights on inventions and innovative know-how transferred to industry, plus the actual drafting of appropriated contracts and agreements;
- Incubation, creation, financial support mechanisms and monitoring of start-ups and spin-offs, promotion of research work within the PRES ULNF.

These development activities and procedures have been organized at regional level which is the right scale for high level skills to be mobilized and optimized. The organization of the Lille Nord de France Valo Centre provides every researcher in the Nord-Pas de Calais with quality service in terms of project engineering, help in drafting projects, the handling on intellectual property, mediation with addressing economic conditions, undertaking market research, and also with contracts or negotiating.

Possible evolution of the structures - SATT: The PRES ULNF has decided to group together the existing development structures in a **"SATT"** (Acceleration of Technology Transfer Company) named "Nord de France Valo". This new structure is being set up in association with the University of Picardie Jules Vernes (UPJV, Amiens) and the University Rheims Champagne Ardennes (URCA, Rheims). Considering the research areas of the future SATT, the PRES ULNF and its partners have devised their project with the nine competitiveness clusters of our inter-regional area, including: *ITRANS* (Transport), *NSL – Nutrition Santé Longévité* (Biology / Health), *PICOM* (ICT and Retailing of the future), *MAUD* and *UP-TEX* (Chemistry and Materials), *IAR* (Agro-resources), *TEAM* ² (Energies) and *AQUIMER* (Halieutics).

The SATT, as a unique service centre for researchers and companies, will become a privileged interlocutor for the competitiveness clusters in terms of the identification of innovative projects and collaborative partnerships. It will integrate the incubation activities, project engineers (promotion, R&D, business) from specific regional actions, and a part of the activity of an ADER (regional economic development agency)…

The organization of the SATT will be based on the strengths of its activities and competences. A **first strand** will gather the legal, economic, fiscal, and strategic competences in relation to the intellectual property issues (management and exploitation of the patent

portfolio) in a specific cross-disciplinary department. **A second strand**, the financial department (heart of the SAS – Simplified Stock Company) will be in charge of the financial and funding strategy as well as the recruitment policy. **A third strand** will cover the management and the follow up of projects such as industrial contracts (collaborative contracts and service agreements), European and international contracts, and national contracts (including the contracts with the ANR, the French **national research agency**). **A fourth strand** will be organized around both top-down and bottom-up activities of economic promotion including marketing research, economic benchmarking, and industrial prospecting for technology transfer.

Finally, a **disciplinary interface unit** will be organized around 7 thematic departments on Biology and Health, ICT, Materials science, Transport, Human and Social Sciences, Environment and Agro-resources. Follow-up committees will be set up for each thematic department to ensure their smooth functioning and to coordinate promotion activities with full respect to the rules of confidentiality and the code of ethics.
The SATT activities will address in particular raising awareness, detection, maturation, protection and management of the intellectual property, contracts and project management, transfer and incubation, and finally business engineering.

5.2.3 ENSEIGNEMENT SUPÉRIEUR, INSERTION / HIGHER EDUCATION, INTEGRATION INTO THE WORKPLACE

We describe here the specific formations in connection with SYMMECOM and general actions taken by the PRES ULNF to favor education and job placement.

SPECIFIC ACTIONS

Staff members and partners of SYMMECOM lead many of the master formations in physics and chemistry fields of the PRES ULNF. All of the master degrees described here were quoted A by the AERES with the exception of the "Chimie et Ingéniérie de la Formulation" (CIF), an M2 option of the master of Chemistry marked A+. They all have strong connections with industrial as well as with academic activities.

Among the different master degrees, it is worth noting the international ERASMUS MUNDUS MASTER **Advanced Spectroscopy in Chemistry** (ASC), a network composed by 7 universities that aims at preparing students to become experts and develop international skills towards doctoral studies, and/or professional industrial careers in chemical analysis and characterization of the structure of materials. This degree, leaded by Pr. S. Cristol, member of the UCCS, graduates around 25 high level students a year and benefits from the existence of the high level analytical platforms of the Chevreul Federation. Two to three students a year pursue they master with a PhD in the Chevreul Federation. The ASC Master delivers expertise useful for the whole projects of SYMMECOM.

Three Master 2 options issued from the Chemistry Master of University Lille 1 are leaded by members of SYMMECOM **(1)** "**Chimie et Ingénierie de la Formulation**" (CIF) M2 option

– see also section 4, CMF partner. An average of twenty students is graduated each year. About half of them pursue with a PhD in renowned French and foreign laboratories and about five in the Chevreul Federation. This degree forms students that will feed projects 4,5,6 of SYMMECOM. **(2)** "**Ingénierie des Systèmes Polymères**" (ISP) M2 option (see section 4-UMET-Formations), this master degree graduates around ten to fifteen students a year with some (two to four) continuing with a PhD at the Chevreul Federation. The concepts, knowledge and competences delivered are useful for projects 2 and 6. **(3)** "**Chimie Energie Environnement**" M2 option (see section 4-UCCS-Formations). This degree graduates around 20-25 students a year. Between 15 to 30 % continue their studies with a PhD in the Chevreul Federation. The master introduces knowledge useful for projects 3,4,5 of SYMMECOM. **(4)** "Organic Chemistry and bionalytical chemistry". Created in 2010, it will bring to SYMMECOM students requested for many projects which involve knowledge in organic synthesis and analysis of complex systems by the so-called metabolomics approach.

Concerning the Master of Physics, the M2 option "**Matériaux**" – see section 4 UMET Formations. The degree graduates around ten to fifteen students a year. 15 to 30% pursue their studies with a PhD in the Chevreul Federation. This degree develops capacities well adapted for projects 1, 2, 3 and 6.

Members of SYMMECOM are also deeply involved in the engineering schools connected to the project (ENSCL, Polytech-Lille and Ecole des Mines de Douai). The Ecole Nationale Supérieure de Chimie de Lille (ENSCL) can be viewed as a general school in chemistry with a strong training in molecular systems and materials. It graduates about 80 students a year, which have during their last year the possibility to prepare a Master degree in co-habilitation with University Lille 1. About 20% pursue with a PhD. One department of Polytech-Lille is specialized in Materials Science, it graduates around thirty engineers per year and 5 to 15 % may pursue their studies with a PhD, often in the UMET laboratory. Regarding the EDM, the TPCIM group is directly in charge of the teaching programs of two majors (Mechanical Engineering IM, Polymers and Composites Technology TPC) of the GEM Graduate School (Douai Campus) and in co-habilitation with Lille 1 for the ISP (polymer systems engineering) joint master program (Lille 1/EMD/ENSCL) and in the Mechanical Engineering joint master program (Lille1/EMD). EMD was also recently accredited to co-deliver the PhD degree in two Doctoral Schools (ED104 SMRE and ED72 SPI).

FUTURE SPECIFIC ACTIONS

Teaching of **nuclear energy** related notions already appears in the Master 2 "Matériaux" (option: Techniques and Materials for the nuclear industry). Efforts are currently made in order to integrate this formation in the program of the Master 2 "Chemistry" (Lille 1) as well as a co-habilitation by the ENSCL and Polytech-Lille engineering schools. This will induce a significant flux increase of the potential numbers of students together with an improvement of attractiveness and image of this domain at the Lille Campus. Besides this, actions are undertaken to obtain a label to this formation from the Institut International de l'Energie

Nucléaire that is currently being created in France. The application for a chair in nuclear energy is programmed in the SYMMECOM project.

Strong efforts are presently undertaken to build up an ERASMUS MUNDUS MASTER in the Materials Science Area between Delft University (the Nederland), Gent University (Belgium) both VUB and ULB universities of Bruxels (Belgium) and University Lille 1. The Lille project is leaded by Pr. A. Legris, UMET Director. This master degree is planned to cover broad aspects of Materials Science and to receive strong support from material manufacturers and transformers of the north of Europe.

We aim to develop the longlife training for our formations. These formations would develop on short duration periods in order to optimize the welcome of long life learners.

Regarding the engineering Schools involved in SYMMECOM (ENSCL, Polytech'Lille & EMD), the strong participation of the staff members of SYMMECOM in the pedagogical teams ensures fast reactivity to integrate new topics in connection with the research projects of SYMMECOM into the teaching programs. Around 20 % of students continue their studies with a PhD and about 10% in the Chevreul Federation.

GENERAL ACTIONS

The formations we manage are included in a wide program developed by the doctoral school SMRE "Science de la Matière, du Rayonnement et de l'Environnement, under the responsibility of the PRES ULNF (details: http://edsmre.univ-lille1.fr/). The regional Universities represent 11 % of the continuing education activity of the entire French universities. The PRES ULNF develops several actions in which SYMMECOM will be involved, in particular the lifelong learning offer. The main initiatives are the following:

- **Master students and PhD candidates**; this new offer will rely on the excellence of the research laboratories: Introduction of Lifelong learning units in the students' initial curriculum "Becoming a lifelong learner" - Assistance in the promotion of the students' qualifications and in their projects management - Tools to keep in touch with the University (newsletters, Pluri-annual Seminars, Creation of a Partnership Resource Center) largely dedicated to the recent developments of the state of the art research.
- **Firms; tailor-built relations** will include a biannual Newsletter, personalized welcome of the company staff in the laboratories of excellence, access to high-level technological platforms and equipment (for which SYMMECOM is largely concerned), international scale seminars, animated by renowned specialists, short-term placement scheme open to staff all along the year, access to the Partnership Resource Center.

The PRES ULNF developed a range of **specialized training courses** combining specific units and research laboratories. This scheme, dedicated to the **socio-economic world**, is based on a network of help desks specialized in the management of careers (support for career management, validation of prior learning, skills assessment, assistance in project identification, specific short courses ...). SYMMECOM aims to develop this policy by

implementing lab training sessions of 4 to 5 days and seminars with researchers on specific themes together with specific companies.

College Doctoral :

The creation of regional Doctoral Schools in 2006 launched a new pooling process of professional training ('Doctoriales', professional insertion, seminars open to the socio-economic world ...). This scheme aims at preparing PhDs for their functions as highly strategic decision-makers within private and public companies and their role as a medium for innovation within these structures (see http://edsmre.univ-lille1.fr/index.php?id=insertionpro for details about the actions developed by our doctoral school SMRE). This dynamics were reinforced at the time of the creation of PRES ULNF in 2009, the desire to develop a unit dedicated to promote PhD students outside academia was materialized through the identification of a "Careers and Employment Department" (Département Carrière et Emploi-DCE) within the Doctoral College.

I - The actual achievements - Actions towards doctoral students:

The shared regional system of support for professional integration of PhDs, coordinated by the DCE, has recorded about 500 entries in 09/10 (+89% compared to 08/09), divided between 16 thematic seminars with the following objectives: develop knowledge of the business world: organization / strategy / role of innovation, situate the research work in the economic and institutional environment, identify and promote skills, "soft skills" acquired during doctoral training. Actions towards the regional socioeconomic world are also developed by regular contacts with MEDEF NPC and partnership at national level between MEDEF and the Bernard Gregory Association (ABG).

Actions in the border area: The PRES ULNF is a leading operator of the PRODOC project "(INTERREG IV for the period 2009 to 2012). Project goal: work on the employability of PhDs in trans-borders areas so as to spur on extra business development. Among the activities: Franco-Belgian "Doctoriales" (one seminar per year, with visits of French and Belgian firms); perception survey of doctoral degrees by firms in the trans-border region. Our ERASMUS MUNDUS Master project perfectly fits this policy.

II – Elements of development prospects

The acquired experience and the parallel constitution of partner networks form solid foundations, essential to the development of a later stage. This includes a true philosophy of contracting with the socio-economic world at the regional level first and then within the framework of the Euro region, the need of communication tools to develop professional communication in English for all PhDs. The developments concern the achievement of knowledge in management / business strategy / project management and the opportunity to learn first-hand (contacts, field experience) the notions of corporate organization. This label is a true training program, in conjunction with the professional project of the PhD student

(see details about the program for the doctoral school SMRE: http://edsmre.univ-lille1.fr/index.php?id=insertionpro).

5.2.4 GOUVERNANCE DU LABEX/ GOVERNANCE

A key objective of SYMMECOM Labex is to tighten the links between the partner Research Units in order to improve their research productivity, their higher education offer and results exploitation. SYMMECOM Labex, supervised by PRES ULNF, has no legal autonomy. It doesn't manage staff members and research equipments which come under joint reseach units and higher education institutions responsibility. Yet, it has full scientific autonomy and approves project that will be carried out by the SYMMECOM Labex partners.

The governance scheme, similar to a **project governance framework**, will be made up of an **Executive Board**, a **Scientific Advisory Board** and a **steering committee**. SYMMECOM Labex shall also be represented and managed by a **Director** assisted by 3 **Deputy Directors**.

The Director will carry the ultimate responsibility and will be responsible for management and financial control of the project. He will ensure the relation with the PRES ULNF and the reporting to the ANR. He will be assisted by 3 Deputy Directors, each of them responsible for one of the three elements of the Knowledge Triangle: Research, Education and Results Exploitation. The Director and Deputy Directors will be selected from and by the SYMMECOM Labex Executive Board and will be expected to serve for a period of four years. They have a shared academic and management role in shaping the orientations approved by the Executive Board and in getting them implemented. They will be assisted in these tasks by an Administrative and Financial Officer who will be hired half time on the SYMMECOM Labex. At the start of the project, the proposed director board will be the following: Hugues Leroux (Pr, UMET), director; Rose-Noëlle Vannier (Pr, UCCS), deputy director Research; Alexandre Legris (Pr, UMET), deputy director Education; Franck Dumeignil (Pr, UCCS), deputy director Result Exploitation.

SYMMECOM Labex supreme decision body is the Executive Board composed of the Director, the 3 Deputy Directors, representatives of each supervising institution, representatives of the regional entities collaborating with SYMMECOM (such as the regional deputy of the French ministry of research and the Conseil Régional and the head of each research unit). A few members are co-opted to preserve a balance between the various interests requiring representation and to provide seats for members with specialist skills. The Executive Board will meet each year. The Executive Board is in charge of discussing and approving the vision, objectives, key strategic options and long-term plans for SYMMECOM Labex, taking due consideration of the Evaluation and Prospective Report issued by the Scientific Advisory Board and the Annual Report on Activities, and Finances issued by the Steering Committee. It will set the measurable success criteria for the foreseen research projects, education programmes and results exploitation strategies. The Executive Board will

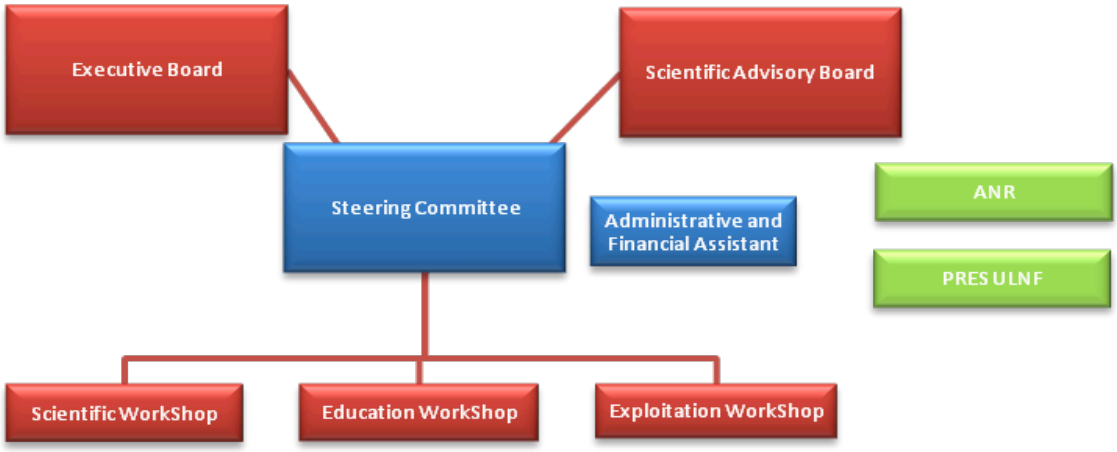
foster the organization of Regional, National and International events. The Executive Board will approve the consolidated and provisional budgets and the overall financial strategy.

The Scientific Advisory Board, composed of 10 members renewable twice, meets yearly about two months before the Executive Board and delivers to the latter an *Evaluation and Prospective Report.* The members of this board are chosen to represent a wide international range of expertise and experience in the scientific fields of SYMMECOM Labex. The main role of the scientific advisory board is to review the evolution of the SYMMECOM works and results, to give advices about the strategic orientation of the project. At a global level the board will monitore the general scientific and industrial evolution outside SYMMECOM at an itnernational level. It will follow the project progress (identifying and handling technical and oragnisational problems) and will propose changes in the project if necessary.

The steering committee is composed by the director (project Co-ordinator), the 3 deputy director and the leaders of the seven work packages. The steering committee will meet six times a year in order to ensure reactivity with agreement decisions related to proposed scientific projects. The steering committee:

- will apply strategic decisions from Executive Board,
- coordinate activities among work packages,
- propose any adaptations of the planning and ensure timely delivery within the framework of the project description and allocated budget,
- propose possible entrance of new participants or exclusion of defaulting partners,
- propose scientific and strategic evolution to the scientific advisory board, inversely the committee examines the proposition of the scientific advisory board for the scientific program, the training, communication and exploitation of research initiatives.

The SYMMECOM project is organized in seven work packages. The WP leaders are responsible for completion of the objectives in their WP. They are in direct link with the director and 3 deputy directors for the day-to-day management of the SYMMECOM project.



5.2.5 ATTRACTIVITE/ATTRACTION

To render our Labex and its local environment attractive, we plan to work along different pathways.

At first it should be reminded that the creation of the SYMMECOM Labex will occur simultaneously with the construction of a new building (8 M €, 2500 m2, "2008 campus plan") to house the research administration of the Chevreul federation and training of masters, giving a combined central role to the structure. In this future configuration, SYMMECOM will beneficit of the main strategic axes (1) The creation of a "Hotel à projet" and instrument housing space (10 M€, 3000 m^2, provided by the IEED project IFMAS French Institute for Agro-sourced materials) to promote industrial partnerships and related exploitation of results (2) The building will also receive three shared analytical platforms (electron microscopy, XRD, surface analysis), directly connected to the research topics developed within SYMMECOM and synthesis platforms (High pressure, materials for future energies …) that are a strong part of SYMMECOM. (3) The building will be a good opportunity to manage research associated to master courses. With these three strong features, the SYMMECOM environment will be an attractive center for both the students and researchers, with SYMMECOM at heart of the system.

As mentioned previously, strength of our research environment is the presence of high-level analytical platforms (see especially the description of partner Chevreul, who manages most platforms). An important focus of the project is to make them more legible by building a "transfer center" in charge of interaction with external academics and local, national and

international companies. In order to ensure attractiveness of this center, we look forward to working with competitiveness clusters which will take in charge the communication and exchange with companies to be regularly informed of service offers (price, type of possible works...)..

A major focus of our project is the creation of synthesis platforms (a main part of the SYMMECOM project). They were thought to be differentiating with unique specificities. Therefore they should have a high degree of attractiveness. This one should be also boosted by the operating strategy that we intend to do, especially we have planned significant budget to visiting professor for extended periods and short stays for PhD students in a framework of collaborations with foreign universities. This mobility strategy should allow foreign researchers to initiate collaborative projects and therefore to lead us toward an added-value on our research activities.

The project plans the creation of international chairs with the aim to attract renowned foreign researchers with high potential to accompany us on the themes with intent to develop. We would also encourage international mobility by sending young doctoral students abroad in the best laboratories but also welcoming foreign students during their thesis to share our analytical and synthesis platforms. Some of our challenges (WP) have placed the international mobility at the core of their strategy

SYMMECOM will intent to attract young people to careers in research. These actions will be conducted to both secondary school and undergraduate students. We have good experience in this aspect; several of us participated for many years to programs "Physique – Chimie itinérante". The goal of these programs is to promote science and research careers. Programs are also targeted to undergraduate students. A major focus will be given in this direction and we plan to spend a budget of 20 k€/y to support these actions, that we will do in synergy with other actors of the university and engineering schools.

The master degree is the pivotal period between training and the beginning of a first research experience. To attract the best students in our university, we plan to set up a financial support scheme to select the best of them in our laboratory as PhDs later. We would plan 5 grants per year (8000 euros each - budget of 40 k€/y).

The attractiveness of SYMMECOM also consists in welcoming and in assisting foreign students. To success this challenge, currently poorly managed, we will use the existing structures within the PRES ULNF which are currently in progress. Within the PRES, the **Euraxess** Service and Mobility centre offers its expertise, that has been developed since its creation in 2004, greatly facilitating mobility schemes for professors and researchers, together with their families when needed. A range of services is on offer to cater for specific needs such as: arrival facilities, housing, administrative papers, on-hand assistance with integrating the family (locating appropriate maternity needs, day-nurseries and schools), organising day-to-day life, practical information, etc. The welcome procedure corresponds to the international standards of researchers, and clearly aims at removing each and every obstacle that can impair international mobility, removing the hassle of inevitable issues, thus

contributing to the attractiveness and appeal of an international academic and research experience within the Nord-pas-de-Calais region.

The PRES ULNF is currently in the way to restructure further the regional organisation of the welcome procedure of first-class researchers as an actual strategy to enhance the appeal of our higher education institutes. This will be achieved by developing a specific welcome structure for international research staff and students that will focus on the existing mobility centre. This fully-comprehensive centre will be an essential lever in the following: the regional centre for resources and networking (pooling experience and skills, on-line regional guide,…) - choice of accommodation offers - range of tailor-made services - information on available French as a foreign language programmes (prior to arrival and on the spot) - discovering the cultural and economic assets of the region - highlighting social activities for the international community - intercultural training for local admin staff on each campus - working closely with local government (the Prefecture for official papers, CAF family allowance Office, CPAM Social Security centre, etc…)

The know-how devised from this new structure will bring extra added-value to the stay of all the international researchers, facilitate their stay, and enhance the image of research in the North of France.

5.3. STRATEGIE DES ETABLISSEMENTS TUTELLES/ STRATEGY OF THE SUPERVISING INSTITUTION

A) The scientific strategy of the PRES "Université Lille Nord de France" (ULNF)

The Establishments of Research and Higher Education supporting the LABEX project have a common research strategy within the PRES ULNF. Through this strategy, the PRES-ULNF aims to be an international leader in research/training in certain scientific fields of high socio-economic impact with a domino effect to other fields with high research potential. It also aims to drive the territorial and socio-economic development through innovation. The roadmap for this strategy includes the following priorities:

- Organization of research around excellent scientific clusters
- Increasing the international attractiveness of research and training programs.
- Enhancing the education and lifelong training programs.
- Reinforcement of the research impact on the territorial and socio-economic development through innovation

Organization of the research around excellent scientific clusters

The scientific strategy of the University Lille Nord de France consists in the structuring of the research around excellent clusters having already a strong international recognition with a domino effect for sectors with high research potential. The scientific programs of these clusters correspond to the priorities of the 7th Framework Program for Research and Technological Development (FP7) in particular, Health, Information and Communication Technologies; Nanosciences, Nanotechnologies; Materials and new Production Technologies,

Environment, Transport and Socio-economic Sciences and Humanities. They also correspond to the three priorities of the National Strategy of Research and Innovation (SNRI).

For each cluster, the partners' strategy is based on the creation of seven LABEX presenting a high scientific potential. The research perimeter of excellence is based on the following projects:

- A Labex in the field of Science and Technology of Communication and Information
- Three Labex in the field of Biology/Health,
- A Labex in the field of the Environment "Physico-Chemistry of the Atmosphere",
- A Labex in the field of Chemistry and Materials Science (**SYMMECON**),
- A Labex in the field of the Human Social Sciences "Argumentation".

Each LABEX is created on the basis of a scientific project with a flexible structure in charge of supporting management by project, multidisciplinary research and emergence of new projects on challenging issues. A logistic support will be devoted for the preparation and management of both ANR and European projects. In addition to the European space, they should reinforce their partnership with countries with high scientific capacity.

The scientific equipment constitutes also a priority. It concerns the reinforcement of the capacity of scientific facilities through an ambitious investment policy and the allocation of human resources. The objective is the positioning of the scientific facilities at the international standards. Particular interest is given to the access of these facilities to the scientific community by encouraging various forms of hosting and the establishment of "Project Hotel". PRES – ULNF provided a support for EQUIPEX projects related to excellent clusters. The management of these projects will be conducted in synergy with LABEX through an integrated management.

Enhancing the internal attractiveness. The attractiveness is a fundamental part of the scientific policy of the University Lille Nord de France. The development of clusters of excellence is subjected to the ability of these clusters to attract both highly talented researchers and students to the master and PhD degrees. A proactive policy of attractiveness will be implemented with the support of Local Authorities. This policy will be based on the allocation of specific resources to attract and keep talented researchers. These means include both the scientific environment (scientific equipment, logistic support, scientific position, research grants post-doc, high-level training for masters and doctoral programs,..), and the establishment of attractive careers. Attractiveness will be developed through tracking actions and the implementation of various procedures such the PRES international Chair and an extensive use of the local, national and European opportunities such as the chairs of excellence of the Region, the ANR program (Chair of Excellence program and post-return, ..) and the PEOPLE / Marie Curie FP7 program.

Enhancing the education and life-long training programs. Clusters already rely on a large base of training programs (masters, engineering schools and doctoral schools). The objective of the PRES -ULNF is to emerge international training programs to attract talent candidates

and to train students in an open international environment. This action aims to establishing a recruitment pool of doctoral students and to train executive graduates to creative and scientific approach. Specific resources will be devoted to these training programs to reinforce their national and international attractiveness.

The life-long training constitutes also a priority for the clusters policy. This training beneficiates of the great achievement and expertise in this field of the PRES-ULNF members. The doctoral program will be re-organized by the creation of a doctoral school for each cluster. Doctoral Schools will focus on providing doctoral students with an additional high-level scientific training, interdisciplinary openness and an awareness of intellectual property and societal and international issues. They should also widely implement the international mobility and the doctoral attractiveness program.

Enhancing the research impact on the territorial and socio-economic development through innovation. Innovation is a key element for both the promotion of research and for the economic and social development. Both the innovation and technology transfer activity constitute a high priority of the PRES-ULNF. Substantial support will be given to the establishment of an innovation ecosystem in partnership with the support of the Local Authorities, the State and economic partners. Priority is given to establishing strategic relation with leading companies, to support small and medium companies and to reinforce the partnership with the competitiveness clusters. A particular attention is paid to the territorial development through the involvement in the competitiveness clusters in the Region (I-Trans, NSL, PICOM, MAUD, UPTEX, AQUIMER, TEAM2), the Economic Excellence Clusters created within the framework "Regional Scheme for Economic Development (SRDE) and the park of technology: EURASANTE (Health/Biology), Haute Borne (Technology), Euratechnologies (IT) and Plain Image (image creation).

The development of the innovation/transfer activity will be enhanced by the establishment of a SATT (Society for the acceleration of the transfer and technology) comprising members of the PRES-ULNF and the Universities of Amiens and Reims. The SATT will be in charge of the maturation of innovative projects, management of intellectual property and technology transfer. It will also provide a high level of expertise in legal, financial and management of partnership projects with the industry.

B) Strategy for SYMMECOM

University Lille 1: Through the LABEX "Molecular systems and Materials under Complex Environments », the University Lille1 aims to become an international leader in the field of "Molecular and Material Science" and to actively participate to the territorial and socio-economic development through innovation.

This LABEX emanates from a major scientific field in the region Nord Pas de Calais with more than 400 scientists, PhD students and administrative and technology staff. It also beneficiates of an exceptional set of advanced analytical platforms (NMR, EPR, electron microscopy, XRD, mass spectrometry, vibrational spectroscopy, surface analysis)

Research groups involved in this Labex are very active in the training programs, innovation activity, international cooperation and collaborative research with the industry. They are also involved in multidisciplinary research programs with other scientific fields, for instance biology, health, Earth Sciences and nanotechnology.

We believe that the exceptional potential of this LABEX together with the high quality management and the strong support of partners through additional human resources and scientific facilities, will present an attractive environment for high level scientists and students and for the development of promoting risky innovative research. This environment will be also conducive for student training, innovation and territorial and economic development.

University Lille1 largely supports this LABEX. In addition to the available human resources, scientific equipment and building infrastructure, the university is committed to provide additional support for this LABEX, in particular in human resources. In addition to doctorate and post doc grants, positions for inviting talent international researchers for long period, University Lille 1 will provide 5 academic supports to the Labex. Morever, the University will supply, building and scientific infrastructure as well as administrative and logistic support and current expenses.

Ecole des Mines de Douai (EMD): The SYMMECOM Labex project directly matches the current strategic roadmap of the EMD. In that context, the contribution of the TPCIM team of the MPE research unit in two work packages corresponds to the decided orientation towards living matter sciences and health related issues and to the strengthening of the EMD expertise in polymeric materials. The above-mentioned strategic priorities have led the EMD to continuously invest in this area (permanent staff, buildings and heavy equipments) for many years so as to constitute a first-class platform dedicated to compounding/forming processes of advanced polymeric systems, unique in France. EMD would be ready to contribute to the SYMMECOM Labex over the next 10 years in the following manner: participation of TPCIM faculty members (equivalent to 4.8 full-time researchers, corresponding to 6.6 M€ full-cost salaries (i.e. salaries+overheads)) and access in the frame of collaborative projects to the above-mentioned polymer processing platform for which a complementary equipment (pharmaceutical extruder + clean room) is asked in the present Labex project. Providing the validation by the EMD Board of Trustees, the appointment of an additional faculty member within the TPCIM group would be moreover considered (redeployment of existing positions).

ENSCL: The SYMMECOM project fits perfectly the ENSCL objectives with about 60% of its academic staff involved in the project, mainly WP2, WP3, WP4 and WP5. The strategy of the ENSCL is to continue its policy of support to its research units, with teaching delegation for young academics, financial support to scientific projects and support to international exchanges. A new lecturer in the field of materials of nuclear was recruited in September

2010 and there is currently some discussion to introduce this field in the training. Moreover, in the coming years we will do our best to create an industrial chair in this domain.

5.4. RELATION AVEC LE MONDE ECONOMIQUE/ CONNECTIONS TO THE ECONOMIC WORLD

Most of SYMMECOM partners are already deeply involved in collaborations with industry. Total, IFP, Arkéma, Adisséo, Renault S.A. GDF Suez, Sanofi Aventis, Servier, CNES, DGA, Hollyday Pigments, AREVA, EDF are among the main partners. Some of those collaborations were initiated through ANR projects. Long term collaborations have already proven their efficiency through various patents.

For instance, in the domain of materials science for health, licences with exclusivity of exploitation were recently clinched. These agreements concerned Perouse Medical which is going to launch a vascular prosthesis issued from collaboration with the SYMMECOM partners by the end of 2010. In the next future, other medical devices based on developments carried out in UMET are going to be launched: a hip prosthesis (Bone & Joints Research), a visceral mesh (Cousin Biotech), an antiviral mask (NOTIVIR project). The perspectives for these industries are the penetration of foreign markets, and the expected economic fallout will firstly have repercussions on employment. This strategy will of course be prolonged in the next 10 years, in relation with the SYMMECOM challenges exposed above. We are already in contact with some companies of the pharmaceutical domain that would be interested in the investigation of the grafting of their drugs onto medical devices. In parallel, we are in touch with various medical devices manufacturers that would be interested in the functionalization of their products with drugs. Being at the interface of both these industries, good perspectives of technology transfers can be expected. In our experience, the lead time extension between the beginning of the investigation in the laboratory and the commercialization of a device should be at least 5-6 years. This includes not only the purely scientific aspects, but it also concerns the application for the authorization for trading.

In the field of Fire, the SYMMECOM have strong partnership with major companies and they are also involved in European consortiums (see the collaborations). Fire is undoubtedly an emotive subject, especially when it comes to scenarios that we can imagine in a “closed system” (e.g. ship or aircraft) and the possibilities to escape are restricted. So fire safety is a great concern of the industry to develop safer materials meeting the regulation. In the project, we will design new fire-safe materials from their processing including the formulations to their modeling. It will offer to the industry a unique expertise to fully control the material and its properties. In addition to this, the simulation of the material in the fire conditions will provide useful information for fire engineers and further for fire fighters. From this brief description, it is clearly shown that the project should attract industrial companies, governmental agencies, insurance companies and others. The project will also promote some aspects of the sustainable development which is of great concern in France and in Europe. We aim to strengthen the already existing collaborations and to create, based

on the very unique approach of the project, a worldwide network gathering industrial companies and governmental agencies supporting the development of fire safe materials. The same approach will prevail for materials in the field of energy and catalysis.

As mentioned previously, strength of our research environment is the presence of high-level analytical platforms (see the description of partner Chevreul, who manages most platforms) and the development of synthesis platforms in the frame of the SYMMECOM project. Among these platforms the REALCAT equipex project under examination has been submitted to build an integrated and versatile High Throughput Technologies (HTT) platform in order to contribute to R&D programs and to accelerate the development of innovative catalysts. The applications are centred on the rapidly growing and strategic biomass valorisation sector, but also on energy and environmental applications. Additionally, the target of such project also relies on fundamental approaches which should consolidate our competencies and should consolidate our attractiveness. The set-up of a platform devoted to materials for future energy will also be unique in Europe and will thus enhance attractiveness of SYMMECOM and offer opportunities for collaborative research. An important focus of the SYMMECOM project is to make them more legible by building a "**transfer center**" in charge of interaction with external academics and local, national and international companies. In order to ensure attractiveness of this center, we look forward to work with competitiveness clusters for dealings with the companies to be regularly informed of service offers (price, type of possible works...). The "transfer center", we plan, should enhance **interaction with regional-national (SMI-SMEs)** and **international companies**. The added value of our platforms will promote their quest for innovation of their products, in particular for the regional and national SMI-SMEs. The domain of expertise of the SYMMECOM project is wide and there is no doubt it will impact the local economy and lead to the creation of new employment, mainly at the local scale.

5.5. EFFET D'ENTRAINEMENT POTENTIEL/ PULL EFFECT

As built, SYMMECOM should generate a pull effect, both for the close research environment, training and transfers towards socio economic development. In this section, we list the effects we expect.

Training: The main orientation of our project is first to consolidate the existing Master Classes which have been reviewed positively with good ranking within the last AERES examination. Particular attention will be paid to The Advance in Spectroscopy and Chemistry Master actually managed by Lille 1 which is unique in the north of France with a network comprising more than 8 European universities. The second aspect concerns the development of master trainings (in particular the ERAMSUS MUNDUS project in material science in the North border area, see section 5.2.3) and the lifelong learning we are conducted

together with the college doctoral and the PRES ULNF. These efforts should attract the best students with a subsequent benefit for the excellence on the research activities of SYMMECOM partners and its close environment.

Analytical platforms. As already said, our Labex beneficiates of a **unique set of technical characterization platforms** of international level. The "transfer center" we plan to set up in the context of SYMMECOM should enhance interaction with external academics and regional-national-international industries and subsequently formal collaborations. This should strengthen academic research activities (and subsequent publications) as well as links and further contracts between research teams and manufacturers. The added value of our platforms will promote the regional and national SMI-SMEs in their quest for innovation of their products.

Synthesis platforms. Several platforms are the core of number of challenge we address in this project. The operating strategies of the platforms have been designed to generate networking with academic partners and business with future industrial partners. As an example of operating strategy, let us cite the **high pressure platform**, which presents a unique arrangement, mainly due to the continuum of pressure (0-140 GPa), with both the large volume modules and diamond anvil cell for small volumes. This is a unique configuration that will allow us to consider multiscale approaches, in synergy with the development of numerical calculations. It is essential to achieve major breakthroughs in understanding the deformation behavior of materials under high pressure. Other international high pressure centers exist in the world, complementary to ours, which are also developing their own instruments. We plan first the integration of our HP platform in an international network, second the establishment of an exchange program with best universities who work on high pressure (Bayreuth, Germany; Berkeley, Japan, Stony Brook ...) with funding stays for periods of 2-3 months for PhD students and professors, which should lead to fruitful collaborations and networking. For the **Future energies platform**, the aim is to develop a set of synthesis equipment that will enable to elaborate and characterize innovative molecular and iono-covalent compounds. It will contain an integrated line of syntheses and characterization under strictly controlled atmosphere (oxygen and water-free), based of interconnected glove-boxes. The platform will also contain ceramurgic equipment devoted to the elaboration of electrochemical devices like porous electrodes. This integrated set of equipment devoted to materials for future energy will be unique in Europe and will thus enhance attractiveness of SYMMECOM and offer opportunities for collaborative research.

Industrial pull effect. Our Labex project is based on strong scientific themes which aim at challenge both fundamental knowledge as well as important societal questioning (energies, biomass, materials for health …). Through the implementation of this labex, we expect to strengthen the interface with industry and to speed up the transfer of fundamental

knowledge to direct industrial applications. We already work with some of them but the high legibility of the Labex "label" should facilitate future collaborations with the objective that these industries invest more in the research activities we drive.

Academic networking. As explained above, the design of the project has a good potential to develop networking with the best laboratories over the world, mainly due to the development of specific synthesis platforms and the high level of our analytical platforms which support all the themes of the project. It should enhance research activities in our perimeter and associated publications.

6. JUSTIFICATION SCIENTIFIQUE ET FINANCIERE DES MOYENS DEMANDES / FINANCIAL AND SCIENTIFIC JUSTIFICATION FOR THE MOBILISATION OF THE RESOURCES

6.1. JUSTIFICATION DES MOYENS DEMANDES (SUR 10 ANS) / JUSTIFICATION FOR THE MOBILISATION OF THE RESOURCES

The ambition of the SYMMECOM Labex is to increase the attractiveness of Lille North of France and, in ten years, to become **a key laboratory with international recognition in the field of molecular systems and materials under complex environment**. SYMMECOM will rely on the **analytical platforms of international stature** currently supervised by the partners, but in order to strengthen and amplify industrial and international partnerships, **high level synthesis platforms** will be developed. These platforms are the core of the project and constitute an important part of the funding request. It will be a window, opened on outside, in connection to the economic world (industrial partners, SME/SMI, other universities…).

Most of personnel costs will be devoted to PhD, post-doc as well as grants to welcome international students and senior academics with the aim to increase international exchanges in the field of research but also in the field of teaching. For a better dynamic, to attract the best students in the SYMMECOM labex, a stress will be put on the **attraction of master students** with attractive grants for best students. For increasing exchange, **disseminations of results**, set-up of international collaborations, always keeping in mind the duality teaching/research, a part of the demand will concern travel cost.

6.1.1 PROJET DE RECHERCHE/ RESEARCH PROJECT

- *Équipement / Equipement (coût unitaire supérieur à 4000 euros HT)*

In the following, we summarized briefly the research workpackages. For each of them we indicate the estimate price for the implementation, running costs and human resources that are required. Only a part of the budget will be asked to the ANR (section 6.1); the rest will be provided by the partners (section 6.2).

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WP1: Multiscale plastic behavior under high pressure

The aim of the "Multiscale plastic behavior under high pressure" project is to create a world leading facility for the study of plastic behavior under pressure with the aim of understanding materials in the conditions of the deep Earth (up to 140 GPa and 3500 K at the core/mantle boundary). To achieve this challenge, we will establish a **high pressure platform** with a unique configuration, combining the possibilities of deformation experiments of samples in the range of 0-15 GPa and 300-2500 K (combination of a multi-anvil press, a "Walker" and D-DIA module for mm-sized sample) and experiments in the 0- 150 GPa pressure range and 300-5000 K temperature range (diamond anvil cell with laser heating module for 100 μm sized samples). This will have to be completed with up-to-date numerical facilities for the computational side of the project. This is a unique configuration that will allow us to consider multiscale approaches, in synergy with the development of numerical calculations. It is essential to achieve major breakthroughs in understanding the deformation behavior of materials under high pressure. The **creation of the platform is estimated at 825 K€**. Details are given below:

Fully equipped multi-anvil press: We will purchase a multi-anvil press that allows deformation experiments in the range of 0-15 GPa and 300-2500 K. This will include the body of the press, a "Walker" module for sample synthesis, and a "D-DIA" module for deformation experiments. To be purchased at the start of the project.

- ***Body of the press***: The framework is designed to generate a load of 1000 tons and to host different modules for high-pressure experiments under hydrostatic or non-hydrostatic conditions. Price estimate: 100 k€
- ***"Walker" module for sample synthesis***: The Walker module is a simplification of the traditional multianvil design. A cylindrical cluster of wedges is used to seat eight tungsten carbide anvils that represent the second level of pressure amplification. They compress an octahedra press medium containing the sample. The Walker module is a versatile device used for achieving pressures up to 25 GPa at temperature up to 2000°C. Price estimate: 100 k€

- *"D-DIA" module for sample deformation*: The D-DIA is an apparatus which is capable of generating pressures up to 15 GPa (or about 450 km depth in the earth) at high temperatures (up to ~2000C). This apparatus is a cubic anvil apparatus with two opposed anvils that can be loaded independently from the four others. It allows then, by advancing those two anvils while retracting the four others, to perform deformation experiments at constant confining pressure and at high temperature. Price estimate: 100 k€
- *Other associated equipments*: Price estimate: 100 k€

High temperature diamond anvil cell: In order to access experimental conditions in the 0-150 GPa pressure range and 300-5000 K temperature range, we will need to build a fully working high temperature diamond anvil cell laboratory. This will includes cells with so called "external heating" cells for experiments at well controlled and stable temperatures up to 1500 K (70 k€), a "double-sided laser heating" system for projects between 1500 and 5000 K (100 k€) and a pressure controller for diamond anvil cells (30 k€).

Sample preparation facility: This high pressure laboratory will have to be fitted with proper sample preparation environment: binoculars, EDM, computer controlled machining systems (CNC), etc. The estimate costs for the sample preparation environment is 100 k€.

Computing facility: The numerical side of the project will require access to up-to-date computer systems. Those will have to be upgraded every two years (4 times during the life of SYMMECOM). Cost estimate 125 k€ for the 10 years project

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WP2: Driven microstructures against fire: new polymeric systems

The project is multidisciplinary and it involves three groups of three different laboratories having specific expertise (multi-site). It gathers researchers of different areas working together and the best way to get fruitful collaborations and to promote the scientific exchanges is to have very high level PhD students and postdocs working. No equipment is asked on this WP.

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WP 3: Platform of elaboration of materials for future energies ; A novel platform will be dedicated to the elaboration and characterization of innovative molecular and iono-covalent compounds. It will contain an integrated line of syntheses and characterization under strictly controlled atmosphere (oxygen and water-free), based on interconnected glove-boxes. This

will be completed by ceramurgic equipment devoted to the elaboration of laboratory-scale electrochemical devices like porous electrodes or innovative seals. This integrated set of equipment devoted to materials for future energy will be unique in Europe and will thus enhance attraction of SYMMECOM and offer opportunities for collaborative research.

The aim is to strengthen partnerships with main actors in the field and increase international collaborations. One of the objectives will be to carry out studies using non radioactive lanthanides such as Ce or Nd, to simulate plutonium and minor actinides. The aim will be to select the most promising systems and define conditions of experiment before transfer to active systems in dedicated installation such as the ATALANTE laboratory. If plutonium and minor actinides are easily simulated with cerium or neodymium, simulation of uranium due to its original chemistry is more complex. For security reasons, although this element is an α emitter, with low activity, a dedicated laboratory will be set-up for experiments. It has been planned as an "hotel project" in the Chevreul Building. In this frame, **the preparation of new carbides precursors needs additional equipments** to allow the synthesis and characterization under inert atmospheres. In parallel, the **development of new materials for electrochemical devices** needs **a careful control of the ceramic microstructure** (preparation of dense electrolyte, preparation of electrode with controlled porosity, first electrochemical tests of single cells, elaboration and tests of sealing). This will be also included in this platform.

Our ambition is to increase our attractivity and, in ten years, to become **a key laboratory with international recognition in the field of Materials for future energy**. For this purpose our personal cost demand is mainly devoted to **international chairs in the field of chemistry of actinides and materials for energy**.

Equipment to purchase: The platform will be dedicated to the elaboration and characterization of innovative molecular and iono-covalent compounds. It will contain an integrated line of **syntheses** and **characterization under strictly controlled atmosphere** (oxygen and water-free), based of interconnected glove-boxes. This will be completed by **ceramurgic equipment** devoted to the elaboration of laboratory-scale electrochemical devices like porous electrodes or innovative seals. This integrated set of equipment devoted to materials for future energy will be unique in Europe and will thus enhance attraction of SYMMECOM and offer opportunities for collaborative research. It will be comprised of:

- A graphite furnace (*150k*€)
- A glove box with very low O_2 and H_2O concentration (*150*k€)
- A set of hydrothermal autoclaves working under controlled atmosphere (ex: Ar, N_2) (*100*k€)
- A dedicated X-ray powder diffractometer coupled with the glove box for direct analysis of carbide precursors (*100*k€)
- Furnaces for precursors synthesis *(20k€)*
- Tape casting for ceramic layers (electrochemical cells) 50k€, Screen printing *(30 k€)*
- A test station for single SOFC or electrolyzer cell test (Frequency analyzer *150*k€), gas

distribution *40*k€
- Automated seal-precursor dispenser (*10*k€) Gas leak detectors *(50k€)*
- Other associated equipment *(150k€)*

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WP4: **Smart nano reactors: towards optimized activity and selectivity**

This project is dedicated to the miniaturiazation of homogeneous and heterogeneous catalytic reactors with concerted and multiscale approaches. It involves the elaboration of nano- or micro-sized reactors and their characterization via time-resolved and ultra fast spectroscopic tools, which help to understand molecular processes taking place in order to optimize the efficiency of those miniaturized reactors. To succeed in our challenge, the equipment is based on two complementary aspects. (i) The relative impact of the architecture of homogeneous and heterogeneous catalysts on their catalytic performances implies the elaboration of miniaturized specific reactors, which will be developed using microfluidic tools. (ii) These micro-nanoreactors will be characterized using devices dedicated to surface characterization of heterogeneous catalysts, and with time-resolved and ultra fast spectrometers.

The "catalytic microreactors" platform (770k€) – elements to purchase

Reactors for oxidations: A multi-post microwave device will allow the screening of various reaction conditions as well as various catalysts within a very short time especially for hydrogen-peroxide-based reactions such as epoxidation, alcohol oxidation, aromatic hydroxylation, olefin cleavage... which can require relatively high temperatures. The second reactor will be more dedicated to catalytic oxidation reactions involving oxygen. As some catalytic amphiphiles will also be designed to oxidations with O_2, a reactor with specific features (powerful stirring of micro-dispersed systems such as emulsions, controlled oxygen pressure...) will be required. *Price: 60 k€*

Dectector of IR-Luminescence: The Group has, for a long time, an expertise in dark singlet oxygenation. A home-made near-infrared spectrometer has been designed to detect the IR-luminescence of singlet oxygen generated from the decomposition/disproportionation of hydrogen peroxide by various catalysts in different reaction media. The liquid nitrogen-cooled germanium photodiode detector used in this device is now out-of-date and need to be replaced by a more sophisticated one, in order to be used on-line with the reactor for oxidation. Such an apparatus will be unique in France. *Price: 30 k€*

Microfluidic microreactors: All the work developed until now has been performed on homemade microfluidic microreactors. In the frame of the SYMMECOM labex we are planning to install a commercially available microreactor system based on a system produced by Corning which is all in glass and which is becoming one of the standard equipment in the fine chemical industry. This system is highly flexible: (i) the number of microreactors may be increased for increasing the production; (ii) several microreactors for different purposes are also available (reaction requiring standard mixing, catalyzed reactions…). The use of a standard microreactor platform will favor collaboration with the industrial partners and the training of Ph D. student for their recruitment. *Price: reactor "staring kit" and specific devices 200k€ + 150 k€ for a complementary kit*.

Surface specific and porous volume analysis: This device is dedicated to detailed investigations of the textural properties of catalytic materials from micro to mesopores involving surface, pore size and porous volume distribution. Two separate and isolated thermal pre-treatment and analysis cells under high vacuum at high temperature allows the analysis of microporous solids such as zeolithe which will be used as typical nanosized reactors for ultra-fast spectroscopic measurements. This equipment will be useful for routinely characterising hierarchically ordered mesoporous materials further utilized as support for further functionalization. *Price: 90 k€*

Lasers: The proposed time-resolved experiments in micro/nano fluidic devices and structured solids require the use of sophisticated ultrafast optical spectroscopic techniques. These techniques are generally based on the use of amplified femtosecond laser sources which include several elements in particular pump lasers and tuneable Optical Parametric Amplifiers. The requested funds are devoted to buy those elements to maintain and complete our sources. *Price: 100 k€*

Operando mass spectrometry and High performance liquid Chromatography: The preparation of highly functionalized compounds through multiphasic catalytic transformations of a diversity of hydrophobic substrates will request efficient identification and quantification of the products of the reaction mixtures both on-line for kinetics measurement and off-line hyphenated with LC for minor product identification. A mass spectrometer coupled with liquid chromatography is the most straightforward analytical tool for a rapid analysis and identification of complex organic products in catalytic reaction mixtures. We request thus a financial support for the acquisition of a LC/MS equipment. *Price: 100 k€*

Langmuir-Blodgett trough: The project aims at developing new catalytic amphiphiles which will be used for the elaboration of new micro-dispersed catalytic reaction media. Some of them will present low solubility in water and/or in organic solvents. However, their physicochemical characterization will be required to understand and predict their behavior

in ternary systems. The formation of insoluble monolayers at controlled packing densities is of great interest and would bring additional information. The determination of "surface pressure isotherms" is a common tool in the study of little soluble amphiphiles. *Price: 40 k€*

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WP-5. Biomass valorization through an integrated biorefinery

The aim of this platform, named REALCAT (to be financed by EQUIPEX), is to **build a versatile High Throughput Technologies (HTT) platform** in order **to accelerate the development of innovative catalysts used for biomass valorisation.** The objective is **to divide the time of development of a catalyst by, at least, a factor 10**. In the short term, the REALCAT platform is intended to be used within the frame of collaborations with French or foreign laboratories involved in catalysis research. We have the potential of re-energizing the biomass production, growing the industry and achieving the original dream of biomass sustainability across the whole of Europe.
No additional resource is expected for this WP since it is funded by other means (FP7, industrial partnerships,…). Thus this platform is not considered in the following mobilisation of resources.

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WP6: Material science for Health

The "Materials for Health platform" will include tools for manipulating the structural state of drugs and tools for the functionalization and characterization of surfaces for biomaterials.

Pharmaceutical Material Sciences aim to manipulate the structural and micro structural states of drugs in order to improve their therapeutic properties. This can be done by a variety of physical synthesis methods. The actual platform already includes usual thermal methods as well as mecano synthesis methods (milling, co-milling, and cryogenic milling). However, it is highly desirable to extend these methods to the many synthesis processes increasingly used in the pharmaceutical industry in order to cover a broader range of polymorphic and amorphous states. It is in particular essential to have at our disposal the freeze-drying, spray-drying and hot melt extrusion techniques.

Freeze drying, Spray drying and electrospray. Freeze drying is essential to amorphize labile materials (proteins for instance) which do not withstand temperature elevations and it provides porous microstructures promoting dissolutions. Spray-drying suits to industrial applications as it allows a fast and continuous production of material. It provides small material particles (100-200µm) which also promotes dissolution. It will also be necessary to

develop equipment dedicated to original amorphization techniques like electrospray and vapor deposited. *Cost estimate: 300 k€*

Hot melt extrusion: We will purchase a modular twin screw extruder designed for small-scale continuous processing (1-5 kg/h) in research and development in the pharmaceutical industry. The stainless steel extruders will be built to GMP standards with a focus on a clean, streamlined design. Quick release clamps will give easy access to screws and process contact surfaces for cleaning or configuration changes. Both barrel liners and the screws themselves will be easily removed for cleaning or product changeover. The barrel will be modular, with interchangeable segments for feeding solids and liquids, or for venting. The screw design will also be modular, which is essential to control both shearing and residence times, at given screw speed and temperature settings and so to control the extreme conditions imposed during medical product processing and consequently the medical product structure and properties. It will be possible to optimize the screw design and processing parameter setting for each product by calculation using specified twin screw extrusion simulation software, already available on the EMD polymer processing platform. Based on the same technology than industrial production tools, the scale-up to industrial production conditions will be greatly facilitated compared to other laboratory devices. This equipment is complementary to the other machines available on the EMD polymer processing platform**.** *Cost estimate: 305 k€ (+ extra clean room 90 k€ contribution EMD cf. § 6.2)*

For biomaterials

- a **QCM-D**, by collecting both the dissipation and the resonance frequency of a quartz crystal, QCM-D technology can be used to characterize the formation of thin films (nm) such as proteins, polymers and cells onto surfaces, in liquid. Complex edifices, such as polyelectrolyte multilayers, can be characterized at any time during their build-up process. Multi-frequency measurements and adapted modeling provide quantification of the film's thickness and viscoelastic properties. Cellular adhesion can be monitored in real time. QCM-D is most sensitive to events that happen close to the surface, being particularly sensitive to the cell's adhesion sites, Biofilm formation or cell adhesion can be detected at a very early stage, QCM-D technology offers the possibility to employ various purpose-designed coatings, creating the opportunity to screen different surfaces for cell adhesion and/or biofilm formation. This apparatus is complementary to other available surface analysis techniques such as E-SPR and E-QCM- (*Cost estimate: 100 k€*)
- **a drop Shape Analysis System DSA100 + high pressure measuring and thermostatable environmental chamber**. This analysis system is currently used for the characterization of surfaces during the different steps of their functionalization. Data obtained allow foreseeing the mechanisms of adhesion of cells on surface. For example the biological phenomena involved in cell or bacteria adhesion is different on hydrophilic and hydrophobic surfaces. In addition, different types of cells will present affinity/repulsion behaviors towards hydrophobic/hydrophilic surfaces.

In combination with the Drop Shape Analysis apparatus, the high pressure measuring and thermostable chamber permit the phenomenologic observation of phase transitions and swelling processes. Therefore this would be an absolutely necessary instrument in our coming investigations - (*cost estimate: 80 k€*)
- a **Zetameter** - This apparatus allows measuring granulometry, zeta potential and molecular weight. It allows clarifying the interactions concerned in the systems dispersed by the means of measurements according to the pH or conductivity- (*cost estimate: 120 k€*)

Summary of the equipment cost of the synthesis platform (from details above)

- "High pressure platform"	825 k€
- "Materials for future energies platform"	1000 k€
- "Catalytic Nano-reactors"	770 k€
- "Materials for Health platform"	905 k€
Total :	**3500 k€**

This financial support is asked at the start of the project, within the first 2 years.

- *Personnel / Personnel cost*

Le personnel non permanent (thèses, post-doctorants, CDD...) financé sur le projet devra être justifié.

Pour chaque poste, donner le coût unitaire et la durée prévue (en mois).

Technical support: To run the platforms, four technicians are required (see above). For work package 7 "Chevreul Institute Access", we anticipate a senior engineer, a junior engineer and a secretary. The essential part of the human resource will be provided by University Lille 1 (see letter of intent).

PhDs : Between 20 and 25 PhD per year will work on the platforms. For the total duration of the project, we expect that about one hundred PhDs for the full time of the project. The PhD funding will be mainly provided by the partners on contracts (ANR, FUI, European project …). We ask a contribution to ANR-Labex for 8 PhD theses over the 10 years of the project (one per year, starting from year 1 to year 8). Cost for one PhD = 3 x 35 = 105 k€ for the three years – Total = 8 x 105 = 840 k€. The affectation of the PhD on workpackages will be ensured by the governance committees of SYMMECOM.

Post-doc: Around 15 post-docs each year will work on work packages 1-6. We ask for a participation to the ANR-Labex for 5 post- doc/year (5 x 50 k€/y = 250 k€/y), for the duration of the project (10 years – 2500 k€). The affectation of the post-docs on workpackages will be ensured by the governance committees of SYMMECOM.

International chairs: We ask for 4 years of international chair (4 x 140 k€/y = 560 k€) on the SYMMECOM project. The choice and the scientific themes (related to the challenges) will be ensured by the governance committees of SYMMECOM.

Total support in personnel: 840 (PhD) + 2500 (post doc) + 560 (chairs) = 3900 k€.

- *Prestation de service externe / Subcontracting*

Subcontracting will be supported by the partner's laboratories on contracts.

- *Missions/ Travel*

Préciser :

- *les missions liées aux travaux d'acquisition sur le terrain (campagnes de mesures…)*
- *les missions relevant de colloques, congrès…*

Dissemination of the results, networking, international conferences, will be supported by the partner's laboratories on contracts.

Short stay for international exchange: In order to ensure scientific exchanges and stimulate creativity, we will dedicate a significant portion of our running cost in the form of travel grants. These grants will be used to

- exchange graduate students with our prestigious collaborators (typical duration 1-3 months)
- invite world scientific leaders to use and visit our facility (typical duration 1-3 months).
- Training in best laboratories.
- Participation to summer schools for young scientists.

Total support for this action : 50 k€/y (total 500 k€)

- *Dépenses justifiées sur une procédure de facturation interne/ Expenses for inward billing (Costs justified by internal procedures of invoicing)*

We plan expenses for inward billing at about 100 k€/y. A large part of these expenses are related to the expertise works on the analytical platforms of the Chevreul institute. Total over the ten years = 1000 k€.

- *Autres dépenses de fonctionnement/ Other working costs*

Toute dépense significative relevant de ce poste devra être justifiée, dont les équipements de coût unitaire inférieur ou égale à 4000 euros HT.

During the life span of the project, the running cost to maintain the WP platforms will be supported by the partner's laboratories on contracts.

6.1.2 PROJET PEDAGOGIQUE/ EDUCATIONAL PROJECT

We devised a two level strategy based on the traditional education "formation initiale" on one side and on the training throughout life (formation tout au long de la vie) on the other side.

The first level consists in improving the attractiveness of the Masters in order to capture high potential students from France and from abroad. A guideline for our policy is to participate, maintain and develop new international cooperative formations like the ERASMUS MUNDUS Master. The existing MASTER (ACS) in our area will be proposed to be extended at the end of the first five years and actions are taken to maintain it once the European label will expire, since the ERASMUS MUNDUS label last at most 10 years. In the same order of ideas the ERASMUS MUNDUS Master "Materials science" project is strongly supported by the university. Besides academic support, industrial implication is foreseen from materials manufacturers and transformers of the north of Europe.

Concerning the second level of education, the organization each year of two to three days high level workshops devoted to people coming from the academic world or from industry will be accomplished. The objective of these schools is to gather technological and scientific information on the research developed by the Labex in order to contribute to technology transfer to the socio economic world.

- *Équipement / Equipement (coût unitaire supérieur à 4000 euros HT)*

Equipments related to the pedagogic project will be supported by the establishments of the partners (University Lille 1 and engineering schools ENSCL and EMD).

- *Personnel / Personnel cost*

Personnel will be provided by the establishments of the partners (University Lille 1 and engineering schools ENSCL and EMD).

However we aim to develop the lifelong training for our formations. We ask for 10 k€/y to welcome teachers within dedicated training courses related to the SYMMECOM project. These courses would be developed on short duration periods in order to optimize the welcome of long life learners. Total from year 3 to year 10 = 8 x 10 k€ = 80 k€.

- *Prestation de service externe / Subcontracting*
- *Missions/ Travel*

We anticipate 10 k€/y to promote the partners formations of SYMMECOM in France and in Europe - 100 k€ for the duration of the project

- *Dépenses justifiées sur une procédure de facturation interne/ Expenses for inward billing (Costs justified by internal procedures of invoicing)*
- *Autres dépenses de fonctionnement/ Other working costs*

The master degree is the pivotal period between academic training and the beginning of a first research experience. To attract the best students in our university, we plan to set up a **financial support scheme** to select the best of them in our laboratory as PhDs students in the followings years. We would like to plan 5 grants per year (8000 euros each - budget of 40 k€/y – **400 k€ for the duration of the project**).

SYMMECOM will intent to attract young people to careers in research. These actions will be conducted towards both secondary school and undergraduate students. We have good experience for these actions; several of us participated for many years to programs "Physique – Chimie itinérante". The goal of these programs is to promote science and research careers. A major focus will be given in this direction and we plan to spend a budget of 20 k€/y to support these actions, that we will do in synergy with other actors of the university and engineering schools. **Total over the 10 year project: 200 k€.**

Organization each year of two to three days **high level workshops or summer schools** devoted to people coming from the academic world or from industry will be accomplished. The objective of these schools is to gather technological and scientific information on the research developed by the Labex in order to contribute to technology transfer to the socio economic world. Asked contribution for this action: 15 k€/y, **total over the 10 year project: 150 k€.**

6.1.3 VALORISATION/ EXPLOITATION OF RESULTS

- *Personnel / Personnel cost*

We plan to recruit **an engineer** to conduct with us the exploitation of research of SYMMECOM. His role will include the pre-industrial questioning and link with the research exploitation department and the incubator "cré-innov" of Lille 1 University and/or with "Nord de France Valo" in the future, as well as with the competitiveness clusters. We plan a salary of 60 k€/y, over the period year 3 to year 10 (480 k€).

- *Prestation de service externe / Subcontracting*

In order to improve the research exploitation of SYMMECOM, we plan to **externalize expertises** (diagnostics) related to our possibilities for patenting – 20 k€ form year 3 to 10 – 160 k€ for the 8 years.

- *Missions/ Travel*

In order to improve relations with industrial partners and exploitation of research structures, we plan to spent about 20 k€/y, over the period year 3 to 10 (160 k€).

- *Dépenses justifiées sur une procédure de facturation interne/ Expenses for inward billing (Costs justified by internal procedures of invoicing)*
- *Autres dépenses de fonctionnement/ Other working costs*

6.1.4 GOUVERNANCE/ GOVERNANCE

- *Personnel / Personnel cost*

We plan to recruit a secretary (half time) for the duration of the SYMMECOM project (20 k€/y – total = 200 k€ over the ten years).

- *Prestation de service externe / Subcontracting*

- *Missions/ Travel*

We plan 10 k€/y for the governance committees expenses, in particular to host the external members. We plan also 10 k€/y for the travel expenses of the directory board of SYMMECOM. Total 20 k€/y – 200 k€ over the 10 years.

- *Dépenses justifiées sur une procédure de facturation interne/ Expenses for inward billing (Costs justified by internal procedures of invoicing)*
- *Autres dépenses de fonctionnement/ Other working costs*

Summary of the mobilization of the resources asked to the ANR-Labex (in k€):

	Research	Teaching	Valorisation	Governance	Total
Equipment	3500	0	0	0	3500
personnel	3900	80	480	200	4660
Subcontractir	0	0	160	0	160
Travel	500	100	160	200	960
Inward billing	1000	0	0	0	1000
Other	0	750	0	0	750
Total	**8900**	**930**	**800**	**400**	11030

SYMMECOM	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year1	Total
Equipments	**2500**	**925**	**0**	**25**	**0**	**25**	**0**	**25**	**0**	**0**	**3500**
Personnel (research)	**285**	**320**	**495**	**495**	**495**	**495**	**355**	**355**	**320**	**285**	**3900**
PhD	35	70	105	105	105	105	105	105	70	35	**840**
Post doc	250	250	250	250	250	250	250	250	250	250	**2500**
Chairs	0	0	140	140	140	140	0	0	0	0	**560**
Travel (inter exchan	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**500**
Inward billing	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**1000**
teaching	**85**	**85**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**930**
Longlife training	0	0	10	10	10	10	10	10	10	10	**80**
Travel	10	10	10	10	10	10	10	10	10	10	**100**
Master grants	40	40	40	40	40	40	40	40	40	40	**400**
Communication	20	20	20	20	20	20	20	20	20	20	**200**
School organization	15	15	15	15	15	15	15	15	15	15	**150**
Valorization	**0**	**0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**800**
Personnel	0	0	60	60	60	60	60	60	60	60	**480**
Expertises	0	0	20	20	20	20	20	20	20	20	**160**
Travel	0	0	20	20	20	20	20	20	20	20	**160**
Governance	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**400**
Personnel	20	20	20	20	20	20	20	20	20	20	**200**
Travel	20	20	20	20	20	20	20	20	20	20	**200**
Total	**3060**	**1520**	**880**	**905**	**880**	**905**	**740**	**765**	**705**	**670**	11030

Management cost of the project (4%) = 440 k€

6.2. AUTRES RESSOURCES / OTHERS RESOURCES

Indiquer de façon détaillée les autres sources de financement prévues pour le projet ainsi que capacité du projet à générer de nouvelles ressources pour assurer la pérennité du LABEX.

Human resources (per year):

- About 170 researchers will be implicated in the research project in SYMMECOM, corresponding to 50 full time researchers of permanent staff (50 FTE - 600 person/month).
- About 30 engineers will be involved in the project, corresponding to 360 person/month
- About 50 PhD will work on the WP of the project: 600 person/month.
- About 12 post doc will work on the WP 144 person/month
- About 15 FTE for teaching SYMMECOM project: 180 person/month

The institutions to which the partners belong are committed to **increase the human resources in case of success of the Labex project.**

Equipments: The SYMMECOM project will benefit from an exceptional high level analytical plateforms (see summary in the Chevreul Partner section). These platforms represent a total investments of 27 M€ over the last 10 years, an average of 2.5 M€/y. We anticipate that this effort will continue over the next ten years. In addition to the expensive equipment, the partners will participate to the medium equipment on contrats (ANR, European programs ...) and from support of their institution. For instance, Ecole des Mines de Douai will support the implementation of the hot melt extrusion equipment by providing the extra clean room (90 k€).

EQUIPEX: two Equipex coordinated by SYMMECOM partners have been submitted in September (META and REALCAT). The platforms to be financed by these projects will be used by the SYMMECOM researchers. Part of budget for these equipments can be considered as external resources (as described in doc A).

Infrastructures: The SYMMECOM project will benefit from the infrastructures (buildings) of the partners (from University Lille 1 and Ecole des Mines de Douai). Note that the creation of the SYMMECOM Labex will occur simultaneously with the construction of a **new building** (**8 M €, 2500 m², "2008 campus plan"**) to house the research administration of the Chevreul Institute and training of masters, giving a combined central role to the structure. In this future configuration, SYMMECOM will benefit of the main strategic objectives
(1) Chevreul building will host three shared analytical platforms (electron microscopy, XRD, surface analysis), directly connected to all research topics developed within SYMMECOM and **two synthesis platforms** (High pressure, materials for future energies) that are a strong part of SYMMECOM.

(2) The building will offer a good opportunity to manage research associated to master courses.
(3) Complementary to the Chevreul building project, creation of a "Hotel à projet" and instrument housing space (10 M€, 3000 m², provided by the IEED project IFMAS French Institute for Agro-sourced materials) to promote industrial partnerships and related exploitation of results. With these three strong features, the SYMMECOM environment will be an attractive center for both the students and researchers, with SYMMECOM at heart of the system.

Contracts and industrial partnerships: The SYMMECOM partners are already involved in numerous research programs on former and ongoing projects at the national and European levels (ANR, FUI, Interreg IV, FP7…). They are also involved in contractual activities with private partners (see partner's description). Through the implementation of this labex, we expect to strengthen the interface with industry and to speed up the transfer of fundamental knowledge to direct industrial applications. We already work with some of them but the high legibility of the Labex "label" should facilitate future collaborations with the objective that these industries invest more in the research activities we drive.

7. ANNEXES / APPENDICES

7.1. REFERENCES BIBLIOGRAPHIQUES DE L'ETAT DE L'ART/STATE OF THE ART REFERENCES

Inclure la liste des références bibliographiques utilisées dans la partie « Etat de l'art ».

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2007- Préparation par voie directe de sels de cobalt ou de nickel d'hétéropolyanions d'Anderson combinant dans la même structure le molybdène et le cobalt ou le nickel utilisés pour la préparation de catalyseurs d'hydrotraitement , Invention de D.Guillaume, E. Payen, C. Lamonier, K. Marchand, Numéro d'enregistrement national 06/06.828, Extension brevet européen 06/07/2007 n° 07290854.4-2104.

2008-Préparation d'acide indoline carboxyliques. A. Maj, F. Agbossou-Niedercorn, G. Servant, en cours de demande par Oril Industries

2010-Composition vitreuse atocicatrisante, son précédé de préparation et utilisation, PCT/FR2010/051012, Lionel Montagne, François Méar, Daniel Coillot Procédure internationale, Date de dépôt: 27/05/2010

2010- Procédé de Préparation d'une Alumine à Mésoporosité Contrôlée, Loïc Rouleau, Sébastien Royer, Christine Lancelot, Franck Dumeignil, Edmond Payen, Pascal Blanchard, brevet mondial WO 2010/004106, publié le 14 Janvier 2010 – Brevet français N°08 03691, publié le 1er Janvier 2010.

Analytical Platforms

Facility	**Nuclear Magnetic Resonance**
Director	Laurent DELEVOYE, Jean-Paul AMOUREUX, Guy LIPPENS
Key equipment	800 and 900 MHz NMR spectrometers for solids / liquids
Label	TGIR CNRS RMN very high magnetic field
Equipment list	900 MHz NMR NB (2009) solids / liquids 800 MHz NMR NB (2004) solids / liquids 400 MHz NMR WB solids / liquids 400 MHz NMR WB solids 400 MHz NMR NB liquids 300 MHz NMR NB liquids 100 MHz NMR WB solids
Equipment investment cost	11 millions euros
Engineers	J. TREBOSC (IR CNRS Chevreul Institute), X. TRIVELLI (IGR USTL), M. BRIA (IGR USTL), B. REVEL (ASI USTL)
Partners from Institut Chevreul	UMR 8181 (UCCS), UMR 8207 (UMET), UMR 8516 (LASIR), USR 3290 (MSAP) & EA 4478(CMF)
Partners from PRES ULNF	UMR 8576 (UGSF)
Other public partners and collaborators	*Région NPdC*: Ecole des Mines de Douai, ENSAIT, Univ-Valenciennes, *France*: Univ. Pierre et Marie Curie, CNRS Orléans, Univ-Rennes, ICMC-Bordeaux, *Outside France*: Univ. Missouri-Rolla (USA), Talahassee (USA), Bombay (Inde), Madrid (Espagne)
Private partners	BRUKER, JEOL, SNECMA, Saint-Gobain, CEA-AREVA, Roquette, Pierre Fabre, ANIOS, SASA, Total.
Research expertise	Quadrupolar nuclei, low-gamma nuclei, ceramics, glass materials, flame retardants
Methodological developments	Resolution and sensitivity enhancement for quadrupolar nuclei (homo- and heteronuclear recoupling or decoupling, indirect detection). Ab-initio calculation of NMR parameters, especially 17O and low-gamma nuclei. The NMR research group is composed of 1PR, 2MCF, 1CR.
Schools and Trainings	International workshops in solid-state NMR (annual), India, China, Japan, Brazil, Korea, France. Annual national practical training to solid and liquid NMR.
Key Projects within 2 years	Dynamic nuclear polarization (DNP)
Notes, remarks	Member of the « groupement scientifique Nord-Pas de Calais, Résonances Magnétiques » (RMN, RPE). Member of the federation « Very high field NMR » FR2950.
3 major publications	Mazoyer, E., Trébosc, J., Baudouin, A., Boyron, O., Pelletier, J., Basset, J-M., Vitorino, M. J.,Nicholas, C. P., Gauvin, R., Taoufik, M., Delevoye, L., Heteronuclear NMR Correlations to Probe the Local Structure of Catalytically Active Surface Aluminum Hydride Species on γ-Alumina, Angew. Chem. Int. Ed., in press **2010**. DOI : dx.doi.org/10.1002/anie.201004310 Lafon, Olivier; Wang, Qiang; Hu, Bingwen; Trebosc, Julien; Deng, Feng; Amoureux,

	Jean-Paul. Proton-proton homonuclear dipolar decoupling in solid-state NMR using rotor-synchronized z-rotation pulse sequences. *J. Chem. Phys.* **2009**, *130*, 14504-14513. Samyn, Fabienne; Bourbigot, Serge; Jama, Charafeddine; Bellayer, Severine; Nazare, Shonali; Hull, Richard; Castrovinci, Andrea; Fina, Alberto; Camino, Giovanni. Crossed characterisation of polymer-layered silicate (PLS) nanocomposite morphology: TEM, X-ray diffraction, rheology and solid-state nuclear magnetic resonance measurements. *Eur. Polym. J.* **2008**, *44*, 1642-1653.

Facility	**X-Rays**
Director	Pascal ROUSSEL
Key equipment	**APEX 2 DUO CCD 4K diffractometer** equipped with de 2 μ-sources (Mo et Cu) and a low temperature chamber **Rigaku Smartlab rotating anode diffractometer** (9kW) for high resolution studies (Ge(220)x2 et Ge(220)x4 incident monochromators) on polycrystalline materials (transmission and reflection mode) and on thin films – Eulerian cradle – high temperature Anton Paar DHS1100 chamber – scintillation counter and high speed detector (Dtex).
Equipment list	♦ **Bruker Apex II DUO CCD 4K single crystal diffractometer** equipped with 2 μ-sources (Mo et Cu) for room and low temperatures experiments ♦ **Bruker Apex II CCD 4K single crystal diffractometer** for room and high temperatures experments ♦ **Bruker D8 powder diffractometer** for studies in different atmospheres up to 1200°C (Anton Paar HTK1200N chamber) – high speed detector (Vantec 1) ♦ **Bruker D8 powder diffractometer** for studies in different atmospheres up to 900°C (Anton Paar XRK900 reactor chamber) – high speed detector (Lynxeye) ♦ **Bruker D8 powder diffractometer** for room temperature experiments – sample-changer 90 positions – high speed detector (Lynxeye) ♦ **Rigaku Smartlab rotating anode diffractometer** for high resolution studies (Ge(220)x2 et Ge(220)x4 incident monochromators) on polycrystalline materials (transmission and reflection mode) and on thin films – Eulerian cradle – high temperature Anton Paar DHS1100 chamber – scintillation counter and high speed detector (Dtex). ♦ **Panalytical Xpert Pro powder diffractometer** equipped with low temperature device (Anton Paar TTK 450 : from -193°C to 450°C) + controlled humidity chamber (Anton Paar THC) + capillary furnace + incident beam monochromator (Kα1) – high speed detector (Xcelerator) ♦ **INEL G3000 powder diffractometer** – incident beam monochromator (Ka1) – low and high temperature devices (transmission and reflection mode) – microdiffraction – curved detector (CPS120) ♦ **Panalytical Xpert Pro powder diffractometer** – Co Kα to avoid fluorescence on ferrous materials ♦ **SAXS and WAXS equipment** – Image Plate and CCD detectors
Equipment investment cost	4 millions euros
Engineers	F. CAPET (IR CNRS), F. DANÈDE (IE USTL), L. BURYLO (ASI ENSCL)
Partners from Institut Chevreul	UMR 8181 (UCCS), UMR 8207 (UMET), UMR 8516 (LASIR) & EA 4478(CMF)
Partners from PRES ULNF	UMR 8520 (IEMN)
Other public partners and collaborators	*Region NPdC* : Ecole des Mines de Douai, Univ. Valenciennes, Univ. Dunkerque ; *France*: Univ. Amiens, Univ. Caen, ICMC-Bordeaux, Ecole Chimie Paris, Univ. Lyon ; *International* : Académie Sciences Rép Tchèque, Bombay (Inde), Sao Paulo (Brésil).
Private partners	SNECMA, Saint-Gobain, AREVA, CEA Le Ripault, CEA Grenoble, CEA Marcoule, Roquette, Total, Peugeot, EDF
Research expertise	Transition metal oxides – Materials for fuel cells – Nuclear Materials – Materials for therapeutic use – Polymers
Methodological developments	Solving modulated structures commensurable or incommensurable (N-dimensional formalism) - Electron crystallography (application of the X-rays formalism to electronic diffraction data), in-situ characterisations
Schools and Trainings	Groupement scientifique Nord, Pas-de-Calais rayons X – neutrons, regular organization of seminars and theme days

3 major publications	A. Hedoux, J.F. Willart, L. Paccou, Y. Guinet, F. Affouard, A. Lerbret, M. Descamps, Thermostabilization mechanism of bovine serum albumin by trehalose. *J. Phys. Chem. B* 2009, *113*, 6119-6126. V. Miri, S. Elkoun, F. Peurton, C. Vanmansart, J.M. Lefebvre, P. Krawczak, R. Seguela, Crystallization Kinetics and Crystal Structure of Nylon6-Clay Nanocomposites: Combined Effects of Thermomechanical History, Clay Content, and Cooling Conditions. *Macromolecules* 2008, *41*, 9234-9244. M. Iorgulescu, H. Kabbour, N. Tancret, O. Mentré, P. Roussel, $Ba_8Co_2Mn_6ClO_{22}$, a quasi-1D hexagonal perovskite polytype containing new 8H-blocks, *Chem Comm*, 2010, 46, 5271–5273.

Facility	**Electron Spin Resonance**
Director	Hervé VEZIN
Key equipment	Pulsed EPR spectrometer ELEXYS E580 9 GHz
Label	
Equipment list	ESP300 Continuous wave 1990 Pulsed EPR ELEXYS E580 9 GHz 1999 Pulsed ELDOR accessory 2003 Pulsed ENDOR accessory 2009 ELEXYS E500 Continuous wave 1990 Laser Yag and electrochemistry apparatus for in situ EPR experiments
Equipment investment cost	2 million d'euro
Engineers	Nadia TOUATI IE CNRS
Partners from Institut Chevreul	UMR 8181 (UCCS), UMR 8207 (UMET), USR 3290 (MSAP) & EA 4478(CMF)
Other public partners and collaborators	ENSCP UMR 7574, Amiens UMR 6007.
Research expertise	Structure, dynamic and reactivity
Methodological developments	Development of a new type of imaging Electron Paramagnetic Resonance in X-band which will image the nuclear spins in a material by coupling electron nucleus via the hyperfine interaction. This technique will be a completely new tool to trace the spatial distribution of nuclear spins in a material containing paramagnetic species. These developments are the subject of a program ANR-ENUSIM managed by the head of plateform.
Schools and Trainings	CNRS Thematic school: Electron Magnetic Resonance and their applications, Carry le Rouet 2006, Electron Magnetic Resonance : advanced methods Autrans 2008, Electron Magnetic Resonance : object studied Carry le Rouet 2010
Key Projects within 2 years	Pulsed field gradient imaging spectrometer
Notes, remarks	Member of French EPR association ARPE
3 major publications	Armand, M.; Grugeon, S.; Vezin, H.; Laruelle, S.; Ribiere, P.; Poizot, P.; Tarascon, J. M. Conjugated dicarboxylate anodes for Li-ion batteries. *Nat. Mater.* **2009**, *8*, 120-125. Gourier, Didier; Robert, Francois; Delpoux, Olivier; Binet, Laurent; Vezin, Herve; Moissette, Alain; Derenne, Sylvie. Extreme deuterium enrichment of organic radicals in the Orgueil meteorite: Revisiting the interstellar interpretation? *Geochim. Cosmochim. Acta* **2008**, *72*, 1914-1923. Moissette, Alain; Marquis, Severine; Cornu, David; Vezin, Herve; Bremard, Claude. Long-Lived Spin-Correlated Pairs Generated by Photolysis of Naphthalene Occluded in Non-Bronsted Acidic ZSM-5 Zeolites. *J. Am. Chem. Soc.* **2005**, *127*, 15417-15428.

Facility	**Mass Spectrometry**
Director	Christian ROLANDO, Caroline TOKARSKI
Key equipment	FT-ICR 9.4 Tesla mass spectrometer
Label	Node of the TGE CNRS High field FT-ICR network IBISA label "Fully operational" Proteomics Plateform
Equipment list	ESI-Q-q-TOF: Applied Q-STAR-Pulsar, 2001 ; nano-LC : LC-Packings Ultimate, 2001 MALDI TOF/TOF : Applied Biossystems 2008 ; nanoLC: Dionex U3000 Probot spotting robot MALDI-TOF: Applied Biosystem Voyager DE-PRO 2000 ESI-ion trap: LC-Q-Deca XP+ ThermoFinnigan, 2002 Triple quadrupole mass spectrometer MicroMass Quattro II, 1997 High resolution magnetic mass spectrometer JEOL MS700, 1997
Equipment investment cost	3 million €
Engineers	Anne-Sophie LACOSTE, IE USTL, Geoffrey VAUVY AI USTL CDD
Partners from Institut Chevreul	UMR 8181 (UCCS), EA 4478 (CFM), UMR 8207 (UMET)
Partners from PRES ULNF	IFR 147 and particularly UMR 8576, Institut Pasteur de Lille
Other public partners and collaborators	Paris 5, UMR-S 747 INSERM ; Institut de recherche Robert-Sauvé en santé et en sécurité du travail, Montréal, Canada
Private partners	French Blood Databank, Biosynthec, GenFit, GSKBio.
Research expertise	Proteomic analysis
Methodological developments	Miniaturisation pour la manipulation des échantillons (cibles MALDI, source nanoESI, colonnes multicapillaires) ; développement des techniques bidimensionnelles en FT-ICR pour l'obtention simultanée de tous les spectres MS/MS d'un spectre MS
Schools and Trainings	Thematic school CNRS 2008 : Fourier Transform Mass Spectrometry (Ambleteuse) ; Thematic school CNRS 2010 : Chromatographies and Mass Spectrometries (Ambleteuse).
Key Projects within 2 years	Very high field 15 Tesla FT-ICR mass spectrometer (Equipex project) New generation Q-q-TOF mass spectrometer
Notes, remarks	The platform is shared with the IFR 147 (USTL Institute of Biology) Member (and head) of the Scientific network Mass Spectrometry in Nord-Pas de Calais.
3 major publications	Solazzo, Caroline; Fitzhugh, William W.; Rolando, Christian; Tokarski, Caroline. Identification of protein remains in archaeological potsherds by proteomics. *Anal. Chem.* **2008**, *80*, 4590-4597. Mirabaud, Sigrid; Rolando, Christian; Regert, Martine. Molecular Criteria for Discriminating Adipose Fat and Milk from Different Species by NanoESI MS and MS/MS of Their Triacylglycerols: Application to Archaeological Remains. *Anal. Chem.* **2007**, *79*, 6182-6192. Le Gac, Severine; Rolando, Christian; Arscott, Steve. An Open Design Microfabricated Nib-Like Nanoelectrospray Emitter Tip on a Conducting Silicon Substrate for the Application of the Ionization Voltage. *J. Am. Soc. Mass Spectrom.* **2006**, *17*, 75-80.

Facility	**Electron Microscopy**
Director	Paul RATERRON
Key equipment	MET FEI Tecnai G2 20 équipé d'une micro-analyse EDS, d'un filtre en énergie Gatan (EELS), de systèmes de précession et de tomographie électronique et d'une caméra CCD ORIUS
Label	Facilité Nationale CNRS-INSU
Equipment list	MET FEI Tecnai G2 20 avec microanalyse EDS, spectroscopie EELS, Précession électronique, Tomographie et caméra Orius MET Philips CM 30 (300 kV) avec EDS et précession électronique MEB-FEG Hitachi S4700 avec EDS et cathodoluminescence. MEB FEI Quanta 400 avec EDS et EBSD. Microsonde électronique CAMECA SX 100. Atelier de préparation des échantillons disposant d'une large gamme de techniques
Equipment investment cost	4 millions d'euros
Engineers	A ADDAD (IR, 50%), JF DHENIN (AI), AM BLANCHENET (IE)
Partners from Institut Chevreul	UMR 8207 (UMET: ex LSPES UMR 8008, ex LMPGM UMR 8517, ex LCOM UMR 8009), UMR 8181 (UCCS)
Partners from PRES ULNF	UMR 8157 (Géosystèmes), UMR 8520 (IEMN), FR 2416 (CERLA)
Other public partners and collaborators	LSFC - CNRS/St Gobain FRE 2770, CRPG Nancy UPR 2300, MNHN LEME UMS 2679
Private partners	EDF, Arcelor-Mittal, Nexans
Research expertise	Science des matériaux
Methodological developments	Développement des techniques de diffraction électronique en particulier la diffraction en faisceaux convergents à grand angle (LACBED) et plus récemment en précession électronique
Schools and Trainings	CNRS formation « Diffraction électronique appliquée à la caractérisation microstructurale des matériaux » ; « School on electron precession »
Key Projects within 2 years	Microscope électronique en transmission de dernière génération
3 major publications	Brownlee, Don, et al. Comet 81P/Wild 2 Under a Microscope. *Science* **2006**, *314*, 1711-1716. Jacob, Damien; Cordier, Patrick; Morniroli, Jean-Paul; Schertl, Hans-Peter. Application of procession electron diffraction to the characterization of (021) twinning in pseudo-hexagonal coesite. *Am. Mineral.* **2009**, *94*, 684-692. Leroux, Hugues; Roskosz, Mathieu; Jacob, Damien. Oxidation state of iron and extensive redistribution of sulfur in thermally modified Stardust particles. *Geochim. Cosmochim. Acta* **2009**, *73*, 767-777.

Facility	**Infrared and Raman Spectroscopy**
Director	Guy BUNTINX, Myriam MOREAU, Isabelle de WAELE
Key equipment	Automated Raman microspectrometer with nanometric plate displacement, (2009), multiexcitation 632 nm, 532 nm, 473 nm, Jobin Yvon
Label	CREST (Centre de Ressources et d'Expertise Scientifique et Technologique) label attributed by the Land plateforme for Innovation and valorization of research
Equipment list	Raman microspectrometer automated with UV excitation (266 nm) Jobin Yvon Raman microspectrometer Kaiser (785 nm), Raman microspectrometer Labram Jobin Yvon (632 nm, 514,5 nm) Raman microspectrometer XY Dilor Automated Raman microspectrometer with nanometric plate displacement, (2009) multiexcitation 632 nm, 532 nm, 473 nm Installation of Rapid Scan and Step-Scan IRTF spectrometer Nicolet spectrometer IRTF Perkin Elmer Microscope IR Scope II Bruker FT Raman spectrometer RFS100 Bruker
Equipment investment cost	1 million euros
Engineers	J. LAUREYNS (IR CNRS), I. DEWAELE (2009, IR USTL), M. MOREAU (IE CNRS)
Partners Institut Chevreul	UMET
Partners from PRES ULNF	IEMN, IRI, CERLA, PC2A, PHLAM, ENSCL (équipe Thermal Spray), Géosystèmes ; École des Mines de Douai
Other public partners and collaborators	Université du Littoral ; ENSAT Toulouse; Chemnitz University of Technology, Germany; Institute for Solid-State Electronics, TU Vienna, Austria; Departament de Química Analítica, Universitat de Barcelona.
Private partners	Michelin, Arkéma (Elf-Atochem), Seb, Macopharma, Rio Tinto (Alcan-Pechiney), Arc International, Johnson Control, Alsthom, Ciments Lafarge, (ATILH), Thales, Syndicat National des Fabricants de Sucre, Brunel Chimie, Hoffmann-La Roche, Jobin Yvon, Total
Research expertise	Automated mapping of microparticles of air pollution and electronic components.
Methodological developments	Chemometrics; development of new statistical methods of data processing, improved spatial resolution
Schools and Trainings	Training activities spectrometry vibration, Festivals of Science, Innovation Shows
Key Projects within 2 years	Infrared Imaging spectrometer. Raman microspectrometer coupled with AFM.microscope
3 major publications	Scolaro, S.; Sobanska, S.; Barbillat, J.; Laureyns, J.; Louis, F.; Petitprez, D.; Bremard, C. Confocal Raman imaging and atomic force microscopy of the surface reaction of NO2 and NaCl(100) under humidity. *J. Raman Spectrosc.* **2009**, *40*, 157-163. Sieber, Brigitte; Liu, Hongqin; Piret, Gaelle; Laureyns, Jacky; Roussel, Pascal; Gelloz, Bernard; Szunerits, Sabine; Boukherroub, Rabah. Synthesis and Luminescence Properties of (N-Doped) ZnO Nanostructures from a Dimethylformamide Aqueous Solution. *J. Phys. Chem. C* **2009**, *113*, 13643-13650. Uzu, G.; Sobanska, S.; Aliouane, Y.; Pradere, P.; Dumat, C. Study of lead phytoavailability for atmospheric industrial micronic and sub-micronic particles in relation with lead speciation. *Environ. Pollut.* **2009**, *157*, 1178-1185.

Facility	**Surface Analysis**
Director	Arnaud BEAURAIN, Pascal GRANGER
Key equipment	Coupled XPS/LEIS/Tof-SIMS spectrometers
Equipment list	Leybold LHS 10 XPS/AUGER spectrometer (1981) VG Escalab 220 XL spectrometer (1997) Integrated XPS/LEIS/Tof-SIMS spectrometers (XPS : KRATOS, ToF-SIMS and LEIS : Ions tof) (2009)
Equipment investment cost	3,5 millions euros
Engineers	Research Engineer (CNRS) recruited in 2009, Technical Engineer (Univ Lille 1) (2009) Assistant-Engineer (CNRS)
Partners from Institut Chevreul	UMR 8181 (UCCS), UMR 8207 (UMET), UMR 8516 (LASIR)
Partners from PRES ULNF	Institut de Recherche Interdisciplinaire- IRI, IEMN: Y. Coffinier's group
Other public partners and collaborators	Research team on Biomaterials, Université Lille II ; Ecole Nationale Supérieure des Arts et Industries Textiles (ENSAIT); Laboratoire de Génie et Matériaux Textiles (GEMTEX)-Roubaix ; Laboratoire des Matériaux Inorganiques UMR 6002 Université Blaise Pascal Clermont-Ferrand ; Département de Physique Appliquée, Université de Gand, Belgique ; Escola Politecnica da USP, Sao Paulo-Bresil; Instituto de Quimica Universidade Federal do Rio Grande do Sul, Porto Alegre (Bresil)
Private partners	Batscap (batteries Lithium) ; JST Transformateurs ; Total, industrial lubrificants ; Nexans (corrosion), Arc International (glasses) ; Arcelor Ugine&ALZ.
Research expertise	Catalysis, Surface functionalization and associated chemical treatments, Biomaterials, Textiles
Methodological developments	DFT calculations for modeling XPS spectra under high pressure (ANR SAPRES) Development of environment XPS devices (ANR SAPRES)
Schools and Trainings	Collaborative program developed under the auspice of the CNRS
3 major publications	Mayer, G.; Blanchemain, N.; Dupas-Bruzek, C.; Miri, V.; Traisnel, M.; Gengembre, L.; Derozier, D.; Hildebrand, H. F. Physico-chemical and biological evaluation of excimer laser irradiated polyethylene terephthalate (pet) surfaces. *Biomaterials* **2005**, *27*, 553-566. Coffinier, Yannick; Szunerits, Sabine; Jama, Charafeddine; Desmet, Remi; Melnyk, Oleg; Marcus, Bernadette; Gengembre, Leon; Payen, Edmond; Delabouglise, Didier; Boukherroub, Rabah. Peptide immobilization on amine-terminated boron-doped diamond surfaces. *Langmuir* **2007**, *23*, 4494-4497. Morent, R.; De Geyter, N.; Leys, C.; Gengembre, L.; Payen, E. Study of the ageing behaviour of polymer films treated with a dielectric barrier discharge in air, helium and argon at medium pressure. *Surf. Coat. Technol.* **2007**, *201*, 7847-7854.

Université Lille1
Sciences et Technologies

DIRVED
Direction de la Recherche,
de la Valorisation et
des Etudes Doctorales

Commitment of the Université Lille1 – Sciences et Technologies for the Labex

"Molecular systems and Materials under Complex Environment" (SYMMECOM)

The scientific strategy of the University Lille1 concerning the LABEX is presented in section 5.3 of the proposal.

Through the LABEX "Molecular systems and Materials under Complex Environments », the university Lille1 aims to become an international leader in the field of "Molecular and Material Science" and to actively participate to the territorial and socio-economic development through innovation.

This LABEX emanates from a major scientific field in the region Nord Pas de Calais with more than 400 scientists, PhD students and administrative and technology staff. It also beneficiates of an exceptional set of advanced analytical platforms (NMR, EPR, electronic microscopy, X-ray diffraction, mass spectrometry, vibrational spectroscopy, surface analysis ...)

Research groups involved in this Labex are very active in the training programs, innovation activity, international cooperation and collaborative research with the industry. They are also involved in multidisciplinary research programs with other scientific fields, for instance biology, health, Earth Sciences and nanotechnology.

We believe that the exceptional potential of this LABEX together with the high quality management and the strong support of partners through additional human resources and scientific facilities, will present an attractive environment for high level scientists and students and for the development of promoting risky innovative research. This environment will be also conducive for student training, innovation and territorial and economic development.

The University Lille1 largely supports this LABEX. In addition to the available human resources, scientific equipment and building infrastructure, the university is committed to provide additional support for this LABEX, in particular in human resources. In addition to doctorate and post doc grants, positions for inviting talent international researchers for long period, the University Lille 1 will provide 5 academic supports to the Labex. Morever, the University will supply, building and scientific infrastructure as well as administrative and logistic support and current expenses.

Friday, November 19, 2010

Professor Philippe Rollet

President of the Université Lille1 – Sciences et Technologies

Cité Scientifique - Bâtiment A3 - 59655 Villeneuve d'Ascq Cedex
Tél. +33 (0)3 20 43 44 37 | www.univ-lille1.fr

PRES Université Lille Nord de France
Monsieur le Président,
SERGHERAERT Christian
1bis rue Georges Lefèvre
F- 59044 LILLE CEDEX

Paris, le 18 novembre 2010

www.cnrs.fr

Objet : Lettre de soutien pour les dossiers LABEX des investissements d'avenir

Monsieur le Président,

Le Comité de Direction du CNRS a examiné avec beaucoup d'intérêt les projets de LABEX qui lui ont été adressés. Il apporte son soutien aux projets qui remplissent les trois critères suivants :

- L'excellence scientifique, le caractère innovant et la plus-value par rapport à l'existant, ainsi que la cohérence avec les orientations stratégiques du CNRS sur le site;
- La pertinence du projet dans la politique du site ;
- L'assurance d'une gouvernance en « mode projet », respectant la structuration des unités de recherche.

Le projet «Systèmes moléculaires et matériaux sous environnements complexes» (SYMMECOM) remplit ces trois conditions et reçoit ainsi le soutien complet du CNRS. En cas de succès de ce projet, le CNRS s'engage à maintenir ses ressources sur le périmètre du projet de LABEX et à entamer des discussions avec ses partenaires pour envisager la façon de mettre en place une programmation pluri-annuelle concertée des ressources futures.

Nous vous remercions d'avance de bien vouloir nous adresser dès que possible une copie de l'intégralité du dossier final que vous déposerez.

Nous vous prions de croire, Monsieur le Président, en notre parfaite considération.

Le Directeur scientifique référent
Jacques MARTINO

La directrice de l'INC
Gilberte CHAMBAUD

Chimie Lille
ÉCOLE NATIONALE SUPÉRIEURE DE CHIMIE

Jean Grimblot, Directeur

Objet : lettre de soutien au Labex SYMMECOM

A qui de droit,

L'Ecole Nationale Supérieure de Chimie de Lille (ENSCL) est une école d'ingénieurs qui forme des scientifiques de haut niveau qui peuvent être qualifiés de généralistes en chimie avec une ouverture internationale forte. En fin de 2ème année du cycle ingénieur, les deux filières proposées au choix des élèves (molécules ou matériaux) sont parfaitement en phase avec les thématiques abordées dans le Labex SYMMECOM. Avec plus de 60% de ses enseignants-chercheurs impliqués dans le projet SYMMECOM, l'ENSCL tient à confirmer son soutien fort à ce projet. Consciente de l'importance de ses unités de recherche, l'ENSCL maintiendra sa politique d'aide à l'acquisition de matériel scientifique moderne et performant, de soutien à des manifestations scientifiques et d'aide à l'international, et de délégation. Ainsi cette année, dans le cadre de la politique du BQR, deux projets jeunes chercheurs ont été soutenus, le premier portait sur l'étude des propriétés thermiques des polymères en combustion, l'autre sur l'élaboration de matériaux pour l'électrolyse à haute température, deux thématiques en parfaite adéquation celles du projet SYMMECOM. Par ailleurs, une réflexion est actuellement menée avec Polytech-Lille sur l'enseignement du nucléaire en master et en cycle ingénieur. Un maître de conférences a été recruté sur cette thématique en septembre 2010, et, dans le cadre du projet SYMMECOM, nous nous engageons, dans la mesure du possible, à soutenir la mise en place d'une chaire industrielle dans le domaine des matériaux pour l'énergie.

Villeneuve d'Ascq, le 18 novembre 2010

Jean Grimblot

Cité Scientifique, Bât. C7 – Boîte Postale 90108 – F-59652 VILLENEUVE D'ASCQ CEDEX – www.ensc-lille.fr

UNIVERSITÉ D'ARTOIS

Arras, le 16 novembre 2010

Service de la Recherche et
des Etudes Doctorales
Resp : Patrick BOIDIN
Tel. : 03.21.60.37.10

LETTRE DE SOUTIEN

Je, soussigné Christian Morzewski, atteste du soutien plein et entier de l'Université d'Artois au projet de Laboratoire d'Excellence « Systèmes moléculaires et matériaux sous environnements complexes », dans lequel est partenaire l'Unité de Catalyse et de Chimie du Solide de Lens (UMR CNRS 8181), et confirme l'engagement en moyens humains qui en découle, tel que défini dans le projet.

Le Président de l'Université,

Christian MORZEWSKI

BÉTHUNE DOUAI ARRAS LENS LIEVIN UNIVERSITÉ D'ARTOIS

SERVICES CENTRAUX
9 RUE DU TEMPLE - BP 10665 - 62030 ARRAS CEDEX
Tél. 03 21 60 37 00 - Fax 03 21 60 37 37
www.univ-artois.fr

Ecole d'Ingénieurs
Centre de Recherche
Mines de Douai

Douai, le 19 Novembre 2010

N/REF : 2010 - JCD/AP
Affaire suivie par : Prof. Patricia KRAWCZAK
Mél : patricia.krawczak@mines-douai.fr
Tél : 03.27.71.21.95
Secrétariat : 03.27.71.21.66 ou 23.18

Le Directeur

à

Monsieur Hugues LEROUX
Professeur
Porteur du Projet de LABEX
« SYMMECOM »
Univ. Lille1 /PRES ULNF

Objet : Projet de Labex SYMMECOM
Soutien de l'Ecole des Mines de Douai

Monsieur le Professeur,

Dans le cadre du Programme d'Investissements d'Avenir (PIA), l'Ecole des Mines de Douai (EMD) suit avec un très grand intérêt le projet de Laboratoire d'Excellence « *Systèmes Moléculaires et Matériaux sous Environnements Complexes* » (Labex SYMMECOM). Ce dernier s'inscrit en effet directement dans le plan de développement stratégique actuel 2007-2011 de notre établissement, ainsi que dans les orientations stratégiques d'ores et déjà arrêtées pour 2012-2016 (note de politique générale validée par notre Conseil d'Administration en 2010). En effet, l'implication de l'équipe TPCIM (Technologie des Polymères et Composites & Ingénierie Mécanique) dans les WP « *Materials science for health* » et « *Driven microstructures against fire : new polymeric systems* » correspond d'une part, à l'orientation actée vers les sciences du vivant et les relations avec la problématique santé (systèmes polymères d'intérêt biomédical et procédés d'élaboration associés), d'autre part à l'approfondissement de la maîtrise des relations existant entre matériaux polymères et composites, procédés de mise en œuvre, microstructures induites et propriétés fonctionnelles résultantes (analyse expérimentale, modélisation, simulation).

Les priorités stratégiques mentionnées ci-dessus ont de fait conduit l'EMD à investir de manière continue en personnels, bâtiments et équipements lourds (constituant une plate-forme de procédés d'élaboration/compoundage/mise en forme de systèmes polymères avancés unique en France). Plus particulièrement, pour développer les thèmes précités, 7 nouveaux enseignants-chercheurs ont été embauchés entre 2006 et 2009 au sein de l'équipe TPCIM et 10 M€ d'investissements sont fléchés sur la période 2007-2013 sur le projet structurant EXTREMOM (« *EXTension du pôle de REcherche sur la Mise en Oeuvre des Multi-matériaux* »). Les extensions des bâtiments du département TPCIM déjà réalisées dans ce contexte ou en cours d'achèvement (finalisation en 2011) permettront d'envisager l'accueil d'équipes extérieures académiques et industrielles, de manière à amplifier les interactions pluridisciplinaires que l'EMD souhaite favoriser, en particulier dans le cadre du Labex SYMMECOM.

J'encourage donc vivement ce projet auquel l'EMD apportera son soutien.

L'engagement pluriannuel envisagé par l'EMD dans le cadre du Labex porterait sur l'implication de 5 ETP de l'équipe TPCIM et sur l'accès, dans le cadre de projets collaboratifs, à la plate-forme existante de mise en œuvre des systèmes polymères. Un complément d'équipement (extrudeuse pharmaceutique + salle blanche) est demandé pour cette plate-forme et serait pour partie co-financé par l'EMD. En cas d'acceptation du Labex et sous réserve de validation par notre Conseil d'Administration, le redéploiement d'un poste d'enseignant-chercheur supplémentaire (Ingénieur ARMINES) au sein de l'équipe TPCIM (affecté au Labex à hauteur de 0,5 ETP supplémentaires) serait en outre envisagé.

Je vous prie de croire, Monsieur le Professeur, à l'assurance de mes sentiments les meilleurs.

Le Directeur,

Jean-Claude DURIEZ

Ecole des Mines de Douai - 941, rue Charles Bourseul - BP 10838 - 59508 DOUAI Cedex - Tél. : 03 27 71 22 22 - Fax : 03 27 71 25 25
www.ensm-douai.fr

Pôle de Compétitivité
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Monsieur Hugues Leroux

Université Lille 1 - UMET

Cité Scientifique

59655 Villeneuve d'Ascq Cedex

Villeneuve d'Ascq, lundi 22 novembre 2010

Réf. : C10-221– OV/ES

Objet : Soutien du pôle MAUD au Labex SYMMECOM

Monsieur,

Par ce courrier, le pôle MAUD souhaite apporter son soutien à la candidature de SYMEMCOM que vous présentez à l'AAP « Laboratoires d'Excellence » dans le cadre du plan d'investissements d'avenir.

Les domaines scientifiques couverts par SYMMECOM sont en très grande partie en correspondance avec les thématiques portées par le pôle, en particulier avec les thématiques « matériaux multifonctionnels », « matériaux biosourcés », « procédés performants et technologies propres ».

Plusieurs formations, de niveau master, pilotées par les partenaires de SYMMECOM ont déjà été labellisées par le pôle MAUD pour leur adéquation avec le cœur de métier et la feuille de route stratégique du pôle ; ce label permet de donner une visibilité accrue à ces formations. Le pôle MAUD pourra également être un relais pour l'offre de formation continue qui sera proposée par le Labex SYMMECOM, et participer via la commission formation du pôle à l'adéquation entre cette offre et les besoins des industriels.

En ce qui concerne la valorisation et le transfert vers le monde industriel, le Labex SYMMECOM pourra s'appuyer sur le programme d'animation du pôle MAUD, notamment sur les « MAUD Business LAB » et sur les ateliers thématiques, mais également sur les ressources du pôle pour l'ingénierie de montage de projets collaboratifs.

Le pôle MAUD soutient le Labex SYMMECOM qui contribue à développer l'attractivité et l'excellence de la recherche en Nord Pas-de-Calais.

Je vous prie d'agréer, Monsieur, mes salutations distinguées.

Olivier VARLET

Directeur Général

Parc Scientifique de la Haute Borne - 5 rue Héloïse - F-59650 Villeneuve d'Ascq
Tél : + 33 (0)3 20 34 54 80 - contact@polemaud.com
Association Loi 1901 (JO du 5 novembre 2005) - SIREN : 484 629 183 - Code APE : 9499Z - N° TVA : FR 54 484 629 183.

www.polemaud.com