Memorandum of Understanding between CNR - Hanyang University
ITM-CNR/Hanyang University Joint Lab for Membrane Technology
Hanyang University, Seoul (South Korea), June 16, 2011

On June 16, 2011 a Memorandum of Understanding between the Italian National Research Council (CNR) and the Hanyang University was signed for the establishment of an International Joint Lab on Membrane Technology at Hanyang University and Institute on Membrane Technology of the CNR. Italian and Korean Research Institutions, such as Hanyang University and ITM – CNR, share a long tradition of cooperation in science and technology. Already starting in the early 90’s there has been an active exchange of visits and successful cooperation, which have led to formal actions, such as signed agreements, joint research projects, bilateral workshops, forums and meeting, while a strong impulse has been given to research training and mobility.

As a positive fall-out of the successfully relationship established between the two organizations, they agreed to sign a Memorandum of Understanding for the following actions:
- Exchange of Research Personnel
- Exchange of Technical Information
- Promotion of Joint Research in the framework of the “Italy-Korea Joint Lab for Membrane Technology between ITM-CNR and Hanyang University” promoted by the Italian Ministry of Foreign Affairs/Embassy of Italy in Korea and by MEST (Korean Ministry of Education, Science and Technology) for the common research and development in the field of membrane engineering.

The Memorandum of Understanding was signed by the President of Hanyang University, Prof. Duck-Ho Lim and by the Director of ITM-CNR Lidietta Giorno, delegate of the Prof. Luciano Maiani President of the CNR.

Immediately after the inaugural ceremony of the “Joint Laboratory” took place with the unveiling of a plaque and a visit to the newly established laboratory.

Korea-Italy Workshop on “Chemistry and Energy”, Hanyang University, Seoul (South Korea), June 16, 2011

The “Korea-Italy Workshop on Chemistry and Energy: Membrane Engineering for a Modern Energy Engineering” was held at the Hanyang University in Seoul on June 16, 2011. The event was sponsored and organized by the Office of Science and Technology of the Embassy of Italy, together with the Hanyang University and ITM-CNR (Institute of Membrane Technology of the Italian National Research Council).

Aim of the Workshop was to further strengthen the already well-established bilateral cooperation between Italy and Korea as far as concerns the applications of membrane technologies for finding sustainable solutions in the energy, water and environmental fields. In fact, this occasion is part of a long tradition of fruitful cooperation in the field of membrane science and technology between Korean Universities and Research Institutions and ITM – CNR for more than 20 years during which an active and informal exchange of visits gave raise to different forms of contractual collaborations and scientific events.

This Workshop was attended by well-recognized representatives of Italian and Korean Research Institutions, Universities and Companies that actively participated in the work.

The Korea-Italy Workshop represented a unique opportunity for discussing and further investigating suitable technological methods and strategies for the solution of important problems related to environmental
Dr. Lidietta Giorno, ITM-CNR, explained as membrane operations can successful operate in biofuels production for facing the environmental needs (e.g., lower green-house gas emissions) and energy security. In addition, membranes can recover valuable products from wastes of biofuels cycles.

Dr. In-chul Hwang presented the successful results achieved by Hyundai Motor Co. in fuel cells electric vehicles and also discussed the technical aspects to be improved before the commercialization the these vehicles.

Dr. Lidietta Giorno, ITM-CNR, explained as membrane operations can successful operate in biofuels production for facing the environmental needs (e.g., lower green-house gas emissions) and energy security. In addition, membranes can recover valuable products from wastes of biofuels cycles.

Dr. Jinko Kim, Econity Co. ltd, discussed the preparation of hollow fibers with an inner diameter of 410 microns by means of a stretching technique. The crystalline properties, pore structure and diameter, water and air flux were measured for these fibers.

Dr. Jong Hak Kim, Yonsei University, synthesized various amphilic graft, particularly self-organizing and nanostructured, for specific applications in fuel cells, solar cells, rechargeable batteries and membranes for separations.

Dr. Hong Sik Byun, Keimyung University, prepared PVDF aligned nanofibers by means of an electro spinning technique also incorporating nanosilver particle for its antibacterial function. Other nanofiber membranes were prepared for Li-ion battery separators.

Ing. Pasquale Punzo, Artes Ingegneria SpA, finally illustrated a membrane based plant for the treatment of water tapped from a river and recently installed at Spe Luminous (Belgium). It includes cross-flow ultrafiltration for clarification and pretreatment, membrane contactor for CO₂ removal and reverse osmosis for demineralization.

Beside the Scientific sessions, some entertaining moments have been organized by the Korean colleagues which created a very enjoyable atmosphere among all participants.

... more on cooperation with Korea

As a further action in her former role as President of the European Membrane Society, Dr. Lidietta Giorno, together with Prof. Young Moo Lee (former President of the Korean Membrane Society) organized a Joint Symposium on “Membranes for Green Energy and Environments” on March 17-18, 2011 at the Hanyang University in Seoul (Korea).

The Workshop was the first activity taken following a meeting on Cooperative actions between the EMS and the MKS held on May 21, 2010 at the Energy Engineering Department of the Hanyang University (again with the presence of Prof. E. Drioli, Dr. L. Giorno and Prof. Y. M. Lee) which put the basis of future cooperation between the two organizations on education, dissemination, research and development of membrane science.
On July 14th 2011 the ITM-CNR Seminar Day on Membranes and Membrane Operations for a Sustainable Development was held at the Sala Stampa of the “Centro Congressi Beniamino Andreaata” of the University of Calabria.

Aim of the Seminar, was to present the state of the art and the developments of the research themes carried out at the Institute on Membrane Technology and has included oral and poster presentations covering the various research activities performed at ITM-CNR.

The Director of the Institute, Dr. Lidietta Giorno, welcoming the participants opened the activities confirming that the ITM–CNR Seminar Day will be an annual appointment for the Institute, being open also to external interested people, also coming from industries.

The opening session was also the occasion for the celebration of the role of Founding Director assigned to Prof. Enrico Drioli. This role was recognized by the Institute Council and a subsequent Institute Meeting in April 2011. Prof. Drioli served as Director of the Institute since its foundation in 1993 (at that time it was named Research Institute on Membrane and Chemical Reactors, IRMERC) up to 2008.

The scientific activities started with a keynote lecture given by Prof. Enrico Drioli on “Why membranes and membrane systems are becoming dominant”.

The programme was subdivided into several sessions, starting from the membrane molecular modelling and design, continuing with membrane preparation and characterization, membrane operations and integrated membrane systems and analysing membrane applications in many strategic fields such as in energy, in gas separation, in biotechnology and in biomedicine.

All these activities are carried out within the frame of various research projects, demonstration, technology transfer and networking actions funded by European Commission, National and Regional Government, Foreign Institutions and Private Companies.

Outlines on the International research cooperation at ITM-CNR were also indicated due to the long tradition of the Institute to have successful collaborations in the field of membrane science and technology with top level Universities and Research Centres spread out through the world.

In the concluding remarks Dr. Giorno illustrated the current status and future perspectives of the Institute, in particular it was pointed out the role of the ITM-CNR as one of major protagonist at international level in promoting the success of the membrane science and technology worldwide.

An overview of the annual average contribution to the socio-economical development underlined the support to more than 25 contracts to young researchers, 10 fellowships, 6 of them for PhD students and about 35 visiting scientists from abroad. The master thesis supervised by ITM researchers during the current year are, at the moment, more than 20.

ITM participates, as partner and/or coordinator, to about 30% of projects related to membranes and membrane operations funded by EU Commission within FP7. Overall, the CNR investment in supporting the current 24 ITM permanent staff is doubled by this personnel in terms of external recruited funds.

The seminar day was attended by about 80 people: students, young and “older” researchers of ITM and by associate professors and researchers of University of Calabria. Overall 14 oral communications and 28 posters were presented.

Further information can be found in the web site www.itm.cnr.it where the e-proceedings of the event are available.
### NEW BOOKS

**Membrane Engineering for the Treatment of Gases: Gas-separation Problems with Membranes**  
*Enrico Drioli, Giuseppe Barbieri, (eds.), Royal Society of Chemistry - 2011 • ISBN: 978-1-84973-244-4*

This two volume set presents the state-of-the-art in membrane engineering for the separation of gases. It addresses future developments in carbon capture and utilization, H₂ production and purification, and CO₂/N₂ separation. Topics covered include: applications of membrane gas separation in the petrochemical industry; implementation of membrane processes for post-combustion capture; commercial applications of membranes in gas separations; simulation of membrane systems for CO₂ capture; design and development of membrane reactors for industrial applications; Pd-based membranes in hydrogen production; modelling and simulation of membrane reactors for hydrogen production and purification; novel hybrid membrane/pressure swing adsorption process for gas separation; molecular dynamics as a new tool for membrane design, and physical aging of membranes for gas separations.

**Membranes for Membrane Reactors: Preparation, Optimization and Selection**  

This text covers, in detail, the preparation and characterization of all types of membranes used in membranes reactors. Each membrane synthesis process used by membranologists is explained by well known scientists in their specific research field. The book opens with an exhaustive review and introduction to membrane reactors, introducing the recent advances in this field. The following chapters concern the preparation of both organic and inorganic, and in both cases, a deep analysis of all the techniques used to prepare membrane are presented and discussed. A brief historical introduction for each technique is also included, followed by a complete description of the technique as well as the main results presented in the international specialized literature. In order to give to the reader a summary look to the overall work, a conclusive chapter is included for collecting all the information presented in the previous chapters.

### Editorial Responsibilities

**Biofabrication**  
*Wei Sun (Editor-in-Chief), Loredana De Bartolo (Editorial Board Member) ISSN 1758-5082 (Print); ISSN 1758-5090 (Online)*

Loredana De Bartolo has been nominated Editorial Board Member of the journal “Biofabrication” published by IOP Science. The journal focuses on the state-of-the-art research and development of biomaterial processing, process science, modeling and design. That is, using cells, proteins and biomaterials as building blocks to manufacture biological systems and/or therapeutic products. Topics include: integrated bio/micro- and nano-fabrication; cell, tissue and organ printing, patterning and assemblies; protein/biomolecules printing and patterning; cell/protein-integrated biological systems; 3D tissue scaffold fabrication. (http://iopscience.iop.org/1758-5082/)

### In brief

**Plenary, Invited Lectures**

**Enrico Drioli** was invited to deliver various Plenary and Invited Lectures at different events:
- Membrane Engineering for the Treatment of High Concentrated Solutions in Desalination. CHISA 2010 – ECCE 7, 28 Aug – 1 Sept., 2010, Prague (CZ)
- Progresses and perspectives for advanced membrane systems in seawater and brackish water desalination. Arab World Water Desalination Conference and Exhibit (ARWADEX 9), Riyadh (SA), April 17th – 20th, 2011

**Lidietta Giorno** represented the European Membrane Society at the Vietnam-France Summer Training Course on “Membrane Technology: Principles and Uses for Water Desalination and Potable Water Treatment” organized by UNESCO-SIMEV in Hanoi (Vietnam), from 15 to 22 May 2011, giving a lecture on EMS and Membrane activities in Europe and at International level.


### Grants

**Fabio Bazzarelli** received a COST grant for young researcher to attend the Workshop on “Characterization of Safe Nanostructured Polymeric Materials”, Pozzuoli (IT) March 3 – 4, organized by the Institute of Chemistry and Technology of Polymers (ICTPCNR) and the University of Naples “Federico II” to disseminate the NaPolyNet project findings and results. Fabio Bazzarelli presented a poster on “Transport properties and physical aging in PIM-1 dense and composite membranes”.

### Seminars

- On Jan. 26th, **John Jansen** was invited to give a seminar at the TU Delft, Dept. of NanoStructured Materials, in the frame of the periodic NSM Science discussions. Topic of the seminar was Free volume probing and transport properties of glassy perfluoropolymer membranes for gas and vapour separation.  
- On Feb. 4th, **Enrico Drioli** was invited to hold a Seminar on Membrane Engineering for Process Intensification Strategy at the University Rovira i Virgili, Tarragona (Spain).
- On July 8th, **Prof. Jesus SANTAMARIA**, from the Department of Chemical Engineering & Nanoscience, Institute of Aragon, University of Zaragoza, visited the ITM-CNR. During his visit Prof. Santamaria held a Seminar entitled: Some perspectives for Nanotechnology in Membrane Technology.

### EMS Council Election

**Alessandra Criscuoli** has been elected member of the European Membrane Society (EMS) Council for the years 2011-2014. Her contribution in the Society will be mainly related to the “Education and Awards” activities.
ITM Researchers abroad

Invited professor at Norwegian Univ. of Sci. and Techn. and Université de Strasbourg

Giuseppe Barbieri was invited (23-26 January 2011) at the "Université de Strasbourg" for holding a Course on "Opérations Unitaires II" for the master's students of Engineering of the "Ecole de Chimie, Polymères et Matériaux".

During this visit Dr Barbieri discussed with Prof. Barbara ERNST and Dr Christine DUMAS about a joint collaboration on metal membranes under development by the French researchers and their use in the near future, c/o the ITM-CNRS, in membrane reactors for hydrogen production and upgrading.

In addition, he had the conference ‘Metal based membrane reactors’ at the same University.

Brazil : bilateral project CNR - CNPq

Within the framework of the bilateral project entitled “Study of the Chitosan-Cell membrane interaction for the Neuronal Regeneration” supported by CNR from Italy and CNPq from Brazil, Simona Salerno and Antonella Piscioneri in the period from 1 to 11 February, 2011 visited the Institute of Physics of São Carlos - IFSC, University of São Paulo, in São Carlos, Brazil. The common project coordinated by Dr. Loredana De Bartolo and Prof. Osvaldo Novais de Oliveira is focused on the functionalization of chitosan membranes to improve neuronal interactions using the Langmuir model and on a theoretical study to investigate the process of immobilization and to compare it with experimental results.

Simona and Antonella during their visit in addition to scientific discussions on the topics related to the project performed experimental work on the modification of chitosan membranes and characterization of the latter.

Besides scientific advantages, the period at the IFSC was for Simona e Antonella a nice opportunity to meet very special and kind people from the team of the Grupo de Polímeros of Prof. Novais de Oliveira.

In the framework of the same bilateral project from 20 to 28 March 2011 Sabrina Morelli and Loredana De Bartolo visited Institute of Physics of São Carlos - IFSC, University of São Paulo, in São Carlos, Brazil. The experimental work performed by the ITM researchers was focused on the surface modification of chitosan membranes with bioactive molecules isolated by the brazilian team and their characterization through RAMAN, Ultraviolet-Visible and Infrared Spectroscopies. Interesting results demonstrated the effective functionalization of membrane surface to be used with neuronal cells.

Czech Republic: bilateral project CNR - AVCR

From 10 to 23 May 2011 John Jansen and Gabriele Clarizia spent two weeks in Prague to study gas and vapour transport in polymeric membranes in the framework of the CNR-AVCR bilateral agreement between ITM and the Institute of Chemical Process Fundamentals (ICPF) and the Institute of Chemical Technology Prague (ICT). During their stay in Prague, under supervision of Dr. Karel Friess of ICT and Dr. Pavel Izak of ICPF they investigated the aging phenomena in polymeric membranes through gas sorption measurements and they studied the preparation and characterization of ionic liquid membranes. The first results of this ongoing work were recently published in Macromolecules (see publications list).

Stage at the Fusion Technology Center, Seoul

During April 2011, I spent three weeks at the Fusion Technology Center headed by Prof. Young Moo Lee, within the collaboration between ITM-CNRS and Hanyang University, Seoul (Republic of South Korea). The experience was a truly outstanding opportunity that allowed me to learn innovative techniques on some aspects of fuel cell technology and, on the other side, to discuss the possible applications of some innovative membranes prepared by Korean side in experimental membrane operations to be performed at ITM-CNRS. During my visit I had the pleasure to discuss and learn about scientific aspects with Professor Young Moo Lee and to meet several Korean researchers. I would like to express my sincere thanks to all of them for their help, kind cooperation and great hospitality. Adele Brunetti, Post-Doc student

Visiting Scientists at ITM

We are Alhamdan Abdulkhosen and Alhudaib Bandar, from Riyadh city in Saudi Arabia. We are chemical engineers, working in Kacst (King Abdulaziz City for Science and Technology). We were trained in the laboratory of ITM on “Membrane reactor-contacts” for direct conversion of benzene to phenol under the supervision of Dr. Giuseppe Barbieri, Teresa and Adele for six months. Our training is due to the cooperation between Kacst and ITM-CNRS. We spent beneficial time there. The people whom we met are very well cooperative. Moreover, we spent very enjoyable time during our stay in Cosenza and the regions around it especially, the green mountains, the lakes the sea and friendly people. Finally, we would like to thank all people who help us in ITM.
Visiting Scientists

Salve a tuttif! My name is Chi Hoon Park, from South Korea. I received Ph.D degree at Hanyang University in Korea. My research field is synthesis and characterization of polymeric membrane, particularly for fuel cell application. Another research area is computer simulation of polymer materials and their transport properties. Here in ITM-CNR, I will mainly focus on the latter work for 1 year under the framework of NEMOPUR project. In Italy, everything is new, interesting and wonderful. Foods and wines are very good, the scenery is fantastic, and every people are very kind. For example, in Korea, Italian food is very popular such as pizza and pasta. However, pizza in its home country, Italy, is really tasty and much better than Korean one. Also here, my research of computer simulation is giving me the opportunities to develop my understanding of polymer simulation. As I have short experience for polymer simulation, now I am learning many things including what I was curious about in Korea. During the period of my post-doc here, I will try not to miss this good chance for both research and foreign experience. I would like to thank all the researchers and students for their kind hospitality for me. Especially to Mariella Liberti and Dr. Lidietta Giorno, I would like to express my thanks for the helps including the complex administrative procedure. Also, I will never forget the helps from my friends, Eun Woo and Sudip. Finally, I really really appreciate Prof. Enrico Drioli giving me this opportunity and Dr. Elena Tocci pending so much her time advising and helping me and my family.

Hello! My name is Suk Young Lee from the Hanyang University, Seoul (Korea). I studied characterization of membrane at ITM CNR from 25 June to 22 July. I worked with Alberto Figoli, Silvia Simone, and Francesco and Sergio. They showed many things of their working and experiment for me. Above all, they are very kind and always smiling to me. So I had great time during being there. I will never forget the experience. I really hope to visit there again and to meet them again as well. Lastly, thank Prof. Drioli very much for inviting me.

Dr. Karel Friess and Dr. Pavel Izák from the Institute of Chemical Technology, (ICT) Prague visited, in the period 1-10 May 2011, ITM in the frame of collaborative bilateral project “Novel composite membranes containing selected ionic liquids and polymers for gas and vapour separations” within the framework of the agreement on scientific cooperation for period 2010-2012 signed between the CNR and the Academy of Sciences of the Czech Republic. The scope of their common work together with Dr. Jansen and Dr. Cianzia from ITM is focused on preparation and testing of the ionic liquid polymeric gel membranes containing various amount of ionic liquid in order to create a separation membrane with improved performance for targeted the gas-gas and gas-vapour separations. This year they continued with permeation experiments of prepared samples based on ionic liquid 1-ethyl-3-methyl-imidazolium bis(trifluoromethylsulfonyl) imides([EMIM][TFSI]) (from 20 wt% to 80 wt%) in poly(vinylidene fluoride-co-hexafluoropropylene) (p(VDF-HFP)) for selected gases and vapors (C1-C4 linear alcohols, linear and cyclic alkanes and aromatics). From determined results two papers for publishing in high impact journals are planned with submission during summer 2011.

Seven Indian students, Kumar Pramod, Apurva Pravin Manvar, Aggarwal Varun, Jha Sriniwas, Saurabh Gupta and Abhilash Roy carried out research activities in the laboratories of the Institute on Membrane Technology at the Department of Chemical Engineering and Materials of the University of Calabria from May 20th to July 20, in the framework of the 2011 Summer Internship. During their stay they participated in the activities of our Institute, attending Seminars and discussing on research projects in progress. This year their work has focused in particular devoted on the following topics: membrane reactors, emulsification, waste water treatment, membrane preparation, food treatments and membrane biosystems.

My name is Mohammed Aljohi, Assistant Research Professor, in the National Center of Biotechnology, King Abdulaziz City for Science and Technology (KACST), Riyadh, Saudi Arabia. I visited ITM-CNR during June 2011 to extend the collaboration work between ITM and KACST. During my stay in ITM I was working with Dr. De Bartolo group. I felt that I know them from long time they where helpful and enjoyable to work with, I would like to thank every member in the group (Sabrina Morelli, Simona Salemo, Antonella Piscinetti, Antonietta Messina, and Sara) for showing me what is the meaning of teamwork. Therefore, I would like to thanks the ITM-CNR for allowing me to stay in their facility for one months to learn about a new line of research for me. I was able to make membrane from different compound (Polyacrylactone, Chitosan, Polyethylene glycol, Polyurethane) and used those membrane for neural cell culture. This will help me and my institute to adopt this type of research in our future work.

Ciao! My name is Alexandra Bushell, I am a PhD student of the University of Manchester. I was privileged to be given the opportunity to come to ITM-CNR and work with John Jahnson and his colleagues for 3 weeks in May 2011. This was made possible through the European Commission 7th framework DoubleNanoMem project. My research is on Mixed Matrix Membranes of PIM-1 and crystalline solids. After a year of sending membranes across to Italy for permeability measurements, I have finally been able to participate in the measurement process for myself.

I was warmly welcomed into the ITM-CNR laboratories. I really enjoyed working here and learnt a lot over the 3 weeks. ITM-CNR is set in beautiful surroundings, with views of the surrounding area that I will miss when I return to Manchester. I would like to thank everyone for making my stay here a happy and productive one. In particular I would like to thank John, Paola, Fabio and Gabriele for their time and friendship. I really appreciate all the help and advice you have given me.

Mona Saad Alsaydlani, from Saudi Arabia is a research visitor from King Abdullah University of Science and Technology. She is currently in the second year of her doctoral studies in Membrane Technology, under supervisor Professor Ingo Pinnau. Mona worked at ITM-CNR on Preparation and Characterization polymeric Membranes for industrial applications from June 5 and till July 22. Mona Said: “I have always believed that experiences are a part of life’s learning curve and I wanted to give a new dimension to my life by joining ITM group, to get practical experience in my field of science”.

Professor Roy carried out research activities in the laboratories of the Institute on Membrane Technology at the Department of Chemical Engineering and Materials of the University of Calabria from May 20th to July 20, in the framework of the 2011 Summer Internship. During their stay they participated in the activities of our Institute, attending Seminars and discussing on research projects in progress. This year their work has focused in particular devoted on the following topics: membrane reactors, emulsification, waste water treatment, membrane preparation, food treatments and membrane biosystems.
Visiting Scientists

Eng. Hamad S. Al-Romaih and Eng. Fahad Al-Shabouna from the King Abdulaziz City for Science and Technology Kingdom (KACST) of Saudi Arabia spent two months (December 2010 - January 2011) at ITM-CNR for training on membrane preparation and membrane contactors. These activities have been carried out under the supervision of Prof. Drioli, Dr. Figoli and Dr. Eng. Criscuoli within the joint project KACST-ITM.

Projects Meetings and Related Activities

DoubleNanoMem Mid-term meeting and Exploitation Strategy Seminar, Delft, January 24 - 25

On 24-25 January 2011 the midterm meeting of the FP7 Project DoubleNanoMem “Nanocomposite and Nanostructured Polymeric Membranes for Gas and Vapour Separations” took place at the Delft University of Technology (The Netherlands). During this meeting an Exploitation Strategy Seminar (ESS) was organized. This is a service of the European Commission (EC) to all projects funded by the Industrial Technologies programme (NMP) under FP7.

The final aim of the EC is not only to produce but also to exploit knowledge. However, until now many European research projects are successful in developing new technologies and bringing forward innovations, but they frequently do not completely use their potential and capacity to exploit this. There is a lack of consideration towards non-technical issues such as protection of results, Intellectual Property Rights, exploitation rights, marketing, regulations and standards, partnership, financing, etc.. For this reason the EC set up the ESS where these topics are extensively discussed. The expected benefits coming from these self assessment seminars for the beneficiaries are the following:

- to learn a methodology for analysing and self-assessing the Research and Technology Development (RTD) results
- to acquire knowledge on the main non technical issues of the project
- to draw up an action plan to increase the chances of successful exploitation
- to acquire the main elements to approach a business plan
- to be able to prepare an adequate PUDK/PUDF in accordance with contractual obligations
- to become aware of and understand the complexity of co-ownership in collaborative research projects.

The seminar in Delft was animated by the consultant Dr. A. Bellé (Cimatec, LaSpezia, Italy) and was attended by 23 persons from different research institutions and SMEs representing the partners of the project consortium (ITM-CNR, Italy; University of Calabria, Italy; The University of Manchester, UK; Cardiff University, UK; Technische Universiteit Delft, The Netherlands; Institute of Chemical Technology Prague, Czech Republic; Katholieke Universiteit Leuven, Belgium; Topchiev Institute of Petrochemical Synthesis, Russian Federation; Tecno Project Industriale, Italy, ZAO STC “Vladipor”, Russian Federation). On behalf of ITM the meeting was attended by Lidietta Giorno (ITM director), Alberto Figoli, Paola Bernardo and John Jansen (DoubleNanoMem coordinator).

During several months before the seminar there was a close cooperation between the animator, the project officer and the project coordinator to identify the exploitable results of the project with commercial/social significance (novel polymers, fillers, membranes and membrane processes). Each partner provided his comments on the possibility to exploit a result and also a filled form to characterize the results from an exploitation point of view (benefits related to the exploitation, partners involved, competitors, industrial partners interested, time to market, etc.). This analysis was useful in identifying the project partners that will invest time and effort in each result and the intentions of each partner with respect to the dissemination and use of all results.

These data were provided during the seminar in the Synthesis Report, together with a Documentary Search elaborated by the seminar organization. During the seminar the project partners and the consultant worked together examining also the following points:

- The Intellectual Property Rights (IPRs) situation in the Consortium
  - This section responded to the following question: “Who has which rights to which exploitable results and under what terms and conditions?”
  - The exploitable results can be related to a Background and a Foreground, distinguishing between knowledge brought from outside the project and knowledge developed during the project. These information need to be suitably connected to make appropriate exploitation arrangements.

- The risk identification and risk analysis and the risk action plan with reducing measures
  - To identify the non-technical factors which could represent potential risks that prevent valuable potential results from being properly exploited. Internal factors may be related to diverging expectations or intentions between project partners (risk for conflict of interest, etc.). External factors include market evolution, legislative or normative influences, lack of acceptance by society, etc.

The risk analysis was done by three groups, one related to the materials development, one involved in the membrane preparation and another one in the process development. For each risk and potential obstacle identified in the PRA, the group discussed possible remedies, precautions or actions that should be taken. The final conclusion is that risks may not necessarily be harmful as long as you know them.

The last part of the ES Seminar addressed the questions raised in a Plan for Using and Disseminating the Knowledge (PUDK), required for projects funded under FP7.

The seminar was an opportunity for the partners of the consortium to increase their awareness related to exploitation issues, and to enhance a team spirit, emphasizing common interests and need for cooperation. A common understanding about IPRs and exploitation was gained, while the open discussion was fruitful in order to explain the potentials, problems, expectations and motivation of each participant.
The overall objectives of NaPolyNet project were: 1) to network at regional, national and international level with experts involved with atomistic modelling at molecular level and engineering modelling both related to membrane systems. NL; Nanobiomatters Sl, ES; Central Laboratory of Physico-Chemical Mechanics At Bulgarian Academy Of Sciences, BG; Gvs S.P.A., IT. Main activities in Institut Fuer Normung E.V., DE; University of Surrey, UK; Inotex Spol Sro, CZ; UK Kingdom; Institutul De Chimie Macromoleculara Petru Poni, RO; Scite Bv, NL; Nanobiomatters Sl, ES; Central Laboratory of Physico-Chemical Mechanics At Bulgarian Academy Of Sciences, BG; Gvs S.P.A., IT. Main activities in which ITM was involved were dealing with atomistic modelling at molecular level and engineering modelling both related to membrane systems. The overall objectives of NaPolyNet project were: 1) to network at regional, national and international level with experts on the characterisation of polymer nanostructured materials in the field of packaging, textiles and membranes; 2) to bridge the gap between scientific and engineering approaches for the improved understanding of the structure-performance correlation in polymer devices; 3) to facilitate transnational access to important and unique equipment; 4) to train young scientists and SME technologists; 5) to harmonise the work necessary for developing new standards in the field of the characterisation of polymer nanostructures for packaging, textiles and membranes. The objectives have been pursued by the mapping of the competences in the different fields of characterisation of polymer nanostructures and setting up a European Open Laboratory (EOL) open to outside the consortium partners and incorporating the best and novel characterisation methodologies and expertise. A lifecycle approach has been adopted with due consideration for health, safety and environmental aspects. In this framework the ITM effort has been devoted to the design by using MD simulations on the workpackage (WP4) “Making the best and novel characterisation methodologies and expertise. A lifecycle approach has been adopted with due consideration for health, safety and environmental aspects. In this framework the ITM effort has been devoted to the design by using MD simulations on the workpackage (WP4) “Making available the latest characterization tools including molecular modelling tools”. Regarding standardization of nanotechnology, that is important for policy makers developing regulatory frameworks in government departments as well as for nanotechnology industries/enterprises, a significant role has been given in the project. A workpackage has been entirely dedicated to the preparation of new standards for polymeric nanomaterials characterization and to provide up-to-date information on the potential toxicological effects and safety evaluation of polymer nano-structured materials on human health and their risk assessments for a wide audience. http://www.napolynet.eu

IMETI meeting – Helmond (The Netherlands), January 19 - 20

Hyflux organised the 5th meeting of the EU-FP7-PIAP-“IMETI - Implementation of Membrane Technology to Industry” is a Marie Curie project for the integration of academia and industry by researcher exchange. The meeting has been held on 19th -20th January in Helmond (The Netherlands). During the meeting, the novel membranes and processes developed within the project have been deeply discussed. In particular, Dr. Giuseppe Barbieri and Dr. Alberto Figoli reported the experiments and novel membranes prepared and characterised during their secondment at Evonik (London) and GVS (Italy), respectively.

NaPolyNet - Final meeting, Pozzuoli (Italy), March 4

Dr. Elena Tocci, principal investigator for the ITM team, participated to the final meeting of the research project “NaPolyNet - Setting up research-intensive clusters across the EU on characterization of polymer nanostructures” ended after 36 months of activities (April 2008 - March 2011). The project was supported by the European Commission under the 7th Framework Programme with the general scope of the call NMP-2007-2.1-3 Characterisation of polymer nanostructures. 15 partners from 10 European countries have been involved: Sopralab Sas, FR; St Mary's University College Twickenham, UK; Universitàet Rostock, DE; Din Deutsches Institut Fuer Normung E.V., DE; University of Surrey, UK; Inotex Spol Sro, CZ; UK Kingdom; Institutul De Chimie Macromoleculara Petru Poni, RO; Scite Bv, NL; Nanobiomatters Sl, ES; Central Laboratory of Physico-Chemical Mechanics At Bulgarian Academy Of Sciences, BG; Gvs S.P.A., IT. Main activities in which ITM was involved were dealing with atomistic modelling at molecular level and engineering modelling both related to membrane systems.

BioNexGen– 2nd meeting, Patras (Greece), March 10 - 11

The FORTH Institute organized the second meeting of the 42 months EU-FP7 funded project “BioNexGen” – “Development of the next generation membrane bioreactor system” (started on 1st September 2010 ). This partner meeting has been held in Patras (Greece), the 10th -11th of March 2011. All the partners reported the results obtained in the first six months of the project focussing on novel membrane preparation and characterisation as well as tests on bioreactor membrane processes. Dr. Alberto Figoli and Dr. Giorgio De Luca took part to the meeting as WP leaders of Membrane Preparation and Computer Modelling Part, respectively. They reported the first results obtained and discussed the future direction of research. Further information is available at the project website: http://www.bionexgen.eu

SCATE Kick-off meeting, University of Oulu (Finland ), March 14

The kick-off meeting of the transnational project entitled ‘Scaffolds for Tissue Engineering – SCATE’, MATERA/BHH-2117 coordinated by Prof. Juha Tuukkanen from University of Oulu, Finland was held on 14 March 2011 at the Department of Chemistry of University of Helsinki. The MATERA is an ERA-NET on materials, an initiative of the European Commission aimed at providing support for the coordination and mutual opening up of national and regional R&D programmes. TEKES and MIUR are the funding national agencies. The topic area of SCATE is Biomaterials for human health improvement. Participants of project are: Prof Mikko Ritala from University of Helsinki, Eng. Tuja Annala from Scaffoldex inc., Dr. Jarkko Räbinä Finnish Red Cross Blood Service, Prof. Mikael Skrifvars from University of Borås, Dr. Loredana De Bartolo from ITM-CNR, Ing. Paolo Canonico SAATI S.p.A, Dr. Marco Morra Nobi Bio Ricerche srl. The project is focused on making resorbable composite scaffold materials for tissue engineering, which stimulate cell differentiation instead of the adverse foreign body reaction. The objective is to test new bioreinspired composites and evaluate their usefulness as scaffold materials. Stem cell assays are developed for predicting the performance of bioactive materials. Project website: http://www.scate.oulu.fi/.

ITM group directly involved in the project is composed by Loredana De Bartolo (scientific responsible), Sabrina Morelli, Simona Salerno, Antonella Piscioneri and Antonietta Messina.
MEDIRAS 6th meeting, Gran Canaria (Spain) March 16 - 17

In the framework of the MEDIRAS (Membrane Distillation in Remote Areas) project, funded by the EC within FP7, the 6th meeting was organized in Gran Canaria, Spain from March 16 to March 17, 2011. Dr. ing Alessandra Criscuoli was the ITM-CNR representative. The European Commission Officer, José Riesgo, also attended the meeting. The activities of the last six months of project were presented. In particular, a discussion was made on the current state of the installations of the different MD-based solar plants (in Tunisia, Panteleia, Tenerife and Gran Canaria). An in depth-discussion about the market introduction of the technology was also carried out. Specifically, three different kinds of end-users were identified: power plant, private house and health center.

During the meeting, a visit of the membrane distillation system developed by the MEDIRAS Consortium and installed at the ITC (Gran Canaria) was also organised.

1st International Workshop on Long life membranes, Grottaferrata (Italy), March 17 - 18

The 1st International Workshop on Long life membranes based on PFSA & SAPs: Preparation and Characterization, was organized by the University of Roma2 “Tor Vergata” in the framework of LoLiPEM (Long-life PEM-FCH & CHP systems at temperatures ≥ 100 °C) EU/FCH-JTI Project. The workshop was held in Grottaferrata (Rome), at Hotel Villa Graziolì on March 17th-18th 2011. This workshop aimed to bring together scientists and students interested in the study and development of new Polymer Electrolyte Membranes for Fuel Cells. It was attended by well-known scientists from 8 countries: Italy, Germany, France, Switzerland, Spain, Poland, the UK, and the USA.

44 participants were present, with 17 oral presentations and 2 invited lectures. 9 presentations was held by members of the Lolipem consortium and 10 by scientists not participating in the LoLiPEM project.

The workshop featured all aspects of synthesis and both structural and functional characterization of membranes, mainly perfluorosulfonic acid (PFSA) and sulfonated aromatic polymers (SAPs), as well as ion and gases transport properties with emphasis on their application in PEMFCs operating above 100 °C. The level of participants and contributions was very high and intense scientific discussions were stimulated throughout the workshop.

LoLiPEM meeting, Grottaferrata (Italy), March 19

A project meeting was held on March 19 in Rome, in cascade with the Workshop. Most of the partners were present and the discussion was focused on some main aspects. Firstly, the results on the preliminary experiments on the MEAs realized with the membranes prepared by some partners were discussed. The design and implementation of a single-cell PEM setup for the long-term durability tests to be carried out on the membranes prepared in the project was presented and the operating conditions to be used were defined within the Consortium. The latest results achieved in the preparation of improved electrodes to be used in MEA were also shown. All of the progress achieved on the preparation, characterization and testing of improved polymeric electrolyte membranes able to withstand temperatures higher than 100°C, together with the preparation techniques and the methods for improving the durability of these membranes were presented. Particular attention was also focused on the permeation measurements carried out on the membrane prepared by the partners for the evaluation of the mass transport properties at different temperatures and relative humidity. http://lolipem.eu/

CapWa - First progress meeting, Wuppertal (Germany), April 12

The first progress meeting of the 3 years project CapWa (FP7-Theme 4 – NMP – 2009 – SMALL) took place on April 12th at Membrana GmbH (Wuppertal – Germany). The meeting was attended by the team leader (KEMA - The Netherlands) and by a number of researchers of each of the fourteen partners. The meeting was officially opened by Dr. Ludwin Daal (from KEMA) and Dr. Wolfang Ansorge (Manager Membrane Development Group), followed by the presentation of Dr. Mohamed Jomaâ Safi (Director of the research unit “Mechanic and Energetic” at ENIT – Tunisia) on some activities currently carried out at ENIT.

 Afterwards, the progress of each project work package was described through nine technical presentations. The project is devoted, as its title describes, to the capture of evaporated “waste” water from, for instance, power and paper/board plants. The produced water could be a source of liquid water. The CNR-ITM has, in this project, a key role for developing new hydrophobic membranes for water capture. The Institute is also involved (i) in the testing of the membranes “as central lab”, (ii) in the membrane module simulation and optimizations, and (iii) in the integrated modular system simulation. Moreover, Prof. Drioli is in charge to conduct regular quality audits with regard to the development of membrane production.

The discussion of the meeting was focused on two main aspects. First of all, the results on the preparation, characterization and testing of the prepared polymeric membranes have been discussed. Also the progresses achieved in the realization of a new membrane module design, in the potting materials and in the experimental lab plant for the testing of the membrane performances under realistic process conditions were presented. The second aspect faced during the meeting was related to the modeling of the system, and in particular to the energy modeling for defining the best operative conditions and the real advantages in the suggested strategies. http://www.watercapture.eu/

Nanoglowa meeting, Gelsenkirchen (Germany) April 13 - 14

The integration of membranes developed during the Nanoglowa project in a production site for CO2 separation was one of the main issues discussed during this meeting in Gelsenkirchen (Germany), where the EoN is. The meeting was held at EoN on April 13-14, 2011. The coal fired power plant in Gelsenkirchen was visited during the meeting. The ITM-CNR, responsible of the “central testing laboratory” of the Nanoglowa project, has continued the characterization of membranes and membrane modules prepared by other partners devoted to the membrane development. New membranes and modules to be tested will be supplied by some partners in these last months for evaluation of the transport properties. http://www.nanoglowa.com/
Focus on Research at ITM

Biocatalytic membrane reactor implemented by membrane emulsification process for the isolation of intermediated reaction compounds

Membrane emulsification technology permits the preparation of high-value emulsions/suspensions via microporous architectures in which very well controlled local shear rates are obtained, leading to a process with much lower energy use and more uniform or size controlled emulsions/suspensions than conventional high-speed mixers, allowing maximization of resources use. The low local shear stress applied and the precisely controlled particle size and size distribution obtained make the membrane emulsification technique the most suitable for formulations with controlled architecture containing labile molecules. An alternative method for increasing the shear-stress at the membrane surface while maintaining a low value along the circuit out of the membrane during emulsification process has been introduced. Using turbulence static promoters was possible to obtain very good emulsion quality in terms of droplet size distribution and stability, even operating at high dispersed phase flux values. For the evaluation of the effect of static turbulence promoters on the droplet size and emulsion stability, the module was modified with internal inserts promoting turbulence. The use of this operating conditions can help not only to obtain smaller droplets size and more uniform size distribution, but also higher stable and concentrated emulsions compared to cross-flow membrane emulsification without insert. This is mainly due to high drag force obtained at membrane level while low shear stress is maintained in the circuit. The process is particularly suitable when shear-sensitive materials are processed. The benefits of the reduction of the cross-section area at cross-flow membrane emulsification proved durability as well; no negative effect was observed because of the reduction during 3 h of emulsification, not even when the oil concentration reached 38% in the continuous phase. Membrane emulsification can be used to implement membrane process in which a multiphase system is needed. A clear example of this is the integration of membrane emulsification process with biocatalytic membrane reactor (Figure 2). This innovative configuration was applied for the first time for the production of oleuropein aglycon, in vivo (olive) produced by the hydrolytic action of beta-glucosidase on oleuropein. This phytotherapeutic, is of high interest because of its high pharmacological action, known in the olive oil. Due to its low water solubility when produced, it is fastly rearranged into hydrophilic molecules, this is the reason why it is not yet commercially available.

The hybrid membrane operation system is able to i) compartmentalize the oleuropein hydrolysis, occurring in aqueous phase within the porous membrane, and ii) to separate and stabilize the aglycon, occurring in organic phase at the membrane lumen side interface, based on the membrane emulsification concept. Polymeric membranes were heterogenized with a 6-glucosidase. The oleuropein passed through the enzyme-loaded membrane where the reaction occurred. The water phase containing reaction products passed through the membrane and met an organic phase recirculated into the lumen side where water-in-oil emulsions were formed drop by drop. Droplets size and stability were adapted so that enough exchange area interface was achieved and once aglycon extraction was completed droplets broke and phases separated spontaneously. The integrated system biocatalytic membrane reactors and membrane emulsification process (or bioreactive membrane emulsification) showed that it is possible to produce and simultaneously isolate the isomer of oleuropein aglycon in one step. Since the isomer of oleuropein aglycon resulted fully soluble in the used organic phase (limonene), the extraction efficiency mainly depended on droplets size (which controlled the water/oil interface area) and the droplet stability (which influenced the contact time between the two phases before the emulsion separated). In membrane emulsification process, the increase of the axial velocity of the continuous phase reduces emulsion droplets size produced and consequently increases the interfacial area between the two phases and the interfacial oil/water stability. The simultaneous reaction and extraction at various limonene axial velocities was carried out and the oleuropein aglycon remained in the aqueous phase (i.e. not extracted in limonene) was measured. Fig. 3 shows the decrease of oleuropein aglycon in the aqueous phase as a function of the increasing axial velocity of limonene phase (which also means that the amount of oleuropein aglycon extracted in limonene increased with increasing of axial velocity). 100% oleuropein aglycon in water represents the product obtained in absence of limonene recirculation.

![Figure 1. a) Oil-in-water emulsions, b) size distribution, c) turbulence promoters](image)

![Figure 2. Innovative biocatalytic membrane reactor that integrates a biocatalytic membrane reactor and a membrane emulsification process](image)
Treatment of arsenic polluted waters by membrane processes

In the last years, different research activities at ITM focused on the treatment of water contaminated by arsenic by using membrane processes. Many of them were linked to European Research Projects, like INNOWA and EURINDIA, and Bilateral Agreements (i.e. Italy-India). Moreover, visiting scientists from Algeria, Spain and Bangladesh also cooperated on this topic [1]. Several approaches have been investigated, either using traditional membrane processes such as nanofiltration, either innovative approaches as adsorption by novel capsules production, extraction by membrane contactors or membrane distillation.

One of the work studied referred to the removal of As(V) from synthetic water by using at lab scale commercial nanofiltration (NF) spiral-wound membrane modules [2]. Among the parameters affecting the As rejection, feed concentration plays a key role for the production of a permeate stream respecting the limits imposed by WHO (MCL=10mg/L).

Another work, the removal of As(V) from an aqueous stream by non-dispersed solvent extraction in a hollow fibre membrane contactor was investigated [3]. To this purpose, microporous hydrophobic poly(vinylidene fluoride) hollow fibres were prepared by the dry/wet spinning technique. The produced fibres were used to perform As(V) extraction experiments in a membrane contactor device, using Aliquat-336 as extractant.

The results showed that the extraction of As(V) is mainly influenced by the pH of the feed, with an optimum reached for neutral values, and increases with the arsenic content in the feed. The extraction is also favoured by working with thinner membranes.

Another line of research was that of developing new adsorbing capsules made of polymer and commercial adsorbing media (TiO₂) (Fig.1). From experimental tests carried out, it resulted that feeds containing 100 ppb of either As(III) or As(V) are efficiently treated [4]. However, the overall As removal performance of the new capsules is not yet as high as the commercial granules. Therefore, further tests also on alternative polymers and adsorbing media are still in progress.

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Recently, the possibility of oxidizing As(III) into As(V), which is less toxic and better removed, by using MnO₂ coated polymeric capsules was investigated. Preliminary results carried out in batch were quite positive, showing the oxidative capability of the produced capsules without problems of MnO₂ release into the water stream.

Alberto Figoli, Alessandra Criscuoli

References:
New Actions

New Projects

Four new national projects have been approved in which ITM contributes with research, demonstration and training activities. Two of them are related to the agro-food sector, one to energy and another to materials. ITM scientific responsible are Lidietta Giorno, Alfredo Cassano, Giuseppe Barbieri and John Jansen, respectively.

ITM researchers are involved in a new project entitled “Design and Manufacturing of Catalytic Membrane Reactors by developing new nano-architectured catalytic and selective membrane materials (DEMCAMER),” recently funded under Seventh Framework Programme, as far as concerns the preparation of zeolite membranes and modelling and simulations of membrane reactors.

Upcoming Scientific Events

Following the first conference on “Membrane Distillation” held in Rome on May 1986, the International Workshop on “MEMBRANE DISTILLATION AND RELATED TECHNOLOGIES” will be held on October 9-12, 2011 in Ravello (on the Amalfi Coast), Italy, organized by the Institute on Membrane Technology (ITM-CNR).

A compelling program, featuring an interesting line-up of international speakers that will present in-depth information about the latest technologies and products will characterize the conference. Oral presentations at the workshop are by invitation only from the Committee. A poster section with contributions presented by researchers to illustrate leading edge research to an international audience will be available at the conference site. The event will represent also an excellent opportunity for networking, collaborations and partnerships among scientist coming from different areas of expertise. Prizes will be assigned for the best poster presentations given by early career researchers.

To summarize and exchange the main problems and solutions on membrane technology in water treatment and discuss the trend to promote membrane’s future application in water treatment on large scale, the 2011 International Conference on MEMBRANE TECHNOLOGY IN WATER TREATMENT: RESEARCH AND APPLICATION will be held on Sep 16-17, 2011 in Harbin, P. R. China. This conference is jointly hosted by Harbin Institute of Technology, Department of Science and Technology (Shandong Province), Weihai Municipal Government, European Membrane Society and National Engineering Research Center of Urban Water Resources and chaired by Prof. Enrico Drioli.