ESF - Research Networking Programme - Call 2009

Proposal

Proposal Number	**09-RNP-124**

Details

Proposal Title	**Precision Polymer Materials (P2M)**
Domain(s)*	PESC;
RI	**No**
Duration (months)	**48**
Budget Req. (€)	**640 000**
Keywords	polymer synthesis; biomimetic; self-assembly; functional materials; smart polymers

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EMRC: Biomedical Sciences; LESC: Life, Earth and Environmental Sciences; PESC: Physical and Engineering Sciences; SCH: Humanities; SCSS: Social Sciences

Proposal for an ESF Research Networking Programme – Call 2009

Section I: (1 A4 single page)

Programme title:

Precision Polymer Materials

Programme acronym:

P^2M

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Indication of which of the principal applicants is the contact person:

Professor Sébastien Lecommandoux

Keywords relating to the topic of the proposal (*up to five; one "keyword" can be a string of not more than three words*):

Polymer synthesis, biomimetic, self-assembly, functional materials, smart polymers

Abstract of the proposal (*max. 300 words*):

The aim of the proposed Programme is to combine the complementary expertise of leading European research groups in the design of precision polymeric materials, i.e. polymers with precisely defined molecular weight, architecture and functionality that are designed to self-assemble into functional materials via strategies that are inspired by or mimic biological self-assembly processes. The main aim of the proposed Programme is to promote interactions and facilitate exchange of, primarily, early career researchers with different backgrounds, ranging from catalysis, polymer chemistry and physics to theory, biochemistry and pharmacy.

The recent developments in polymer synthesis methods allow the design of sophisticated (co)polymers. In the mean time, the ability to control and direct self-assembly has considerably improved. Another recent domain consists in the design of multifunctional systems, mainly for drug-delivery applications, able to load a large amount of therapeutic molecule, to release its content in a spatial and temporal controlled manner, and with the capability to serve as a contrast agent. As a result, one of the main challenges of today is to move from the current use of polymer materials in a "passive" way to an "active" one, where the polymer itself will have a functional role.

The central part of the proposed research project concerns the design of multifunctional polymer nano-edifices. By learning from the principles used in Nature to achieve responsive, dynamic, active materials, it is possible to utilize synthetic or biological polymer systems to design active biomaterials. Such a biomimetic approach can have considerable impact, not only for biomedical applications, but also in the design of functional nanomaterials. The groups involved have great experience in the synthesis, characterization and modeling of complex and functional polymer systems, allowing a synergy for the elaboration and optimization of novel bio-inspired and functional materials with fine-tuned properties and for their future industrial application.

Previous or concurrent applications to the ESF for any of the ESF instruments:

The P^2M application follows two previous ESF Programmes, namely the SUPERNET (1999-2004) and STIPOMAT (2005-2009) Programmes. The SUPERNET Programme was devoted to synthesis, characterization and theory of multicomponent complex polymer systems. Besides supporting exchange grants, conferences were also organized in the frame of SUPERNET, which helped to establish fruitful collaborations between different European teams. As a result of these collaborations new multicomponent systems were synthesized and studied and a significant number of joined publications have appeared. Because of this successful Programme, a next Programme was launched in 2005 with the aim to focus more particularly on stimuli-responsive materials: the STIPOMAT Programme. Indeed, at the end of SUPERNET, it was recognized that concerted research efforts should be devoted to the synthesis, characterization and theory of stimuli-responsive materials due to their numerous potential applications. Most of the SUPERNET participating groups were indeed included in the STIPOMAT Programme in order to benefit from the expertise previously gained. Other new groups were also included due to their relevance to the STIPOMAT Programme. The numerous student exchange and outstanding research conferences organized in the frame of STIPOMAT also resulted in very significant scientific publications that allowed this Programme to be recognized at an international level. All these facts and the previously gained expertise encouraged us to introduce a proposal for the P^2M Progamme that will go a step further by focusing on Precision Polymer Materials, where biomimetic and bio-inspired strategies will be applied to well-defined polymer structures. The "core partners" of Stipomat have been included, but the participating groups have been extended in order to cover different fields of applications. Actually, as can be seen later in the proposal, a large number of relevant groups have already express their interest in participating to such an ambitious project.

Status of the relevant research field, scientific context

On one side, the 20th century polymer industry has mainly resorted to monomers arising from petroleum-based products. This has led to the development of polymeric materials that are well positioned in many key aspects of our daily-life. However, there is a critical need to diminish our reliance on fossil resources and to invent new polymer systems that respond to the needs of our modern societies.

In addition, most synthetic polymers are the result of the use of metallic species that catalyze or initiate elementary reactions, with the noticeable exception of polymers obtained by free radical means. Nowadays, new and original polymers come to market through small to mid-size companies which target niche applications, whereas large polymer companies focus on the quality and safety of their products and their processes of production. Concerned with the sustainability of chemical processes, the recyclability of products and their effects on human health, our advanced societies are obliging chemical companies to address these issues. According to its definition, sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs."

On another side, the building principles and the perfect structures found in nature have served as motivation and as models. The combined efforts have led to polymers and block copolymers with ordered architectures. The design, synthesis, characterization and controlled self-organization of the required well-defined materials on different length scales are the key technology for today and tomorrow. As a result, block copolymer materials are widely used in industry as thermoplastic elastomers, reinforcement materials, adhesives, but also as scaffold or template for microelectronics. Their ability to self-assemble in bulk and in solution into well-defined and predictable nanostructures also opened avenues in drug delivery systems, biosensors or electronic devices. The thorough understanding of the self-organizing processes as well as the understanding and the precise control of structure and function on multiple length scales will be essential prerequisites for any significant progress.

However, precise control of monomer sequences remains one of the most fundamental unsolved problems in polymer synthesis, and indeed in all of polymer science and engineering. The full potential of self-assembly in complex polymer systems will require the development of new synthetic methods that afford improved control of chain sequences. In current synthetic methods, the statistical nature of polymerization processes limits control of molecular architecture, whereas biological synthesis enables exquisite control at the price of severely limited chemical diversity. Inspiration from biology can indeed really be a model together for the synthesis of precise and controlled polymer sequences and to build highly ordered and functional polymer devices. Indeed, biological macromolecules achieve multiscale order and function through an exquisitely orchestrated ensemble of primarily simple weak interactions (van der Waals, H-bonding, ionic, hydrophobic, metal-ligand,…) between molecules. The coordination of these interactions results in well-organized materials with great mechanical strength (bone, skin, spider silk), biological specificity (antibodies, receptors), catalytic activity (enzymes), and energy-harvesting capability (photosynthesis). Similarly, polypeptides, block polypeptides, and polypeptide-polymer conjugates have been shown to form controlled self-assembled structures that have distinct features relative to structures formed from synthetic block polymers. Polypeptides have defined conformations (e.g., coil, helix, sheet), and the presence of these conformations has been shown to vary the types of assembled structures that can be formed from these materials. These conformations are sensitive to changes in temperature and solution conditions, so the structures assembled from these building blocks are therefore also similarly sensitive, and can form the basis of new classes of sensing and mechanically responsive materials. Understanding the self-assembly

behavior of biological molecules such as polypeptides as models for such behavior in complex polymers is a key step in generating the necessary understanding of synthetic materials.
As an additional functional difference in biomolecular assembly, proteins present functional groups in specific positions along the polymer chain, and this controlled group placement (monomer sequence) controls their folding behavior and directs their complex assembly. This functional group-placement control can also be used purposefully to direct the assembly behavior of the macromolecules; this potential advantage has not yet been exploited to its full extent in part due to current limitations in polymer synthesis. Biologically-based assembly mechanisms continue therefore to serve as compelling models for the production of well-ordered polymeric and biopolymeric materials that are able—on the basis of their controlled organization—to harvest energy, emit light, store information, and guide the functions of living cells. A key challenge will be to simultaneously develop the synthetic, theoretical, and processing capabilities needed to master the structural control that these new materials will make possible.
Finally, the overall goal of P^2M will be the advancement on the fundamental knowledge in polymer science and engineering beyond the state of the art. More specifically the design and synthesis—through sustainable polymer chemistry methodologies—of new functional polymers with self-assembling and/or templating properties towards nanostructured materials, material systems and devices using simple processing methods. The ultimate goal is to design new functional polymer materials and processes for the future information and communication, energy, life science and environmental technologies as well as to train highly skilled people who will be joining either the academia, traditional and high technology industries or will be contributing in creating new high tech industrial sectors.

Objectives and envisaged achievements of the proposed Programme:

As previously stated, an integrated approach between synthesis, characterization, modelling and theory of precision polymer materials will be developed within the P^2M Programme, together with the impact of such complex and functional self-assemblies toward applications, ranging from bio-electronic to medicine. A major concern in the Programme will be the training of young researchers, who will benefit of the fruitful exchanges of knowledge and expertise occurring between the participating groups. In order to illustrate this integrated approach, some examples of research topics that will be investigated within the P^2M Programme are described below. Three different objectives can be emphasized: precision polymer synthesis, controlled and directed self-assembly, and (multi)functional polymer materials.

1. Precision Polymer Synthesis

New approaches in polymerization catalysis

A striking observation is the extreme diversity of metallic catalytic systems employed in polymer synthesis. In most cases, the metallic catalyst represents minute amounts and yet remains in the final polymer. In sensitive domains such as biomedical, packaging, and microelectronics, metal-based catalysts are prohibited. Organic and enzymatic catalysis appear today as the most reliable alternatives to metal-mediated catalysis for polymer synthesis. Organic and enzymatic catalysts can be designed to break down into innocuous products at the end of their functional use.
New concerns for the coming years are thus to implement sustainable routes to polymers by using either bio-inspired organo-catalytic platforms and/or modified enzymes, or single organic catalysts such as *N*-heterocyclic carbenes (NHCs). These three families of catalysts have already proven their effectiveness in some key polymerization reactions. A particular aim will be to develop multi-task catalytic platforms.

Controlled polymerizations for defined polymeric architectures

Controlled polymerization techniques are key processes for the realization of this Programme. Polymerization techniques allowing a perfect control of the macromolecular parameters (molecular weight, stereo-regularity, location of functional groups…) and architectures (block, star-like, comb-like, dendrimer-like and hyperbranched polymers) are indeed needed to obtain some of the starting materials that will be further used in this Programme. Typical examples are living anionic and controlled radical polymerization techniques which are commonly used by several partners of the Programme. Additional synthetic tools such as the popular "click"-chemistry approach will be also used in order to add specific functional groups or to create macromolecules with complex topologies. Emphasis will be put on the introduction of functional groups at precise locations in the resulting polymer chains. Such functional groups will allow to introduce specific motives for further supramolecular secondary interactions (e.g. hydrogen-bonding or metal-ligand interactions), following a protein-mimicking approach. With the same idea to obtain bio-mimicking polymer systems, stimuli-responsive polymer blocks will be also introduced in order to induce conformational changes of those polymer block under variations of external parameters usually found in natural systems such pH, temperature, redox process and light.

Hybrid Polymer-Biological polymer systems

The synthesis of well-defined biological – synthetic polymer conjugates is an important area of research given the potential of the resulting materials for a broad range of applications. In spite of the vast interest in these materials, however, the synthesis of well-defined peptide/-protein–polymer conjugates, i.e. hybrid constructs which combine (i) a defined number of peptide/protein segments with uniform chain lengths and defined monomer sequences (primary structure) with (ii) a defined number of synthetic polymer chains, is still a challenge. The three main strategies that are currently used for the preparation of peptide/protein synthetic polymer conjugates, (i) α-amino acid N-carboxyanhydride (NCA) ring-opening polymerization, (ii) solid phase peptide synthesis (SPPS), and (iii) protein biosynthesis each have their limitations and drawbacks and there is a clear need for improved methodologies to synthesize biological-synthetic hybrid constructs with enhanced control over the conjugation site and the number of attached polymer chains.

2. Controlled and Directed Self-Assembly

The idea here is mainly to combine block copolymer self-assembly, mainly driven by the chemical incompatibility between both blocks and the entropy minimization of the resultant structure, with other controlled and precise interactions, mainly coming from supramolecular chemistry (H-bonding, metal complexation, secondary structure, chirality,…) and biology (peptide, protein and DNA building blocks).

Self-assembly via supramolecular interactions

Since the Nobel Prize of Lehn, Pedersen and Cram, supramolecular chemistry has become increasingly important, and is now a major field in chemical research. Self-recognition and self-assembly are the two pillars on which supramolecular chemistry is based, involving mainly interactions of non-covalent nature (van der Waals, hydrogen bonding, coordinative interactions…). The large range of interaction strength, directionality, and reversibility offered by these interactions allows unprecedented control over the structure and properties of materials, enabling the synthesis of large and complex structures with diverse functions interesting for many different fields. In recent years, supramolecular polymer chemistry, applying the principles of supramolecular chemistry to the synthesis of macromolecules, has gained special interest. Various approaches towards supramolecular polymers have been considered so far. They can be classified according to the nature of the non-covalent interaction (i.e. hydrogen bonding, coordinative interactions…) and to the structure of the supramolecular polymer (i.e. polycondensation-type supramolecular polymers *vs.*

supramolecular block copolymers). In polycondensation-type polymers, each monomer or macromonomer are linked by non-covalent interactions. This approach requires the use of monomers or macromonomers bearing at least two binding sites that could be further condensed through supramolecular interactions. In the second approach, supramolecular linkers are introduced at specific locations in block copolymer architectures leading to supramolecular block copolymers. This should lead to systems combining the characteristic features of block copolymers (e.g. microphase separation between immiscible constituent blocks) to the ones of supramolecular polymers (e.g. reversibility and tunability of the strength of the supramolecular bonds). The supramolecular linkers can be used to either bridge together different homopolymer blocks, or to link together different block copolymers. Such systems will be studied thoroughly by several partners of this Programme.

Peptide and Protein-based self-assemblies

Peptide/protein – synthetic polymer conjugates, which covalently combine one or more copies of a peptide sequence or protein with one or more synthetic polymer elements, offer unique possibilities to integrate the properties and functions of bio(macro)molecules and synthetic polymers in a single hybrid material. Peptide-synthetic polymer conjugates have attracted interest for a number of reasons. First of all, the peptide segment can endow these materials with unique self-assembly properties and induce the formation of hierarchically-organized nanoscale structures, both in solution and in the solid state, with a much higher level of complexity as compared to e.g. ordinary block copolymers. In several instances, the sensitivity of the peptide secondary structure to environmental parameters such as temperature, pH or ion-strength allows to reversibly manipulate the nanoscale structure formation of these hybrid materials. Peptide-synthetic polymer conjugates, e.g. are of interest for drug and gene delivery, as structural materials and hydrogels and to direct mineralization. Covalently combining proteins and synthetic polymers is of interest for numerous reasons. The conjugation of an appropriate synthetic polymer can be used, for example, to modulate the biological activity of a protein. From the polymer perspective, the attachment of a protein may endow a synthetic polymer with unique functional and structural properties.

DNA-based self-assemblies

Systems based on DNA are rare but very promising. The use of DNA to build up 2D and 3D nanostructures is based on the unique and reversible recognition properties of oligonucleotides (ODN), and interest in such applications has recently increased in recent years. To date, there has been no intensive or systematic exploration of the coupling of ODN to polymeric materials. In most examples, ODN has been grafted onto conductive backbones, mainly to build biosensors. Up to now, the field was mainly constrained by limits on the attainable length of the nucleic acid segment imposed by the use of solid phase synthetic methods. Nowadays, the DNA-based technologies reached a certain maturity and the elaboration of DNA-based block copolymers can be envisaged. As for peptide or protein based self-assemblies, DNA-based technologies aim at combining a precise control of the self-assembly process together with a predefined biofunctionality. This would open a new field of interdisciplinary research, at the interface between polymer chemistry, biology and nanoscience.

3. (Multi)Functional Polymer Materials

Drug Delivery Systems

New advances in drug design and delivery, systems biology, and more generally in nanomedicine ensure that the potential of polymer science and technology to improve health care is stronger than ever. Indeed, based on existing FDA approved structures, polymers have led to many significant advances in medicine. The recent developments in synthetic methods allowed the design of sophisticated polymers and block copolymers based on biodegradable or highly biocompatible segments. In the mean time, precise and directed self-assembly has considerably improved. Although progress has been

made in polymeric biomaterials, several challenges exist in the implementation of such materials as medical tools or applications. A key barrier is the difficulty of directly correlating structure-property relationships with cellular function. An additional challenge in drug delivery includes the delivery of sensitive biological drugs such as proteins, antibodies or Si-RNA, which are highly sensitive to process conditions due to their tendency to denature. As a consequence, the therapeutic activity of the drug is drastically reduced. Another recent domain consists in the design of multifunctional drug-delivery systems, able to load a large amount of therapeutic molecule, to release its content in a spatial and temporal controlled manner, and with the capability to serve as a contrast agent for magnetic resonance imaging or other imaging methods.
The main challenge of the coming decade is to move from the current use of polymer materials in a “passive” way to an “active” one, where the polymer itself will have a functional role.

Surface Active Materials
The development of materials with intelligent surface properties, e.g. sensing properties, ultrahydrophobicity and switchable wettability is of great importance for many micro- and nanotechnological applications. Using both grafting-onto (chemi- and physisorption) as well as grafting-from strategies (surface-initiated polymerization), the activities in the framework of this programme will aim at using the latest synthetic advances and state-of-the-art micro/nanolithographic tools to generate thin polymer coatings that are molecularly defined with respect to chemical composition and architecture and have properties that are fine-tuned for a range of applications varying from biomaterials coatings, to microfluidics and sensors.

Nano-Reactors
The possibility of (functional) block copolymers to self-assemble into nanodomains of precise shape, size and chemical environment is a key feature allowing a possible use of these systems as nanoreactors. Typical examples are based on core-shell type block copolymer micelles formed by self-assembly of block copolymers in selective solvents. After stabilization of the shell by crosslinking and removal of the core-forming chains, a nanocage is obtained that can be further functionalized in the inside by adequate catalysts. The inside cavity can be therefore used as a nano-confined environment for performing catalytic reactions. The in- and out fluxes of reacting molecules and reactions products can be controlled by the permeation through the cross-linked shell that can be eventually be modulated via stimuli-responsive properties.

Bio-Electronic Polymer Materials
Conductive polymers started to find applications in electronic devices such as diodes, inks, flexible screen, transistors and so forth. However, the coupling of electronics with living tissue holds the key to a variety of important life-enhancing technologies and still represents a very challenging area for the future. One example is bio-electronic implants that record neural signals and/or electrically stimulate neurons. These devices offer unique opportunities to understand and treat conditions such as hearing and vision loss, epilepsy, brain degenerative diseases, and spinal cord injury. A second example is sensor arrays that utilize living cells as the bio-recognition element. These devices offer tremendous value in new drug development and in detectors/sensors protecting human and animal health and the environment. Key to these technologies is a fundamental understanding of electrical communication at the interface between electronic materials and living cells. Improved understanding of this interface will translate to implants that are more stable and dissipate less power, and sensors that offer better sensitivity and lower detection limits, both unresolved and pressing needs in the field. Here again, the limiting step is still in the design and synthesis of well-defined polymer building block able to “code” all the information (biological and electronic).

Facilities and expertise which would be accessible by the Programme:

All the facilities and expertise available within the different partners of the research Programme will be accessible to everyone. The main purpose of such a Programme is to share a maximum of knowledge and know-how in order to obtain a deeper understanding and solve fundamental and applicable problems. The different partners have been selected in order to cover the broadest range of competences, ranging from theory and simulation, catalysis, organic chemistry, peptide chemistry, biochemistry, polymer physics, colloid physics, to biology and biomedicine. In addition, all the groups selected are experts in their field and have the most advanced and sophisticated equipments available.

Expected benefit from European collaboration in this area:

The goal of the Programme is to establish European leadership in the elaboration of highly controlled polymeric architectures and their self-assembled structures via bio-inspired and biomimetic approaches. The project aims to bring together leading European research teams acting in these topics in joint multidisciplinary investigations.
The Programme will benefit of the strong contacts, exchanges and collaborations that were previously established in the frame of the two previous SUPERNET (1999-2004) and STIPOMAT (2005-2009) Programmes. Transfer of knowledge and expertises is expected between the already established research groups and new young scientists. More specifically, the outcome of the proposed Programme is expected to strengthen European competitiveness in the three following areas:

- Scientific excellence since the research topics envisaged in the present project are clearly located at the forefront of science, more specifically in the fields related to polymers, nanosciences and self-assembled structures. This part will be essentially valorized by publications in renowned scientific journals.
- Training of young researchers through collaborations between different labs. Special emphasis will be devoted to PhD students and post-docs.
- Transfer of expertise and competences between different laboratories, which is a direct consequence of the exchanges of researchers. These transfers are expected to occur in either an intergenerational way (from already established groups to young Professors) or an international way (e.g. from Eastern Europe to central Europe and vice-versa).

The topic of the proposed Programme is certainly a key issue for polymer science, and more generally for chemistry, in the next future. Elaborated polymers exhibiting specific functions and/or responsive behavior can indeed be obtained by mimicking biological processes in hybrid or fully synthetic complex polymer structures. This proposal is clearly multidisciplinary and is merging together people from many EU countries and associated states which have been carefully selected on the basis of their integration in the project. Moreover, the unique combination of precise synthesis, state-of-the-art characterization, theory and modeling is certainly one of the most interesting characteristic features of the present proposal.

European context

(list of relevant R&D networking activities at the European level directly related to the proposal, and already existing or envisaged collaboration activities, in particular, networks or activities under the EC Framework Programme, COST or under any other international Programmes or organisations. State how the Programme would complement these and any applications on this or a similar topic to these organisations):

The majority of the proposed participating groups have a long-standing collaboration in the frame of the successful ESF Programmes SUPERNET and STIPOMAT, which concentrated on polymer synthesis, characterization and theory of multicomponent polymer systems, respectively stimuli-responsive polymeric materials. The SUPERNET

and STIPOMAT Programmes have resulted in a large number of European collaborations and have allowed numerous exchange visits of early career scientist between the different partners. Apart from the scientific successes of these Programmes, as evidenced from the large number of publications, these Programmes have also enabled exchange of young career scientists in a very "unbureaucratic" fashion. The opportunity for PhD students, e.g. to participate in these Programmes provides them with unique experiences which are critical in view of the globalization job market. Exchange visits are also possible in the framework of EC Framework or COST Programmes, but usually only within a relatively narrow defined scope. The proposed Precision Polymeric Materials (P^2M) Programme, in contrast, has a very broad scope and essentially encompasses all research activities that focus on "precision polymers" in the broadest sense, i.e. (computational) design, synthesis, characterization and properties. As a consequence, the Programme will allow and promote interactions, exchange of know-how and scientists between research groups of very different and diverse background and stimulate collaboration in a multidisciplinary way that is not possible within the framework of other existing Programmes.

Proposed activities, key targets and milestones:

Workshops and conferences: The Steering Committee organises international workshops with around 50 participants which are held about once a year. The main contributors to the Programme will discuss the advancement of common research during this annual meeting. In addition larger international conferences with around 100 participants will be organized every two years and will cover a broader range of people.
Between the conferences and workshops the supervision will be organized by members of Steering Committee. Connection between different teams both on national and international level will be organized using electronics telecommunication including organization of teleconferences.
Short-term fellowships: These are mainly for young scientists, who need further training and expertise in new experimental and modelling methods for a fruitful continuation and broadening of their research scopes. Short term fellowships are intended to facilitate the transfer of knowledge and techniques relevant to research from one laboratory to another within Europe (at least one contributing country should be involved). The grants are for periods up to six months.
Short scientific visit grants: These cover the costs of short visits of senior researchers working in the area of the Programme, in order to carry out joint work primarily in one of the STIPOMAT participating laboratories.

Duration (48 or 60 months)**: 48 months**

Budget estimate (in €) by type of activities and per year of the Programme
(Please use the headings listed in the section "*Level and use of a Programme budget*" of the Call, as appropriate. Do **not** include the ESF administration fee in the annual budget. This is calculated and included by the ESF office before submission for funding to MOs)**:**

	Year 1	Year 2	Year 3	Year 4	Total
Exchange of researchers (short visits and exchange grants)	100 000 €	100 000 €	100 000 €	100 000 €	400 000 €
Workshops and conferences	40 000 €	80 000 €	40 000 €	80 000 €	240 000 €
Total	140 000 €	180 000 €	140 000 €	180 000 €	**640 000 €**

Scientific and financial management: The Programme will be managed by the Steering Committee members (i.e. the chairman, the representatives from each country and a delegate from the ESF), who will meet at least one time per year to take

decisions and actions for both the scientific and financial management of the Programme. The Steering Committee will elect every year a sub-committee of 4 people among the Steering Committee members who will be in charge of the evaluation of the short-term fellowships and the short scientific visit grants. The Steering Committee will be also in charge for the planning of the workshop and meetings. A website will be organized by the chairman, in which all information related to the Programme activities will be available. Each representative from a country will be responsible of the communication and advertisement about the Programme activities in his respective country, and of the relations with his national funding agency.

Section III: *(not more than 3 A4 single pages+ 1 single page for global dimension if applicable)*

List of *names and full coordinates of the* ***envisaged Steering Committee members listed by country*** *in alphabetical order (One member per collaborating country; this can be a provisional list and names can be added to it later)**:***

Here is the list of Steering Committee members/country who already agreed:

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15- Portugal

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16- Russia

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17- Serbia

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19- Spain

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20- Sweden

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21- Switzerland

Prof. Harm-Anton Klok

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22- Turkey

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Programme Collaborations: names and affiliations (including department, institute, university) of the **researchers/research groups** that are foreseen to participate in the Programme's activities **listed by country:**

1. Austria

- Prof. Robert Liska, Institute of Applied Synthetic Chemistry, Division Macromolecular Chemistry, Vienna
- Prof. Jürgen Stampfl, TU Wien, Inst. für Werkstoffwissenschaft und Werkstofftechnologie
- Prof. Christian Slugovc, TU Graz, Institut für Chemische Technologie Organischer Stoffe (ICTOS)
- Prof. Heinz Redl, Ludwig Boltzmann Institute for experimental and clinical Traumatology
- Prof Dr. Dieter Falkenhagen, Department of Environmental and Medical Sciences, Head of the Center for Biomedical Technology, Donau-Universität Krems

2. Belgium:

- Profs. J.-F. Gohy, A. Jonas, C. Bailly et S. Demoustier-Champagne, Université catholique de Louvain.
- Profs. F. Du Prez, P. Dubruel and R. Hoogenboom, Department of Organic Chemistry, Polymer division, Ghent University.
- Profs. B. Van Mele, Physical Chemistry and Polymer Science, Vrije Universiteit Brussel
- Prof. E. Nies and B. Goderis, Department of molecular and nanomaterials, Katholieke Universiteit Leuven
- Prof. T.Junkers, Organic and Polymer Chemistry, University Hasselt
- Profs. C. Jérôme and A.-S. Duwez, Centre for Research and Education on Macromolecules (CERM), University of Liège.

- Profs. J.-P. Ryckaert and Y. Geerts, Laboratoires de Physique et de Chimie des Polymères, Université libre de Bruxelles.
- Prof. Ph. Dubois, Laboratory of Polymeric and Composites Materials (LPCM), Prof. R. Lazzaronni, Service des Matériaux Nouveaux, Université de Mons-Hainaut.

3. Bulgaria

- Prof. Christo Tsvetanov, Dr. Stanislav Rangelov, Bulgarian Academy of Sciences, Institute of Polymers, Sofia
- Prof. George Georgiev, University "St. Kliment Ohridsky", Sofia

4- Czeck Republic

- Prof. Karel Ulbrich, Institute of Macromolecular Chemistry, Department of Biomedicinal polymers

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- Prof. Søren Hvilsted Danish Polymer Centre, Department of Chemical Engineering, Technical University of Denmark.
- Prof. Jørgen Kjems, Department of Molecular Biology, University of Aarhus

6. England:

- Prof. Neil R. Cameron, Department of Chemistry, University of Durham
- Prof. I. Hamley, University of Reading
- Prof. S. Armes, Department of Chemistry, University of Sheffield.
- Prof. David Haddleton, Department of Chemistry, University of Warwick
- Prof. Rachel O'Reilly, Department of Chemistry, University of Warwick
- Prof. Ian Manners, Department of Inorganic and Materials Chemistry, University of Bristol
- Prof. Simon Holder, School of Physical Sciences, University of Kent
- Prof. Cameron Alexander, School of Pharmacy - The University of Nottingham

7. Finland:

- Prof. H. Tenhu, Department of Chemistry, Dr. R. Serimaa and M. Torkelli, Department of Physics, University of Helsinki
- Prof. O. Ikkala, Technical University of Helsinki

8. France:

- Profs. Sébastien Lecommandoux, Henri Cramail, Daniel Taton, Georges Hadziioannou, Laboratoire de Chimie des Polymères Organiques (LCPO) CNRS, Université de Bordeaux
- Prof. C. Amiel, Laboratoire de Recherche sur les Polymères CNRS, Thiais.
- Prof. Jean-François Gerard, Laboratoire Ingénierie des Matériaux Polymères, Université de Lyon
- Dr. Oleg Borisov, Dr. Laurent Billon, IPREM, Université de Pau
- Dr. Patrick Guenoun, Laboratoire Interdisciplinaire sur l'Organisation Nanométrique et Supramoléculaire (LIONS), SIS2M-C.E.A. Saclay
- Dr. Julian Oberdisse, Laboratoire des Colloïdes, Verres et Nanomatériaux (LCVN), Université Montpellier II
- Prof. Bernadette Charleux, CPE Lyon, Laboratoire de Chimie, Catalyse et Procédés de Polymérisation
- Dr. Carlos Marques, Institut Charles Sadron CNRS, Université de Strasbourg.
- Dr. Ivan Huc, Institut Européen de Chimie de Biologie, Université de Bordeaux
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- Prof. Maria Vamvakaki from University of Crete, Dep. Materials Science and technology and IESL FORTH

11. Ireland:

- Dr. Andreas Heise, Dublin City University, School of Chemical Sciences

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- Dr Michael Morris, University College Cork (UCC), Department of Chemistry, National University of Ireland
- Prof. Dermot Diamond, The National Centre for Sensor Research (NCSR), Dublin City University

12. Israel:

- Dr. Ronit Satchi-Fainaro, Department of Physiology and Pharmacology, Sackler School of Medicine, Tel Aviv University
- Prof. Doron Shabat, School of Chemistry, Faculty of Exact Sciences, Tel-Aviv University, Tel-Aviv
- Prof. Ayelet David, Ben-Gurio University of the Negev, ayeletda@bgu.ac.il
- Prof. Dror Seliktar, Dept. of Biomedical Engineering, Technion-IIT Technion City, Haifa
- Prof. Ishi Talmon, Technion, Haifa

13. The Netherlands:

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- Prof. J.J.L.M. Cornelissen, University of Twente
- Prof. A. Herrmann, RU Groningen

14. Poland:

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15. Portugal

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16. Russia:

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- Prof. Olga Vinogradova, Institute of Petrochemical Synthesis, Russian Academy of Sciences, Moscow.

17. Serbia:

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- Prof. Martin Malmsten, Department of Pharmacy, Uppsala Biomedicinska Centrum

21. Switzerland:

- Prof. H.-A. Klok, EPFL, Polymer Laboratory, Institute of Materials, EPFL Lausanne
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- Prof. Holger Frauenrath, Laboratory of Macromolecular and Organic Materials, Institute of Materials, EPFL, Lausanne.
- Prof. W. Meier, Department of Chemistry, University of Basel,
- Prof. A. Gorban, Polymer Physics Group, Department of Materials,
- Prof. A.D. Schlüter, ETH Zürich, Polymer Chemistry Group, Department of Materials.
- Prof. Raffaele Mezzenga, Institute of Food Science and Nutrition, ETH Zürich.

22. Turkey:
- Prof. Mehmet Sayar, Koc University, Department of Mechanical Engineering
- Dr.Mustafa Güler, UNAM-Institute of Materials Science and Nanotechnology, Bilkent University
- Prof. Levent Demirel, Koç University, Chemistry Department, Rumelifeneri Yolu, Sarıyer, 34450 İstanbul
- Prof. Yusuf Yagci, Gürkan Hizal, Istanbul Technical University, Department of Chemistry, Istanbul
- Ass. Prof. Amitav Sanyal, Boğaziçi University, Department of Chemistry

Global dimension

Proposals with a global dimension should include one additional page outlining the key persons in the global network(s), the scientific benefits expected from the collaboration and the status of the non-ESF request for funds**: Not applicable**

Section IV: *(not more than 3 A4 single pages in total)*

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EDUCATION AND EXPERIENCE

2005	Full Professor, ENSCPB - University of Bordeaux (ENSCPB)
2004	Habilitation (HDR), 26.11.2004 - University of Bordeaux (ENSCPB)
1998	Assistant Professor at the Laboratoire de Chimie des Polymères Organiques (LCPO-CNRS-ENSCPB)
1998	Postdoctoral Fellowship at the University of Illinois at Urbana-Champaign (Professor S.I. Stupp)
1996	PhD at the University of Bordeaux (CRPP-CNRS, Professor F. Hardouin)

AWARDS

Junior Member of the Institut Universitaire de France, IUF (2007)
Bronze Medal Award of the CNRS (2004)
Award for the best PhD thesis from French Chemical Society (1996)

MEMBERSHIP

French Polymer Society (GFP), French Chemical Society (SFC), American Chemical Society (ACS), Controlled Release Society (CRS).

SYNOPSIS OF THE RESEARCH ACTIVITY AND SCIENTIFIC PRODUCTION

- General domain of interest: Therapeutic Nanotechnologies, Self-Assembly and Supramacromolecular chemistry, Polypeptide synthesis and self-assembly
- More than 75 communications, including 60 orals and 40 on invitation.
- More than 65 publications.
- Defence of 11 PhD thesis.
- Coordinator ou partner in 5 National Research Programmes (ACI/ANR) and Work-Package leader a European Programme (LARGE- FP7, Nanother 2008-2012).
- Co-editor of ”Block Copolymers in Nanosciences”, M. Lazzari, G. Liu, S. Lecommandoux, Wiley-VCH (2006)

SCIENTIFIC ANIMATION

- Director of the Research at the Ecole Nationale Supérieure de Chimie et Physique de Bordeaux (ENSCPB-University Bordeaux 1).
- Member of the Scientific Comity of the Laboratoire Léon Brillouin (LLB-CEA Saclay, France).
- Expert for the “Observatoire des Nano et Micro-Technologies” OMNT.
- Editorial Board of “European Polymer Journal”, Elsevier, “The Open Macromolecules Journal”, Bentham Science Publishers and “Advances in Natural Sciences”, Vietnamese Academy of Science and Technology (VAST).
- Organizer of several meetings: "Club Nanomatériaux pour les sciences du Vivant 2008" (100 participants, national) and "Stimuli-Responsive Polymeric Materials 2008" (85 participants, international ESF)

FIVE MOST RECENT RELEVANT PUBLICATIONS

1- Biomimetic Doxorubicin Loaded Polymersomes from Hyaluronan-block-Poly(γ-benzyl glutamate) Copolymers. K. Kumar Upadhyay, J.-F. Le Meins, A. Misra, P. Voisin, V. Bouchaud, E. Ibarboure, C. Schatz and S. Lecommandoux. ***Biomacromolecules*** ASAP (2009), DOI: 10.1021/bm9006419
2- Self-assembly of polypeptide-based block copolymer amphiphiles. A. Carlsen, S. Lecommandoux. ***Cur. Opin. in Col. & Int.. Sci.*** 14 (5), 329-339 (2009).
3- Polysaccharide-block-polypeptide copolymer vesicles: towards synthetic viral capsids. C. Schatz, S. Louguet, J.-F. Le Meins, S. Lecommandoux. ***Angew. Chem. Int. Ed***., 48, 2572 (2009)
4- A Versatile Synthetic Approach to Polypeptide Based Rod-Coil Block Copolymers by Click Chemistry. W. Agut, D. Taton, S. Lecommandoux. ***Macromolecules*** 40, 5653 (2007)
5- Micelle Density Regulated by a Reversible Switch of Protein Secondary Structure. R.E. Sallach, M. Wei, N. Biswas, V. P. Conticello, S. Lecommandoux, R. A. Dluhy, E. Chaikof. ***JACS*** 128(36), 12014-12019 (2006)

Harm-Anton KLOK

Date of birth : June 21st, 1971
Place of birth : Hoogezand-Sappemeer, The Netherlands
Nationality : Dutch

EDUCATION

Aug 1989 – Oct 1993	Studies of Chemical Technology, University of Twente (Enschede, The Netherlands)
Nov 1993 – Jan 1997	Research and teaching assistant in the group of Prof. M. Möller (Organische Chemie III/Makromolekulare Chemie, Universität Ulm, Ulm, Germany) Topic of PhD Thesis: "*Supramolecular and polymeric building blocks for the development of optical ion sensors*"
November 10th, 2004	Habilitation on "*Protein-mimetic polypeptides and protein-inspired hybrid block copolymers*" and venia legend in macromolecular chemistry (RWTH Aachen, Aachen, Germany)

EMPLOYMENT HISTORY

Dec 1992 – Mar 1993	Research stay at the Central Polymer Research Laboratory of BASF AG (Ludwigshafen, Germany)
Feb 1997 – Nov 1997	Postdoc in the group of Prof. D. N. Reinhoudt (Laboratory of Supramolecular Chemistry and Technology), University of Twente (Enschede, The Netherlands)
Dec 1997 – Jan 1999	Postdoc in the group of Prof. S. I. Stupp (Departments of Materials Science and Engineering and Chemistry), University of Illinois at Urbana-Champaign (USA)
Feb 1999 – Feb 2003	Project-leader in the group of Prof. K. Müllen, Max Planck Institute for Polymer Research (Mainz, Germany)
Mar 2003 – Sep 2008	Assistant Professor (tenure track) and director of the Polymers Laboratory (Institute of Materials), Ecole Polytechnique Fédérale de Lausanne (EPFL) (Lausanne, Switzerland)
Oct 2008 – July 2009	Associate Professor and director of the Polymers Laboratory (EPFL) (Lausanne, Switzerland)
August 2009 –	Full Professor and director of the Polymers Laboratory (EPFL) (Lausanne, Switzerland)

RESEARCH INTERESTS AND COMPETENCES

Materials & synthetic strategies: Peptide/protein-based materials and peptide/protein-polymer hybrids; Surface-initiated polymerization and polymer brushes; Controlled/"living" polymerization and macromolecular engineering; Dendritic and hyperbranched polymers.
Fields of application: Polymer therapeutics/Nanomedicine; Smart hydrogels; Controlled drug delivery and release systems; Polymer surface modification; Biomaterials coatings; Protein microarrays; Biomineralization; Environmental sensors.

PROFESSIONAL MEMBERSHIPS

American Chemical Society (ACS), Materials Research Society (MRS), Koninklijke Nederlandse Chemische Vereniging (KNCV), Swiss Chemical Society

AWARDS, ACADEMIC HONOURS

1) Talent-postdoctoral fellowship of the Netherlands Organization for Scientific Research (NWO). (01.12.1997 – 01.12.1998).
2) Emmy Noether Fellowship of the Deutsche Forschungsgemeinschaft (DFG). (01.09.1999 – 30.04.2003).
3) Thieme Journal Award, 2002.
4) Arthur K. Doolittle Award, American Chemical Society (Polymeric Materials: Science and Engineering Division), 2007.

FIVE MOST RECENT RELEVANT PUBLICATIONS

1- S. Tugulu, H.-A. Klok, Stability and nonfouling properties of poly(poly(ethylene glycol) methacrylate) brushes under cell culture conditions, **Biomacromolecules** 2008, 9, 906 – 912.
2- B. Apostolovic, H.-A. Klok, pH-Sensitivity of the E3/K3 heterodimeric coiled coil, **Biomacromolecules** 2008, 9, 3173 – 3180.
3- M. A. Gauthier, H.-A. Klok, Peptide/protein – polymer conjugates: synthetic strategies and design concepts, Chem. Commun. 2008, 2591 – 2611.
4- M. A. Gauthier, M. I. Gibson, H.-A. Klok, Synthesis of functional polymers by post-polymerization modification, **Angew. Chem. Int. Ed.** 2009, 48, 48 – 58.
5- M. I. Gibson, E. Fröhlich, H.-A. Klok, Postpolymerization modification of poly(pentafluorophenyl methacrylate): synthesis of a diverse water-soluble polymer library, **J. Polym. Sci. Part A: Polym. Chem.** 2009, 47, 4332 – 4345.

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EDUCATION AND EXPERIENCE

June 2003:	BSc in Chemistry, Macromolecular chemistry, University of Liège (ULg).
01/10/1993–01/10/1994:	Fellowship from I.R.S.I.A.
01/10/1994-01/10/2000:	Teaching Assistant ULg.
May 3rd 1999:	PhD in Sciences, supervisor: Prof. R.Jérôme (CERM, ULg),
01/10/2000-01/10/2003:	Chargé de Recherches by the Belgian National Foundation for Scientific Research (FNRS).
01/10/2001–01/10/2002:	Post-doc at the Eindhoven University of Technology with Prof. U. S. Schubert.
01/09/2002–01/09/2003:	Invited Assistant Professor at the Chemistry Department of the Université catholique de Louvain (UCL).
01/09/2003–31/08/2006:	Assistant Professor UCL.
Since 01/09/2006:	Professor UCL.
Since 01/08/2008:	Part-time (20%) Professor at the Eindhoven University of Technology, Laboratory of Macromolecular Chemistry and Nanoscience.

AWARDS AND COMMITTEES

1989:	1st Lauréat of the "Olympiade Belge Francophone de Chimie".
1999:	Jean-Servais Stas award for the PhD thesis.
1998-2001:	Member of the "Comités de Lecture du LURE", Université Paris-Sud, Orsay.
2000-2003:	Member of the Steering Committee of the SUPERNET (Experimental and Theoretical Investigation of Complex Polymer Structures) European Science Foundation network.
Since 2004:	Member of the American Chemical Society.
Since 2005:	Coordinator of the STIPOMAT (Stimuli-responsive Polymeric Materials) European Science Foundation network.
Since 2005:	Chairman for the Polymer Division of the Royal Society of Chemistry (Belgium).

SYNOPSIS OF THE RESEARCH ACTIVITY AND SCIENTIFIC PRODUCTION

- General domains of interest: Synthesis of polymers including "living" and “controlled” polymerization techniques, ionic polymers, liquid crystals, surfactants, supramolecular chemistry, self-associating polymers in aqueous and non-aqueous media, stimuli-responsive materials, nanomaterials, adsorption of polymers on substrates, nanopatterned surfaces…
- More than 130 scientific publications.
- Supervision of more than 25 master students, PhD students and post docs
- h factor of 27, more than 2000 citations

FIVE MOST RECENT RELEVANT PUBLICATIONS

1- "Lubrication by charged polymers" U. Raviv, S. Giasson, N. Kampf, J.-F. Gohy, R. Jérôme, J. Klein, **Nature** 2003, 425, 163-165

2-"Dilution-induced spheres-to-vesicles morphological transition in micelles from block copolymer/surfactant complexes" Z. Hu, S. Varshney, A. M. Jonas, J.-F. Gohy,, **J. Am. Chem. Soc.** 2005, 127, 6526-6527.

3-"Solvent-induced morphological transition in core-crosslinked block copolymer micelles" H. Huang, R. Hoogenboom, M. A. N. Leenen, P. Guillet, A. Jonas, U. S. Schubert, J.-F. Gohy, **J. Am. Chem. Soc.** 2006, 125, 3784-3788.

4-"Connecting micelles by metallo-supramolecular interactions: towards stimuli responsive hierarchical materials" P. Guillet, C. Mugemana, U. S. Schubert, F. Stadler, C. Bailly, C.-A. Fustin, J.-F. Gohy, **Soft Matter** 2009, 5, 3409-3411

5- "Multicompartment micelles from a metallo-supramolecular tetrablock quatercopolymer" J.-F. Gohy, C. Ott, S. Hoeppener, U. S. Schubert, **Chem. Commun.** 2009, 40, 6038-6040.