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Preface

Proton-conducting membranes for PEM fuel cells

This special volume of the «Journal of Power Sources» contains some of the most relevant papers submitted at the occasion of the symposium «Materials for PEM Fuel Cells», organized by us at the European Materials Research Society Spring Meeting from June 8 to 12, 2009 in Strasbourg, France.

Innovative ionomer membranes are the general topic of these articles. In this domain, the development of membranes with long durability at temperatures above 100 °C would be a major achievement, paramount for the future success of PEM fuel cell technology. Higher working temperatures have important advantages, such as faster electrochemical kinetics, less anode poisoning due to fuel impurities and less cooling requirements so that smaller radiator areas can be utilized in fuel cell vehicles. In stationary co-generation applications, warm water supply is made easier. However, important membrane improvements are required to reach this objective and this is a difficult task.

One approach is to design new organic–inorganic composite membranes, especially with nanoparticles: several articles are devoted to this topic. Di Noto et al. report on "new inorganic–organic proton-conducting membranes based on Nafion and hydrophobic fluoroalkylated silica nanoparticles". Casciola and colleagues study "Methanol permeability and performance of Nafion–zirconium phosphate composite membranes in active and passive DMFCs". Mihailescu et al. investigate metal oxide nanoparticles synthesized by pulsed laser ablation. Stamatin and co-workers make a comparative study of polysilicic acid insertion in fuel cells membranes. Kurdakova et al. study PBI-based composite membranes.

Other strategies include new or improved fully organic polymers: Sen et al. report on "Nafion/Poly(1-vinyl-1,2,4-triazole) Blends as Proton Conducting Membranes". Lufrano and colleagues investigate "Sulfonated Polysulfone Membranes as Electrolyte in a Passive-mode Direct Methanol Fuel Cell Mini-stack". Sakri et al. study "new grafted copolymers by ozonization of poly(vinyliden fluoride)". Finally, Monir et al. investigate a fully inorganic system: "Proton Conductivity of Ordered Mesoporous Materials Containing Aluminium".

Modelling approaches gain more and more importance in physical sciences. In direct connection with the development of improved proton-conducting ionomers is the modelling of proton conduction, as shown in the article by Kuleshova et al. "Theoretical simulations of proton conductivity: basic principles for improving the proton conductor". A better mechanistic understanding can help to design better materials: Stamatin and co-workers study the conduction mechanisms in poly-perfluorosulfonated membranes impregnated with intrinsic semiconducting polymers.

Two articles of this volume are devoted to improved analysis of mechanical properties. Carlotti et al. use Brillouin light scattering to determine Young's modulus of Nafion membranes. Knauth et al. determined mechanical properties of sulfonated aromatic polymers by combination of stress–strain tests and dynamical analysis.

The special volume closes with an article on very promising evolutions for the future of fuel cell technology using micro-systems made by microtechnologies. The article by Frank et al. describes a "Polymer Electrolyte Membrane for Micro Fuel Cells structured by Optical Lithography".

This volume presents some of the hot topics of ionomer development: synthesis and characterization of organic, hybrid or inorganic membranes, proton conduction modelling, microsystems. It should be of significant interest for all colleagues working in PEM fuel cell research and development.

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M.L. Di Vona*
University of Rome Tor Vergata, Department of Chemicals Science and Technology, Via della Ricerca Scientifica 1, 00133 Rome, Italy

P. Knauth
Université de Provence-CNRS : Laboratoire Chimie Provence (UMR 6264), Centre St Jérôme, Marseille, France

G. Alberti
Chemistry Department, University of Perugia, via Elce di Sotto 8, 06123 Perugia, Italy

* Corresponding author. Tel.: +39 0672594385; fax: +39 0672594328.
E-mail address: divona@uniroma2.it (M.L. Di Vona)

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