ICMPE acknowledges the contribution of several of its members in the writing of reviews, books and book chapters:


Best poster awards from the Federation of European Materials Societies at Euromat 2013: The use of Spark Plasma Sintering to prepare glass-ceramics in the CuAs-Se system for thermoelectric applications, by J-B. Vaney and B. Lenoir (DL), J. Monnier, E. Alleno and C. Godart (ICMPE, CMTR Team), G. Delaizir (SPCTS), A. Piarristeguy, M. Ribes (CMTR Team), G. Delaizir (SPCTS), A. Piarristeguy, M. Ribes (CMTR Team), A. Pradel (ICGM), A. P. Gonçalves and E. Branco Lopes (IST/ITN-CFCMUL).

Mathilde Laurent-Brocq (CR, MCMC Team) has been selected (30/209) by the journal SCIENCE for its NextGen Voices Survey. Her answer to the question “If you had 5 extra hours per week to devote to advocacy for science, how would you use that time?” has been published in SCIENCE Vol. 344, 16 January 2014. 54 scientists attended the meeting and contributed to 26 oral presentations.

A large variety of materials (from metal to ceramics, hydrides and carbides), thermicas (phase diagrams, calorimetry, thermodynamics) and approaches (OFT, Calphad, experimental data) have been presented, either from the industrial or fundamental point of view, and led to fruitful discussions. The oral presentations are available on the web site of the GdR.

Distinctions


The 1st meeting of the GdR “TherMatHIT: Thermodynamique des Matériaux Haute Température” has been organized by J.-M. Joubert and J-C. Civeillo (CMTR Team) at ICMPE on the 16th and 17th of January 2014. 54 scientists attended the meeting and contributed to 26 oral presentations.

The Electrochemical Society (ECS) has recently created a new ANR research programs and participate to recently created research groupings, because today’s science cannot be conducted alone but must be shared with others.

Editorial

For this new edition of our newsletter, we focus on a variety of topics, including energy storage, biomaterials, drug and ecotoxicity. This reflects the broad scope of the research activities at ICMPE, covering both fundamental aspects and envisioned applications: finding new materials for alkaline or lithium-ion batteries, investigating the scale effects on the electrochemical behavior of Na particles, understanding the fate of organic contaminants in the environment or functionalizing scaffolds based PHA to improve adhesion of cells.

Besides these scientific achievements, we also present our newly recruited young scientists, full of strength and determination at the beginning of their careers. Some of them have already received awards and we are proud to acknowledge them. Finally, we start looking forward to conduct new ANR research programs and participate to recently created research groupings, because today’s science cannot be conducted alone but must be shared with others.

New Research Groupings (GdR)

The GdR HySpAC on “Hydrogen, Systems and Fuel Cells” has just been created with the support of ING and INSSIS Institutes of CNRS. Operational for 4 years (2014-18), it federates researchers and industrial partners, more than a hundred research teams, working in the field of hydrogen production and storage, fuel cells and integrated systems.

Four working groups cover the communities of production, purification and storage of hydrogen (STOPHE), of low temperature (PACEEP) and high temperature fuel cells and electrolyzers (PACEOS), and of integrated systems (PACEOS) representing all research centers active in these areas. HySpAC is directed by Olivier Joubert, Pr. at the IMN-CNRS-University of Nantes. Fermin Cuevas, researcher at ICMTR (CMTR Team) is responsible for the STOPHE working group.

The Energy Storage

Effect of magnesium on the calendar corrosion in Nickel-Metal Hydrides (Ni-MH) batteries

In the field of electrochemical energy storage, metallic hydrides are used as materials for negative electrode in alkaline Ni-MH batteries. To improve the properties of these negative electrodes, understanding the corrosion processes taking place during operation (calendar and cycling) is an important issue for cycle life.

The present study focuses on the (La,Mg)2Ni7 system. The new Mg-containing alloy offers lighter molar mass and better storage capacity but the corrosion effect related to Mg are unknown. The calendar corrosion in 8.7M KOH alkalai medium was investigated for pure LaNi5 and La1−xMgxNi5 alloys.

By combination of structural and elemental characterizations, the corrosion products are evidenced. We observe the formation of platelets and needles, with a better morphological definition in the case of Mg-containing samples. The needles are associated to La(OH)3 and possess nanometric inner hollow channels. The platelets are made of Ni(OH)2 for pure LaNi5. When Mg is present, we demonstrate that Ni and Mg combine in a pseudo-binary hydride Mg2Niδ(OH)2. It is concluded that substitution by Mg modifies the corrosion product and morphology, but does not speed up the calendar corrosion process.

TEM micrograph of a twinned martensite microstructure - by Julie Bourgon, laureate of the Pierre Armand Jacquet Award (SF2M) – see page 4
Novel Routes to Epoxy Functionalization of PHA-Based Electrospray Scaffolds as Ways to Improve Cell Adhesion

Straightforward and versatile routes to functionalize the surface of poly(3-hydroxyalkanoate) (PHA) electrospray fibers for improving cell compatibility are reported under relatively mild conditions.

The modification of nonfunctional PHAs is implemented through two different methodologies (Figure 1) to introduce epoxy groups on the fiber surface: (1) preliminary chemical conversion of double bonds of unsaturated PHAs into epoxy groups, followed by electrospraying of epoxy-functionalized PHAs blended with nonfunctionalized PHAs, (2) electrospraying of nonfunctionalized PHAs, followed by glycidyl methacrylate grafting polymerization under UV irradiation. The latter approach offers the advantage to generate a higher density of epoxy groups on the fiber surface. The successful modification is confirmed by ATR-FTIR, Raman spectroscopy and TGA measurements. Further, epoxy groups are chemically modified via the attachment of a peptide sequence such as Arg-Gly-Asp (RGD), to obtain biomimetic scaffolds.

Human mesenchymal stromal cells (hMSC) exhibit a better adhesion on the fiber surface; (1) preliminary chemical conversion of double bonds of Li3-2xCoxN compounds. XRD study has shown a linear decrease of the cell volume versus Co content showing a solid solution behavior of the Li13CoxN system for 0.3 ≤ x ≤ 0.44. The hexagonal symmetry of LiN is maintained without any change in terms of ordering, in spite of the high value of LiCo substitution.

In order to better understand the consequence of Li substitution by Co ions on the layered ordered structure of LiN, a XAFS study was required to investigate the Co local structure. We found that Co atoms are oxidized in Li13CoxN compared to metallic Co and their solid solution nature is confirmed. EXAFS investigations as a function of the Co content x (Figure, left) show that the continuous decrease of interlayer distance versus x, described from XRD data, accounts for an average of the Co-N and Li-N distances, weighted by the number of these bond lengths. In addition, the present work supports the proposal that the Li3-xN bonds contract (see scheme in the Figure) with x due to a significant increase of coulombic attractive forces locally induced by the progressive Li+/Co2+ substitution between LiN layers.

Effect of Cobalt substitution on Li13-Co3N local structure: a XAS investigation

Layered lithium transition metal nitrides are studied as alternative anode materials for rechargeable Li batteries. Among them, Li13CoN has been selected due to its high specific capacity and cycle performance in the 1.4-2.0 V potential window. However some questions remain regarding the structure of Li13Co3N compounds. XRD study has shown a linear decrease of the cell volume versus Co content showing a solid solution behavior of the Li13Co3N system for 0.3 ≤ x ≤ 0.44. The hexagonal symmetry of LiN is maintained without any change in terms of ordering, in spite of the high value of LiCo substitution.

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Upcoming Conferences and Workshops

The annual meeting of the GD "Thermoelectricité" will take place the 13th and 14th of October at ICMPE. Contact: allee@icmpe.cnrs.fr, mormier@icmpe.cnrs.fr

The workshop "Batteries en Île de France", co-organized by J-P. Pereira-Ramos (ICMPE) and Henri Grout (PHENIX) will be held at ICMPE the 4th of December 2014. Contact: perereira@icmpe.cnrs.fr

A workshop “Valorisation des Bio-ressources” is organized by ICMPE on the 27th of November 2014. Contact: langlois@icmpe.cnrs.fr

Research Projects about to start


ANR PATTER 2015-16. Patterning of silicon surfaces by a contact etching process using metal electrodes. Partners: ICMPE, S. Bastide ; IEMN (Lille 1) ; LGEF (SUPELEC/CRNRS).

Project Title: Drugs and ecotoxicity

Anticipating the fate of organic environmental contaminants: a predictive approach applied to the pharmaceutical furosemide

The presence at trace levels of organic contaminants in the environment is currently an environmental concern. When these contaminants are subjected to environmental transformations, environmental transformation products (ETPs) are obtained, whose structures often remain unknown. The absence of information concerning these new compounds makes them unavailable and consequently makes their environmental detection as well as their (eco)toxicological study impossible. Our article describes a multidisciplinary approach that seeks to both anticipate the fate and evaluate the impact of organic environmental contaminants.

Our approach consists of three steps. First, isolated and fully characterized transformation products (TPs) of the parent molecule are obtained. In the second step, the parent molecule is subjected to environmentally relevant transformations: the detection of previously characterized TPs allows the concomitant identification of plausible ETPs. The third step is devoted to the toxicological evaluation of the identified plausible ETPs.

In a previous paper, the identification of TPs of furosemide (a diuretic also known as an environmental contaminant) has been achieved. In this paper and by the means of environmentally relevant methods, a compound of type pyridinium is demonstrated to be an ETP of furosemide. Toxycity of this pyridinium is also highlighted for the first time.

Direct assessment from cyclic voltammetry of size effect on the hydrogen sorption properties of Pd nanoparticles/Carbon hybrids

Nano-metals dispersed in carbon matrices constitute an important class of materials that find application in various fields like energy storage, energy conversion or catalysis. Among others, Pd/carbon composites are of a model system to study the effect of particle size on Pd hydride phase formation can be directly evaluated by electrochemical means.

PD particles dispersed in high surface area graphite powders have been synthesized at different sizes: 2, 6 and 18 nm. Their voltammograms (see Figure) exhibit couples of peaks related to the α (A/C) and β phase (A/G) that show a clear trend: as the Pd particle size is reduced, the H content increases in the α phase and decreases in the β phase. The total H content decreases from 0.6 to 0.42 H/Pd, in agreement with solid/gas measurements and the theory.

Furthermore, the sensitivity of the electrochemical signals allows following in situ changes in Pd particle size during cycling. We could indeed detect an increase in particle size when cycling in the Pd oxide region (confirmed by ex situ XRD).

Contact: bastide@icmpe.cnrs.fr

International Newsletter
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Figure 1: Schematic procedures for surface aotection of electropun PHA nanofibers

Contact: renard@icmpe.cnrs.fr

Human mesenchymal stromal cells (hMSC) exhibit a better adhesion on the latter scaffolds than on non-functionalized PHA mats (Figure 2). These approaches are suitable for the introduction of biomacromolecules on the fiber surface, thus enabling the immobilization of enzymes or proteins, and paving the way to the development of novel functional scaffolds for tissue engineering.

Figure 2: SEM micrographs of nanofibrous scaffolds after 5 days of hMSC culture on PHAs, followed by glycidyl methacrylate grafting polymerization.

Contact: muller@u-pec.fr

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Drugs and ecotoxicity


Contact: martens@icmpe.cnrs.fr
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Welcome our new researchers

Mathilde Laurent-Brocq has joined the MCMC Team as Chargée de Recherche - CNRS. She works on the relationship between the chemical composition, the structure/microstructure and the mechanical behavior of metallic alloys. More specifically, she is studying high entropy alloys, which are processed at the ICMPE Material Preparation Facilities, using nano-indentation.

Sabrina Belbekhouche and Céline Charbonneau have joined the SPC Team as teachers-researchers (UPEC). S. Belbekhouche's core expertise is in polymer science, macromolecular assembly and surface modification. This includes: polymer synthesis, study of the physical chemistry of surfaces/interfaces and use of controlled assembly at the sub-µm scale. Current applications of her research are mainly for biological applications.

C. Charbonneau works on the development of smart and hybrid biodegradable presenting specific mechanical properties. More specifically, she studies the relationship between the chemical architecture of polymer chains, the structuring and the rheological behavior of biodegradables.

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