Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014

Final Report on the Evaluation of the Institute

Name of the Institute: Institute of Macromolecular Chemistry

Fields, in which the Institute registered its teams:

Chemical sciences

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Commission No. 4: Chemical sciences
Chair: Dr Habil, Academician Christian Amatore

Date(s) of the visit of the Institute: November 30 - December 4, 2015
Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:

- **Supramolecular Systems and Selfassociation Processes (SUPRAMOL)**
- **Biomacromolecular and Bioanalogous Systems (BIOMOL)**
- **Polymer Materials and Technologies (MATER)**
- **Structure and Dynamics of Macromolecules (STRUCTURE)**
- **Polymers for Optoelectronic and Energy Applications (OPTOEL)**

A. Evaluation of the Institute as a whole

1. Introduction

The main mission of the institute is to carry out fundamental and applied research in the chemistry, physical chemistry and physics of macromolecules and polymer materials. Macromolecular and supramolecular systems represent a very active area of current soft matter research.

Organic supramolecular systems make use of the principles of supramolecular organization known from natural systems, namely hydrogen bonds, pi-stacks, attachment to surfaces, and shape control. These principles are used both for the organization of macromolecules and low-molar mass systems. The aim is usually to produce functional materials, which show unusual properties such as photo-conductivity, ion conductivity of protons or lithium ions. The applications range from conventional polymers with favorable mechanical properties to functional materials that can be used in batteries, optoelectronics or advanced drug and gene carriers.

Moreover, building blocks that nature uses are employed to generate biomimetic systems as well as hybrids containing natural and synthetic moieties. Hence, as in many modern institutes of polymer science there is strong a emphasis on applications towards biological systems in this Institute as well.

Obviously, research in macromolecular science is interdisciplinary in nature and requires not only a mastering of the above principles into expert syntheses but also a constant involvement and feedback of physical models and methods to sustain the syntheses, analyse their outputs and test and characterize their performance. In perfect accordance with these requirements, as the equivalent centers across the world demonstrate, the Institute fosters cooperation between the different teams to stimulate profitable interactions among its diverse expertise within the Institute.

2. Strengths and Opportunities

The Institute has a long tradition in Macromolecular Chemistry and used to be well embedded in — and well considered — in the corresponding scientific community. Accordingly, the Institute continues to organize conferences on macromolecular science and one international workshop, ‘Career in Polymers’, a satellite meeting specifically aimed to young scientists.

The age distribution of the employed scientists in the institute seems adequate to maintain effectively its future scientific performance. Though, a slight shift to younger PIs and co-workers is desirable to improve the present structure. However, the Committee has been pleased to notice that this is already underway.

The Institute has been developing a convincing strategy of funding and has modernized buildings as well as the infrastructure and instrumentation. In view of the topics covered, the success in getting grants seems to be fair.

Finally, the outreach into education (teaching at universities, training of Ph.D. students, hiring of postdoctoral fellows) seems to follow a clear strategy. The international hiring of Ph.D. students and postdocs is excellent and could be increased.

3. Weaknesses and Threats

The Institute covers a very broad range of topics in polymer science. After the retirement of leading scientists, the Institute is in a long-lasting transition state and, in the Director's own words, there is a *'need to concentrate actively the research capacities on the significant research directions'*.

This present status is perfectly mirrored by the research output of the Institute. This has been nearly steady during the 5-year period evaluated, and even a slight tendency to decrease is apparent. The IFs of the published articles are generally average, being a bit on the lower side and more or less constant over the years (around 3 ±0.5; note in this respect that there is a general relative increase by ca. 5-7% in all journals Ifs, so a near constant average IF of publications amounts in retrospect to a slight annual decrease).

Finally, the strategic plan reported by the Director, seems to be designed mostly to pursue the research profiles covered so far, though a certain emphasis on biomedical applications is noted.

4. Recommendations

The Institute and its teams should focus on fewer topics and increase international collaboration with universities and other research institutes to recover its past worldwide status. Similarly, the planned researches mostly follow present directions

and main stream ideas, while a certain fraction of especially innovative, but risky, ideas should be initiated.

Steps in this direction have already been undertaken to focus more effectively the current research efforts, as evident in the creation of the 5 departments (SUPRAMOL, BIOMOL, MATER, STRUCTURE, OPTOEL). However, the Direction of the Institute should now pursue this effort at the level of several of these sub-structures by identifying topics where a Department has unique expertise and has a chance to become a worldwide visible player. This is essential to increase the present attractiveness of the Institute towards foreign students and postdoctoral fellows previously trained in leading research institutions.

5. Detailed evaluations

As detailed after in the evaluation of the individual teams, the Institute tries to be engaged in virtually all timely topics of polymer science. This evidently generates problems, because the Institute lacks the size and the resources to produce major impacts in all the fields covered. Consequently, the publications of the Institute appear at best in leading specialized international journals of the field, such as *Macromolecules, Biomacromolecules, Langmuir, Soft Matter* etc. However, in other analogous internationally Institutes across the world, leading groups also publish in higher rank international journals with a broader scope and readership. Accordingly, if the team leaders are engaged in international review panels and act as reviewers for international specialized journals, they are seldom part of the Editorial Boards of these journals. Similarly, the number of plenary lectures at international conferences or meetings of similar stature is rather small. In short, most scientists of the Institute cannot be considered as leaders and trendsetters in their respective fields.

This ensemble of comments reflects somewhat the present lessened international status of the Institute. Most importantly, this decrease in visibility hampers setting up international collaborations and attracting international researchers. Indeed, most of the topics covered by the Institute are implemented in many laboratories worldwide, so that even if the works performed in the Institute have certainly a recognized quality, they generally do not exceed the threshold levels to attract definite attention.

The Institute in part compensates for this by the yearly UNESCO/IUPAC Advanced Course in Polymer Science, addressing young scientists within a 10-months stay at the Institute. This initiative is highly appreciated.

A significant part of the research in the Institute involves chemical synthesis and physico-chemical characterization by thermal analysis, scattering, spectroscopy, and microscopy. Such work is typically performed by students in order to obtain the necessary information for their theses and, at the same time, broaden their fields of expertise needed at later stages of their career. This is certainly important, but they would benefit from interactions with groups of recognized international level as occurs in analogous Institutes worldwide.

Concerning other education matters, the Committee has been pleased to see that most of the Institute scientists are teaching at all levels at Universities and supervise BSc., MSc., and Ph.D. students, and deliver as much as possible lectures aimed to general public.

B. Evaluation of the individual teams

Evaluation of the Team: Supramolecular Systems and Self-association Processes (SUPRAMOL)

1. Introduction

The main activity of this Team consists in combining the principles of polymer syntheses with those of supramolecular chemistry to offer new classes of polymers with supramolecular organization. Supramolecular systems represent a very active area of current soft matter research. Organic supramolecular systems make use of the principles of supramolecular organization known from natural systems, namely hydrogen bonds, pi-stacks, attachment to surfaces, and shape control. These principles are used both for the organization of macromolecules and low-molar-mass moieties. The aim is usually to produce functional materials in this way with specific properties, e.g., photo conductivity, ion conductivity such as of protons or lithium ions, thermo-responsivity, pH-responsivity, or can be used as drug carriers as well as for other biological aims.

Novel defined polymers with narrow distributions are thus synthesized from methacrylates, methacrylamides, *N*-vinyllactams, etc., using anionic, cationic and radical polymerization processes. In the "biological area, a focus is made on glycogen and cellulose derivatives, and biodegradable polyesters to allow elimination by organisms introduced to these drug carriers. Besides the synthetic strategies involved, this activity involves delicate phase separations and nanoprecipitations techniques that the team members seem to master excellently. However, the research in this area has substantial overlap with the BIOMOL team. Though this does not lead to duplication, collaborative interactions should be favored. In addition, a significant activity is noted on the preparation of nanocomposites based on polyhedral silsesquioxane derivatives, as well as the polymeric nanoparticles containing radioactive atoms, spin labels and fluorescent moieties.

2. Strengths and Opportunities

The team takes advantage of the long tradition of macromolecular science including polymer physics in that Institute and has gathered a sufficiently large but still well-

manageable number of talented staff, representing a right proportion between chemists and physicists with a good age distribution.

The group has access to an excellent instrumental park and to facilities covering all the needed methods for combining synthesis, characterization, radiochemistry and physical chemistry.

The team appears to be responsive to grant calls and reach a sufficient success-rate to raise adequate financial support, though this involves many small grants primarily from public sources, in particular the Grant Agency of the Czech Republic.

3. Weaknesses and Threats

The research topics are certainly interesting but follow established routes. Several investigated systems are rather conventional block copolymers, rather than well designed supramolecular polymers, as those generated by other comparable teams elsewhere. The only exceptions seems to be (i) the ATRP polymerization of isobuten-POSSMA monomers that was previously thought not to be accessible, and (ii) the success in treatment of mammary carcinoma on mice by radiotherapy through a polymeric system allowing local delivery.

While the total financial support is found to be sufficient, the fact that the large number of grants with limited finances each requires too much time-consuming management.

4. Recommendations

Focus to less topics, and undertake researches which present a significant level of risks. This is the only way through which the team has a chance to become a world-wide player and attract more foreign students as well as postdocs.

Cooperation with international institutions (both in academia and industry) should be more pronounced.

5. Detailed evaluations

The team conducts a large numbers of project areas, such as ‘radionuclide-labeled polymer systems’, ‘thermoresponsive nanoparticles’, ‘pH- and stealth sensitive as well as biocompatible drug delivery systems’, ‘stimuli sensitive and biocompatible copolymers’, phospholipid nanoparticles’. Moreover, the team is engaged in pursuing

polymer synthesis with specific building blocks such as the polyhedral oligomeric silsesquioxane (POSS) moiety, mesogenic groups for polymeric liquid crystals, branching, polymer-clay hybrids, radical polymerization, and modification of cellulose.

The topics covered are treated or have been treated in numerous laboratories in many countries that are devoted to macromolecular science. The work at CAS resulted in several papers in leading specialized international journals of the field, such as *Macromolecules, Biomacromolecules, Langmuir, Soft Matter* etc. However, internationally leading groups also publish in high rank international journals with a broad scope and readership. In vivo testing with clinically approved drugs is acknowledged.

Overall, with exception for a few important topics mentioned above, the researches performed in the Team can be judged good but not trendsetting. This is reflected by the fact that the team members who have editorial activities do so only in highly specialized journals

Concerning education, it is noted that the team staff are teaching at all levels at universities and supervise BSc, MSc, and Ph.D. students. The training received by the students within the group is judged adequate in chemical synthesis or physico-chemical methods such as characterization by thermal analysis, scattering, and microscopy.

Finally, while the effectiveness of the strategy and plans presented by the Director for the team future are undeniable, they essentially extend the research profile covered so far and still list too many topics among which none seems to present any significant risk.

Evaluation of the Team: Biomacromolecular and Bioanalogous Systems (BIOMOL)

1. Introduction

Biomacromolecular and Bioanalogous Systems represent a very active area in polymer sciences. In contrast to synthetic polymers the building moieties are amino acids or nucleic acids and the principles of supramolecular organization known from natural systems, namely hydrogen bonds, pi-stacks, attachment to surfaces, and shape control are employed.

The aim is usually to produce functional materials for biomedical research and applications, such as drug carriers or nanomedicine by designing systems with specific interactions with cells or contrast agents for imaging. However, it is noted that the researches in this area have a substantial overlap with the SUPRAMOL team.

2. Strengths and Opportunities

The young interim team leader, appointed after the retirement of the previous team leader, is active in this field and can be expected to lead the team towards particularly successful research in this area.

The group results are very attractive for young researchers as illustrated by the supervision of ca. 30 Ph.D. students. Such a high number may only be reached when the climate in the group is very good, a fact that illustrates the quality of the group management.

The strength of the team is in biomedical research, where the team is involved in an international cooperation in cancer treatment. Indeed, the group has developed excellent successful cooperative projects involving leading international and national universities and research institutions (more than 50 joint papers have been published through these collaborations during the evaluation period).

Finally, in view of the topics covered in the Team, the success in grant applications seems to be fair.

3. Weaknesses and Threats

The leader of the team has to finish his complete installation. Though good portents are apparent in this rejuvenating direction, the present action must be pursued. Indeed, in view of the previous leader's strong reputation, this will not be an easy task.

The chemical syntheses proposed for the planned works (different variations of click chemistry) are relying on very well developed methods and are state of the art, so they do not offer sufficient visible synthetic innovative potential beyond that of the sought applications.

4. Recommendations

The Institute Direction should help the leader of the team to complete his installation and sustain his present actions.

Focus to less topics, where the team has a chance to become a world-wide player and attract even more foreign students as well as postdocs.

5. Detailed evaluations

The team conducts a large numbers of project areas, such as 'copolymers as tumor-specific carriers and targeting of drugs', thermoresponsive and surface modified nanoparticles', 'hydrogels for biomedical applications', as well as 'polymer biomaterials and biomimetic systems' for various applications, drugs and genes delivery. The team is mainly engaged in synthesis and characterization. Biomedical functions are investigated through national and international collaborations involving European groups (see below) that are typically specialized in the biomedical use of the systems prepared by the team.

The topics covered are timely and already subject to investigations in numerous laboratories in many countries in the field of macromolecular sciences. In most cases, however, the ensuing systems have not yet made their way to clinical testing and use. Therefore, the collaboration established with a clinic is especially acknowledged.

Similarly, collaborations involving business sector are mentioned, but their details and importance were not clear enough to evaluate them seriously.

The group researches have resulted in several papers in leading specialized international journals of the field, being devoted to polymer science (*Biomacromolecules*) and pharmaceutical aspects of polymer chemistry. However, the group is encouraged to publish in high-rank international journals with a broad scope and readership, such as the *Journal of the American Chemical Society* or *Angewandte Chemie*, as internationally leading groups do. However, this requires that the works should be not only excellent but also trendsetting.

Concerning education, it is noted with pleasure that teaching is performed at all levels at Universities with supervision of Bachelor, Master, and Doctoral students and that the team members perform lectures in front of general audiences. It is noted that the team is attractive to Ph.D. students (30) who receive an adequate training in chemical synthesis or physico-chemical methods such as characterization by thermal analysis, scattering, and microscopy.

Scientific reputation of the team is good but has not reached a high international visibility. As stated above, the topics covered by the team are already treated in many laboratories worldwide. Similarly, although the members of the team, in particular the former team leader, perform in international review panels or are members of Editorial Boards of international specialized journals, the absence of invited plenary lectures in international conferences shows that greater efforts need to be made to increase the international visibility.

Nevertheless, as noted above, the BIOMOL team has been known to engage in international collaborations with universities in the Netherlands (Utrecht), Germany (Karlsruhe, Halle, Ulm), the UK (Oxford), France (Paris), Sweden (Uppsala, Göteburg). This seems to be rather unique in comparison with the other teams of the Institute, and allows the team to attract students and postdocs from these countries.

Declaration on the strategy and plans for the future

The future work indicated follows the profile covered so far. We did not see new ideas or focus to lesser and better defined project areas. The research thus follows main stream ideas and does not involve especially innovative, but risky ideas. The new team leader is encouraged to expand in this direction.

Evaluation of the Team: Polymer Materials and Technologies (MATER)

1. Introduction

The group presently concentrates its efforts in several different areas among which advanced polymer nanocomposites, smart polymers with functions, and recycling of polymer materials. Indeed, traditionally, polymer materials and technologies represent the core of polymer science. However, industry is reluctant to introduce new polymers, i.e., those based on new monomers (repeat units), so that the aim nowadays is to improve the performance of established polymers by blending them with other ones or create composites by adding other materials such as clay, sophisticated nanoparticles and organic-inorganic hybrids.
The research in this team mostly focusses on technological aspects of polymer science.

2. Strengths and Opportunities

The team combines with fair success basic research on nanocomposites and characterization with applied research in polymer processing.

It is noted that several of the results have led to patents.

3. Weaknesses and Threats

Owing to the main goals of the team, the polymer experts in the Committee were surprised that advanced methods of polymer characterization such as Fourier Transform Rheology were apparently not known. Besides the anecdotic circumstance, this may evidence inadequate mastering of the characterization methods used in the group.

The recycling of polymeric materials is a very important current problem for industrial and environmental purposes. However, the problems connected with “depolymerisation” of polymers are huge and must be addressed on large scales. In this respect, doubts have been raised during the on-site visit, but not adequately answered, for questioning the ultimate viability of polymer recycling by microwave heating beyond small scale applications.

Only 3 doctoral theses have been defended in the reviewed period.

4. Recommendations

Focus on less topics, where the team has a chance to favorably compete with other institutes and industry and to attract more foreign students as well as postdocs.

Properly evaluate the potential influence of microwave irradiation on the rates of depolymerisation to ascertain its validity beyond academic work.

5. Detailed evaluations

The team conducts a large numbers of topics based on ‘commodity polymers’ such as epoxy, polyurethanes, and polycarbonates. The studies include the effects of modified synthesis, e.g. employing ionic liquids, processing (rheological studies), blending with other polymers, producing different nanocomposites and generating hybrid systems.

Such works are usually very specialized and, accordingly, are mostly published in highly specialized journals, which is also the case for this team. It should be acknowledged, however, that several of the results have led to patents, a fact that demonstrate their applicative usefulness.

This team is the only one in the Institute that covers technological aspects related to polymer sciences. It thus plays an important role in order to strengthen the interaction of the Institute as a whole with industry. The materials investigated are often from industrial partners, mostly national, but also international, e.g. Japan. The amount of funding, however, is not clear, as contracts are not disclosed. From the figures given, the collaboration seems to be rather limited. However, the topics investigated by the team are treated in many laboratories, in particular in industry and institutes devoted to applied materials science.

The members of the team, in particular the team leader, are engaged in international review panels, and are reviewers and members of Editorial Boards mainly in the Czech Republic and adjacent countries. This and the fact that the team seems to have no or very few foreign collaborators point out to a limited international visibility, a fact that is evidenced by the apparent lack of plenary or invited lectures in international conferences, or alike.

The works intended to be developed in the future correspond more or less to a continuation of those already engaged without new ideas involving a certain level of risk. The planned researches thus follow main stream ideas and do not involve especially innovative perspectives. However, the team could take the opportunity created by the fact that several of its experienced scientists will retire soon to rejuvenate not only the personnel but also the fields covered.

Evaluation of the Team: Structure and Dynamics of Macromolecules (STRUCTURE)

1. Introduction

The properties of polymers are governed by their structure *and* their dynamics over wide length and time scales. Moreover, soft matter systems composed of synthetic as well as natural moieties are often not uniform, but include regions with different degrees of order. Thus, it is no surprise that the characterization of structure and dynamics of macromolecular and supramolecular systems represents an ongoing challenge. This calls for combined use of as many complementary methods of polymer characterization as possible, such as microscopy, scattering, spectroscopy and rheology. Moreover, these methods must be developed further and all leading institutes actively participate in such developments.

Due to the versatility of the techniques used, the research in this area often involves collaboration with the other teams and even other Institutes of CAS, which is acknowledged for the Institute.

2. Strengths and Opportunities

The team has a well-defined strategy of combining techniques such as X-ray diffraction, vibrational spectroscopy, molecular modelling and solid-state NMR spectroscopy, with emphasis on the latter. Here the team takes part in current method developments and successfully cooperates with the J. Heyrovsky Institute of Physical Chemistry of the CAS in studies of zeolites and their catalytic function.

3. Weaknesses and Threats

The focus on solid-state NMR is acknowledged. In order to be competitive with international developments, substantial investments in the equipment have to be maintained.

4. Recommendations

This team plans to further strengthen the role of solid-state NMR spectroscopy as an advanced tool of characterization based on recent developments of this technique elsewhere. The Center of ‚STRUCTURE' as part of cooperation between different Institutes of the CAS should be maintained.

5. Detailed evaluations

The team covers many topics in collaboration with the other teams and beyond. Special emphasis is placed on solid-state NMR, where the current developments in so-called' NMR crystallography', i.e. the combination of NMR, X-ray diffraction and DFT computer simulation are applied, e.g. to active pharmaceutical ingredients (APIs) and zeolites (in cooperation with the J. Heyrovsky Institute of Physical Chemistry of the CAS). Vibrational spectroscopy is applied to polyaniline oligomers and nanostructures. The structure of modified polymers is unraveled by MALDI-TOF mass spectrometry and size-exclusion chromatography. Last, but not least, X-ray scattering is used to unravel the structure of various polymer systems. The team, however, is not known for developing new spectroscopic techniques.

Due to the collaborative nature of the research, where researchers of team STRUCTURE typically cooperate with synthetic chemists, the results are published in a wide variety of journals, recently including *Angewandte Chemie*.

The team is developing into an indispensable part of the Institute and has the potential to become a 'highlight'.

The team is relatively small and the age structure shows that a significant amount of the work is probably done by students at different stages, i.e. those pursuing for Bachelor, Master or Doctoral degree. Teaching is performed at all levels at Universities by the Team staff members.
Scientific reputation and visibility in international comparison: Compared with the other teams, the activity in reviewing or organization of scientific conferences is rather limited. Similarly, the editorial outreach is apparently limited to local and specialized journals. The team leader also leads the 'Joint Laboratory of Solid-State NMR Spectroscopy', a fact that is appreciated, but one wonders about his absence in international Conferences on Magnetic Resonance as invited speaker or organizer. Similarly, the Team ability to attract foreign researchers is poor as evidenced by the fact that the team seems to be formed mainly by nationals of the Czech Republic.

Compared with other teams, the research plan for future work is ambitious, with emphasis on application of solid-state NMR spectroscopy. This includes asking for funding of an instrument at higher field and addition of Dynamic Nuclear Polarization (DNP) for signal enhancement. This will allow studies of macromolecules at surfaces.

Also, it is planned to increase the activity on studying the structure of pharmaceuticals.

Evaluation of the Team: Polymers for Optoelectronic and Energy Applications (OPTOEL)

1. Introduction

Energy conversion is a very timely topic, which is in the focus of many groups worldwide. Polymers and supramolecular assemblies are of substantial interest in this area, because they can potentially be produced at low cost and their mechanical flexibility represents a special advantage. Last, but not least, graphene and graphene-related systems generated another boost for the field. As a consequence, the international competition in this area is particularly high and includes groups in Asian countries such as Japan, China, and Korea.

2. Strengths and Opportunities

The team tries to be involved in many fields of energy conversion. These important issues are treated by whole institutes and consortia worldwide. If focused on a specific topic, where the team has special expertise, it could successfully participate.

3. Weaknesses and Threats

In view of the diversity of the topics treated, which even include biomedical applications, there is a definite threat that the team cannot be competitive in any of the topics it claims to pursue. This becomes clear, when it is compared with the much more advanced approaches in other institutes of the CAS, e.g. the Department of Electrochemical Materials in the J. Heyrovsky Institute of Physical Chemistry.

4. Recommendations

This team is the weakest of all teams in the Institute. If its activities are continued, a major focusing and restructuring of the research is needed.

5. Detailed evaluations

The team conducts a large numbers of project areas, such as ‘conducting polymer–silver composites’, ‘luminescent and low-band gap donor-acceptor conjugated copolymers‘, ‘polymer composites with plasmonic nanoparticles’, or ‘materials for organic field-effect transistors’. A smaller effort concerns ‘ion conductive membranes’

and ‘gas-separation membranes’. Moreover, the team is engaged in pursuing polymer synthesis such as polyaniline in defined morphology, or identifying new monomers for conjugated polymers.

Adding silver in a conducting polymer has been done by many groups. Additionally, the ‘novel’ materials for LEDs or solar cells are not really breakthroughs. High efficiencies of PLED was already demonstrated in the 90’s, but the problem is their short lifetime at high intensities, and solar cells efficiencies of their low-band gap polymers are not mentioned. It is also known that plasmonic effects in organic devices are very hard to exploit, as usually the gain is so small that it is not worth the effort to make the device structure much more complicated (and more sensitive for electrical shorts). Real relevant problems for PLEDs like ‘how to harvest more efficiently triplet excitons’, or for solar cells like ‘what can be done to reduce the strong binding between electrons and holes (increasing the dielectric constant?)’ are not addressed. Also, the molecular arrangement of molecules in field-effect transistors has been studied by many groups in the last 15 years.

As in the other teams, the results are published in specialized journals of different reputations. This is surprising for this team because its fields experience a ‘hype’ in recent years, and international competitors publish in top journals addressing a broad audience, including *Science, Nature group, JACS, Angewandte Chemie, Advanced Materials* etc.

In summary, the work of the team can be specified as mostly ‘me too’ activities, making it the weakest in the Institute in terms of its scientific outreach.

A significant part of the research in this team involves chemical synthesis or physico-chemical characterization and measurements of the function of the materials. It is not clear, whether working in such a team is beneficial for the students. Teaching at all levels at Universities and supervision of Bachelor, Master, and Doctoral Students is documented, as well as lectures to public audiences.

As stated above, the topics covered by the team are treated in many laboratories worldwide. The members of the team, however, seem to be mainly engaged in national activities and do not seem to be able to attract foreign researchers, a fact at contrast with the blooming activity elsewhere in the world. Also, the Committee did not notice plenary lectures in international conferences, or alike.

The future work indicated follows the activities covered so far. We did not see new ideas or hints about focusing to lesser and better defined project areas. Such focus is absolutely needed in order to reach competitiveness in view of the strong worldwide competition in most of the Team projects.

Date: December 27, 2015

Commission Chair: Dr Habil, Academician Christian Amatore