LCPO - Laboratoire de chimie des polymères organiques

Rapport Hcéres

agence d'évaluation de la recherche
et de l'enseignement supérieur

Section des Unités de recherche

AERES report on the research unit

Laboratoire de Chimie des Polymères Organiques (LCPO)

From the

Université de Bordeaux 1

CNRS

Institut Polytechnique de Bordeaux (IPB)

June 2010

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Le Président
de l'AERES

Jean-François Dhainaut

Section des unités
de recherche

Le Directeur

Pierre Glorieux

June 2010

Research Unit

Name of the research unit : Laboratoire de Chimie des Polymères Organiques (LCPO)

Requested label : UMR

N° in the case of renewal : UMR 5629

Name of the director : Mr Henri CRAMAIL

Members of the review committee

Committee chairman

Mr Frans DE SCHRYVER, Max Planck Research Award for Chemistry, Heverlee, Belgique

Other committee members

Mrs Anne BLEUZEN, ICMMO, UMR 8182, Université de Paris 11 Paris-Sud

Mr Robert JEROME, Université de Liège, Belgium

Mrs Nelly LACOME, LADIR, UMR 7075, Université Pierre & Marie Curie Paris 6

Mr Richard LAVERY, Institut de Biologie et Chimie des Protéines, UMR 5086, Université de Lyon

Mr Ludwik LEIBLER, ESPCI, Matière Molle et Chimie, UMR 7167 CNRS

Mr Ilan MAREK, Sir Michael and Lady Sobell Academic Chair, Schulich Faculty of Chemistry, Technion-Israel Institute of Technology, Israël

Mr Klaus MÜLLEN, Max-Planck Institute for Polymer Research, Mainz, Germany

Mr Claude PIGUET, Department of Inorganic Chemistry, University of Geneva, Switzerland

Mr Philippe SCHAEFFER, Institut de Chimie de Strasbourg, UMR 7177, ECPM, Université de Strasbourg

Mr Troels SKRYDSTRUP, Aarhus University, Dept. of Chemistry, Aarhus, Denmark

Committee members suggested by CNU, CoNRS, CSS INSERM, CSS INRA, INRIA, IRD

Mr Mir Wais HOSSEINI, CNU representative

Mrs Yanling LI, CoNRS representative

Observers

AERES scientific advisor

Mr Max MALACRIA

University, School and Research Organization representatives

Mr Jean-Rodolphe PUIGGALI, Vice-Président du Conseil Scientifique, Université Bordeaux 1

Mr François CANSELL, Directeur, Institut Polytechnique de Bordeaux (IPB)

Mr Jean-Marc HEINTZ, Directeur, Ecole Nationale Supérieure de Chimie, Biologie et Physique (ENSCBP-IPB)

Mrs Christine MAHODAUX, service valorisation, Délégation Régionale Aquitaine Limousin, CNRS

Mr Jean-François BAUMARD, Institut de Chimie, représentant CNRS

Report

1 • Introduction

- Date and execution of the visit

The visit was planned and executed on Wednesday October 28th from 08.00 till 17.00 at the Bordeaux 1 campus in the facilities of the IPB/ENSCBP

- History and geographical localization of the research unit. and brief presentation of its field and scientific activities

The unit has since the previous evaluation undergone a substantial change. Three members left but two members, one CR1 CNRS and PRex on a chair d'excellence, joined from outside UB1 and in 2011 7 members of UMR 5103 (USB2) will join. As a result the unit is spread over three locations IPB/LCPO, UB1 B8 and UB1 A11. The unit has since its creation in 1985 built a very strong international reputation in Polymer science and in particular polymer synthesis focussing on polymerization mechanisms and macromolecular engineering with potential applications in adhesion, life science and energy fields. This should result in the evolution of LCPO into a center for Advanced Functional Polymer Materials embedded in local and national efforts.

- Management team

At present Prof. Henri Cramail is the director but in the next period besides the director a vice director, Prof. S Lecommandoux, is foreseen as well as an executive scientific board containing besides the director and vice director also the theme coordinators

- Staff members

	Past	Future
N1: Number of researchers with teaching duties (Form 2.1 of the application file)	11	17
N2: Number of full time researchers from research organizations (Form 2.3 of the application file)	6	5
N3: Number of other researchers (Forms 2.2 and 2.4 of the application file)	0	1
N4: Number engineers, technicians and administrative staff with a tenured position (Form 2.5 of the application file)	8.5	12
N5: Number engineers, technicians and administrative staff without a tenured position (Form 2.6 of the application file)	1	2
N6: Number of Ph.D. students (Form 2.7 of the application file)	17	36
N7: Number of staff members with a HDR or a similar grade	12	18

2 • Overall appreciation on the research unit

- Summary

The unit, which operated as a highly integrated team, has established internationally recognized expertise in polymer synthesis along five themes : polymer chemistry from traditional to sustainable routes optimizing polymerization by eco friendly proccesses or using renewable resources; creative macromolecular engineering leading to novel polymeric architectures and engineering through self assembly; polymer nanotechnology for life science with polymer applications in drug delivery and diagnostic tools ; polymers for organic electronics addressing fundamental questions in photovoltaics; surface and interphase design for advanced materials focussing on adhesion and nanocomposites. All themes have resulted in publications with almost 50% in journals with an IF over 4 and most also in patents. The extension of the unit and advent of novel expertise has lead to a reorganization in four themes leaving the creative macromolecular engineering as an underlying fundamental layer in each theme but focussing in general on more advanced functional polymer materials. This has led to an evaluation in which part of some themes are mixed as far as the past is concerned.

- Strengths and opportunities

Excellent synthetic polymer chemistry leading to high quality scientific production as well as patents, strong interaction with the local environment and with industry. Highly recognized for this expertise internationally. Strong team spirit and coherent functioning of the unit. Excellent “governance” of the director. The extension of the group and the strong input of new and complementary expertise in particular in the energy area can lead to successful development of the next step towards advanced materials.

- Weaknesses and threats

Where in the past the strength was in the synthesis and the weakness in the missing step towards material aspects, this can now be realized. However great care will have to be taken not to loose the outstanding synthesis expertise and to diligently integrate both function and synthesis in two of the themes targeting respectively life science and polymer electronic materials which will require implementation of additional novel concepts. The multiphase polymer materials theme lacks novelty and is more a smart application of the existing expertise towards focussed industrial aplications, and as such better described as a knowledge transfer effort. The fact that the unit is spread over 3 locations should be eliminated by assembling all parts in e.g. a fully renovated UB1 B8.

- Recommendations to the head of the research unit

The director should keep the excellent team spirit and make sure that in particular in theme 2 and 3 the creative macromolecular engineering expertise is exploited properly and to the full.

- Production results

A1: Number of lab members among permanent researchers with or without teaching duties who are active in research (recorded in N1 and N2)	16
A2: Number of lab members among permanent researchers with or without teaching duties who are active in research (recorded in N3, N4 and N5)	4
A3: Ratio of members who are active in research among staff members [A1/(N1+N2)]	1
A4: Number of HDR granted during the past 4 years	1
A5: Number of PhD granted during the past 4 years	36
A6: Other relevant item in the field	

3 • Appreciation team by team and/or project by project

LCPO TP1/R1 (theme number in Project and Report)

Sustainable Polymer Chemistry

Title of the team : Sustainable Polymer Chemistry

Name of the team leader: Mr D. TATON

- Staff members

	Past	Future
N1: Number of researchers with teaching duties (Form 2.1 of the application file)	2.6	5.1
N2: Number of full time researchers from research organizations (Form 2.3 of the application file)	2.7	3.6
N3: Number of other researchers (Form 2.2 and 2.4 of the application file)	0	0
N4: Number engineers, technicians and administrative staff with a tenured position (Form 2.5 of the application file)	0.7	1.5
N5: Number engineers, technicians and administrative staff without a tenured position (Form 2.6 of the application file)	0	0
N6: Number of Ph.D. students (Form 2.7 of the application file)	17	8
N7: Number of staff members with a HDR or a similar grade	4.8	8.2

Theme 1 is dedicated to « Polymer Chemistry/Synthesis » which is the keystone onto which the activities of the other themes rely. This core research activity covers the whole front of the poly-addition mechanisms in an innovative way, which regularly results in important headway in each of these processes. LCPO is one of the very best laboratories in polymer synthesis all over the world, with a leading position in tailoring/design of synthetic macromolecules. This unique position is assessed by a large number of publications with a high impact factor, invited lectures, patents and defended PhD theses under the impetus of 5 project leaders over the evaluation period. The number of contracts is also impressive, mainly ANR and industrial contracts – some of them lasting for many years. On the basis of all these criteria, theme 1 is the most productive and internationally renowned activity in LCPO, in agreement with the effort focused on it for many years and its decisive impact on the laboratory life and evolution.

As result of its top international position, theme 1 activity attracts very fruitful scientific collaborations with renowned foreign laboratories selected for complementary expertise and opportunity to progress further and to add value to LCPO expertise, impact and visibility. Needless to say the industry is keen on collaborating with LCPO in order to share its know-how and expertise and at least to improve the performances of their products and processes if not to innovate. The basic research being a must, LCPO has the capacity to convince all types of public funding agencies to provide it with the necessary financial support. The international visibility of LCPO makes it an important partner in scientific networks, scientific and industrial clusters and a place where post–docs want to work.

All the outstanding scientific achievements and attractiveness of LCPO through theme 1 activity would not have been possible without the high coherence of its internal organization based on the integration and collaboration of all its actors, their involvement in some of the other research themes, their capacity to exchange ideas and to promote accordingly a stimulating scientific animation and ultimately to make cutting edge projects emerging. From the meeting of the evaluation committee with the scientific council and with the PhD students and post-docs, it is obvious that the management is very appreciated for its transparency and efficiency, good communication and structuring of the research.

The project as a whole is not merely an extension of the subprojects that contributed to the success and reputation of LCPO in polymer synthesis during the evaluation period. Indeed, the willingness to innovate is vivid as supported by the intended development of sustainable polymer chemistry through three major routes with the purpose to answer concerns raised by the society as a whole. Organic and enzymatic catalysis is the first of these strategies that LCPO started to implement during the last few years with already an activity at the forefront of this emerging field. The two other new subtopics « Polymers from Renewable Resources » and « Green Processes » are fully justified by economic and society needs. They will be effective levers for raising funds and there is a large place for innovation. A pioneering effort is clearly requested in these research areas and how fast LCPO will be able to put its fingerprint on them is not clear yet.

In conclusion LCPO enjoys a very well-established international reputation in Polymer Chemistry for a long time. This leading position has been maintained if not reinforced by the originality and innovation of its contribution during the evaluation period.

High scientific ambition and strong capacity of being active at the very forefront of challenging topics account for a special recognition by the scientific community, industrial partners and funding agencies.

The unavoidable evolution of the society pushes LCPO to engage itself in fields that start to be investigated by polymer scientists all over the world. It will take some time for LCPO to develop its own expertise and to reach international visibility in these areas, which is in no way a threat but will need an adapted management of the research organization in order to preserve its leading position in Polymer Chemistry and to progress rapidly in the newly investigated fields.

- Recommendations:

Highly controlled polymer synthesis must remain the core activity of LCPO. Association of young well-educated scientists with experimented polymer chemists is essential to maintain scientific animation and skilled experimentation at a high level while targeting innovation.

Please note that for this theme staff of past theme 2 and 3 are considered for the report of Future theme 2

Polymer Nanotechnology for Life Science, LCPO TP2/R2-R3

Title of the team : Polymer Nanotechnology for Life Science, LCPO TP2/R2-R3

Name of the team leader: Mr S. LECOMMANDOUX

- Staff members

Past Theme 2: Macromolecular Engineering

	Past	Future
N1: Number of researchers with teaching duties (Form 2.1 of the application file)	**1.9**	-
N2: Number of full time researchers from research organizations (Form 2.3 of the application file)	**1.7**	-
N3: Number of other researchers (Form 2.2 and 2.4 of the application file)	**0**	-
N4: Number engineers, technicians and administrative staff with a tenured position (Form 2.5 of the application file)	**1.5**	-
N5: Number engineers, technicians and administrative staff without a tenured position (Form 2.6 of the application file)	**0**	-
N6: Number of Ph.D. students (Form 2.7 of the application file)	**12**	-
N7: Number of staff members with a HDR or a similar grade	**2.4**	-

Past Theme 3: Polymer Nanotechnology for Life Science Future Theme 2: Polymer Nanotechnology for Life Science

	Past	Future
N1: Number of researchers with teaching duties (Form 2.1 of the application file)	**1.7**	**3.6**
N2: Number of full time researchers from research organizations (Form 2.3 of the application file)	**0.4**	**0.4**
N3: Number of other researchers (Form 2.2 and 2.4 of the application file)	**0**	**0**
N4: Number engineers, technicians and administrative staff with a tenured position (Form 2.5 of the application file)	**0**	**0.2**
N5: Number engineers, technicians and administrative staff without a tenured position (Form 2.6 of the application file)	**0**	**0**
N6: Number of Ph.D. students (Form 2.7 of the application file)	**2**	**2**
N7: Number of staff members with a HDR or a similar grade	**0.8**	**1.5**

The unique capacity of LCPO to tailor synthetic macromolecules has been cleverly exploited as discussed under the headings: Theme 2 and Theme 3 of the Report. Actually the research activities brought together in the Theme 2 convincingly illustrate the large range of novel macromolecular architectures and nano-objects that LCPO has prepared and characterized while emphasizing their potential in nanosciences and nanotechnologies. Theme 3 officially started 2 years ago with the purpose to exploit the expertise collected in Theme 2 and to have it dedicated to life sciences. It is thus reasonable to discuss the results and impact of Themes 2 and 3 all together; consistent with the decision of LCPO to merge these 2 themes into one, headed Theme 2 « Polymer Nanotechnology for Life Science » in the Project.

As a whole, the scientific quality and impact of the results are unquestionable and outstanding in many aspects, as is the case of unimolecular branched macromolecules and macrocyclic copolymers. This appreciation is assessed by a high number of scientific publications in the best journals in the field, patent applications/extensions, invited lectures and a high number of defended PhD theses. The characterization work which is first rate has the benefit of national and also international scientific collaborations. 5 project leaders are the architects of this impressive achievement.

The national and international reputation of the leaders in Themes 2 and 3 is well-established on the basis of invited lectures in international forums, book edition, and contributions of book chapters upon invitation and organization and chairing of conferences. The large number of post-docs is evidence of the attractiveness of the running topics and, indirectly, of the effectiveness of the funding policy of LCPO. In this respect, the large number of public contracts and industrial contracts show how successful LCPO is in raising the funding for the Themes 2 and 3.

Participation as a sub-project leader in a large FP 7 program dealing with treatment and diagnosis of cancer must be emphasized, and collaboration to a National Institute for Health (NIH) US program as well. LCPO is also an active member of the GIS « Advanced Materials in Aquitaine », which allows it to be involved in 3 biomaterial-oriented projects. These pieces of information explain the highly visible presence of LCPO in scientific networks and partnerships in France and abroad. The interest paid by the industry is a strong indicator of the application potential of the conducted research.

Themes 2 and 3 reflect the ambition of LCPO to exploit and valorize the acquired scientific knowledge and know-how in polymer synthesis. Indeed, nano-structuring the polymeric matter through a bottom-up approach is the scientific strategy herein proposed for designing polymer systems with high added value in order to tackle health concerns and problems of society. This strategy is supported and encouraged by the visiting committee.

The discussion of the management and scientific life aspects that has been reported for LCPO as a whole, holds for the group of people active in Themes 2 and 3.

In the future, the expertise that LCPO has acquired in macromolecular engineering will be dedicated to the development of functional nanostructures endowed with responsiveness to external stimuli and/or ability to recognize specific molecular targets. Two major types of functional systems are envisioned, i.e. drug delivery systems (DDS) and biosensors.

At the time being, several types of nanoparticles with potential as DDS have been prepared, i.e. latex-based particles, dendrimeric-like polymers and biomimetic self-assemblies, whose physico-chemical properties have been studied and biological relevance has been tested in preliminary experiments. The very challenging field of biosensors will be initiated in conjunction with the « Polymer Electronic Materials » team (new Theme 3).

The very ambitious reorganization of the former Themes 2 and 3 must be encouraged. It will be as successful as the polymer chemists at LCPO will be able to translate their traditional competence of designers into biomedical applications. This is the most challenging aspect of the project; whose complexity and how to cope with it need a further deep analysis and adequate strategies. The challenge of going from tailored macromolecules to biomaterials available on the market place is increased by the strong international competition. Therefore fruitful collaboration with motivated and rapidly responding experts in biology and medicine is of the utmost importance. The proper management of this issue added to the capacity of LCPO to engineer well-defined systems should be one of the best assets for being a key player in the field.

In conclusion an ambitious and challenging project based on the in-house expertise in designing synthetic or hybrid (synthetic/biological) polymer systems is proposed with the purpose to elaborate bio-mimetic drug delivery devices, hopefully with multiple functionalities (targeting, imaging, sensing). In addition to this already running research, an emerging project aims at coupling the competences of the actors in Themes 2 and 3, in order to build up bio-electronic implants and sensor arrays. This envisioned internal collaboration through a transverse project must be encouraged.

LCPO has the capacity to innovate in the design of bio-inspired polymer systems with well-defined properties and functions and to have them adapted to the requirements of specific biomedical applications through a feed-back process with biological testing. It can compete successfully in the first part of a process going from macromolecules to applicable devices, i.e. fundamental approach followed by proof of concepts. This is a unique opportunity of entering the arena of nanotechnology for life sciences and becoming a key player in the future.

To be successful, the research activity must go beyond the classical approach and expertise of polymer scientists, in order to reach rapidly a good understanding of how artificial devices adapt themselves to a living environment and have then the envisioned role without causing deleterious perturbations. This task is very complex because experts of completely different fields have to collaborate with the same motivation and ability to communicate and to make new ideas and appropriate strategies emerging. The complexity of the task should not be underestimated.

The way that led Theme 1 to an international leading position should be a source of inspiration for the evolution and growth of Theme 2, which must also integrate the additional issue of the unavoidable interplay of very different disciplines and expertise.

LCPO TP3/R4

Polymer electronic Materials and Devices

Title of the team: Polymer electronic Materials and Devices

Name of the team leader: Mr G. HADZIIOANNOU

- Staff members

	Past	Future
N1: Number of researchers with teaching duties (Form 2.1 of the application file)	1.5	2.9
N2: Number of full time researchers from research organizations (Form 2.3 of the application file)	0.5	0.7
N3: Number of other researchers (Form 2.2 and 2.4 of the application file)	0	0
N4: Number engineers, technicians and administrative staff with a tenured position (Form 2.5 of the application file)	0	1.3
N5: Number engineers, technicians and administrative staff without a tenured position (Form 2.6 of the application file)	1	1
N6: Number of Ph.D. students (Form 2.7 of the application file)	2	6
N7: Number of staff members with a HDR or a similar grade	1.5	2.3

The relevant themes of this unit in the past and described in the report section relate to PEDOT particle formation and synthesis of block copolymers with one conjugated segment. They represent good, but not overly creative solid polymer chemistry. The number and quality of the publications is good and many of them have been published in first class journals in the field.

The impact and visibility was limited by the fact that the synthetic work was not extended toward processing studies and device formation and thus appeared somewhat underexplored.

Since the joining of a Prex and the creation of a chair of excellence with particular emphasis on this theme, the work toward polymer electronics has been lifted to a much higher level and holds potential to become unique in France. This relates to the combination of existing and new synthesis, processing and device physics as well as fabrication aspects including clean room facilities.

The three subprojects of the excellent project on LEDs, photovoltaics and information storage are creatively and competently planned from both a fundamental and functional point of view. They will benefit from classical polymer physics competence since issues like morphology control and phase separation will be applied in attempts at device optimization.

In conclusion excellent governance will lift the potential of the theme to an oustanding level if the efforts of the team leader can further optimize and creatively integrate the interaction between the excellent synthetic expertise of the unit and the imported physics and device know how.

LCPOTP4/R5

Multi Phase polymer Materials

Title of the team: Multi Phase polymer Materials

Name of the team leader: Mr A. SOUM

- Staff members

	Past	Future
N1: Number of researchers with teaching duties (Form 2.1 of the application file)	2.3	4.4
N2: Number of full time researchers from research organizations (Form 2.3 of the application file)	0.7	0.3
N3: Number of other researchers (Form 2.2 and 2.4 of the application file)	0	0
N4: Number engineers, technicians and administrative staff with a tenured position (Form 2.5 of the application file)	0.8	2
N5: Number engineers, technicians and administrative staff without a tenured position (Form 2.6 of the application file)	0	1
N6: Number of Ph.D. students (Form 2.7 of the application file)	3	1
N7: Number of staff members with a HDR or a similar grade	2.5	4.9

The research within this theme focused on two technology areas, adhesives and nanocomposites. Both topics are of interest to industry and have aroused considerable effort all over the world and also in France. In the area of adhesives and interfaces, the group made a noticeable contribution in the past by promoting the use of hydrophobic-hydrophilic block and multiblock copolymers to manage adhesive and mechanical properties in humid environments and in water. Regretfully this promising research direction was not pursued aggressively enough and the potential output and impact could be much higher here. The idea of combining surface segregation with the formation of «breath figures», to obtain non-trivially organized surfaces, seems attractive but as for today more thorough and quantitative studies are needed to unveil and explore its full scientific and technological potentialities.

The field of polymer nano-composites including carbon nanotubes dispersions treated within this theme is particularly competitive. In this context, and so far, the scientific results of the group are quite meager and the proposed approach although sound and professional in principle appears to be not very original nor innovative. The research here seems to be driven by urgent demands and support from industrial partners rather than by clear scientific or technological vision.

The research within this Theme was not sufficiently original and made a limited impact and it not really benefited from the enormous potential of the neighboring first class research on polymer synthesis and macromolecular engineering. The committee notes with satisfaction and encourage the desire of the laboratory members and management to improve the inter-themes collaborations and couple inventive synthetic chemistry with more application oriented projects within this Theme. The committee thinks that industrial partners will also benefit from such involvement and interconnections. It is important though to fix ambitious goals and focussed research. For example, the projects concerning cellulose modifications and cellulose nano-whiskers and fibers reinforced nanocomposites are potentially interesting. Inclusion of chemistry based on renewable feedstock as developed within Theme 1 offers unique opportunities as well. The collaboration with ITERG is to be encouraged.

In conclusion, hitherto, research within Theme 4 although sound and professional had a limited output and impact in this very competitive area. In particular, it did not fully integrate all potential benefits from the first class synthetic chemistry and macromolecular engineering potentialities present within LCPO. There is a strong drive within the group to improve this situation and this is to some extent reflected in research project. Also, the integration of researches with expertise in natural filler chemistry and collaboration with ITERG an institute specialized in green feedstock bode well for the future.

Laboratoire de Chimie des Polymères Organiques UMR CNRS 5269 (LCPO)

Note de l'unité	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
A+	A+	A	A+	A+

Nom de l'équipe : LCPO TP1/R1 Sustainable Polymer Chemistry

Note de l'équipe	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
A+	A+	A+	A+	A+

Nom de l'équipe : LCPO TP2/R2-R3 Polymer Nanotechnology for life Science

Note de l'équipe	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
A	A+	A+	A	A

Nom de l'équipe : LCPO TP3/R4 Polymer electronic Materials and devices

Note de l'équipe	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
A+	A	A+	A+	A+

Nom de l'équipe : LCPOTP4/R5 Multi Phase polymer Materials

Note de l'équipe	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
B	B	B	B	B

Le directeur et les membres du Laboratoire de Chimie des Polymères Organiques prennent acte du rapport émis par le comité de visite de l'AERES et le remercient pour son analyse et ses recommandations qu'ils intégreront dans leur projet de laboratoire.

Le Directeur de l'unité :
Professeur Henri CRAMAIl

Le Président de l'Université Bordeaux1 :
Professeur Alain BOUDOU

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