Morphological and Spatial Aspects in Polymer Degradation: From Heterophasic Polymers to Proton Exchange Membranes Used in Fuel Cells

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(A) Attack sites by HO• in model compounds for membranes used in fuel cells were determined by spin traping. The HO• radicals were generated by UV irradiation of H_2O_2.[1]

CH_3COOH : CH_3 group

↑

CF_3COOH : COOH group

↑

CF_3SO_3H : SO_3H group

↑

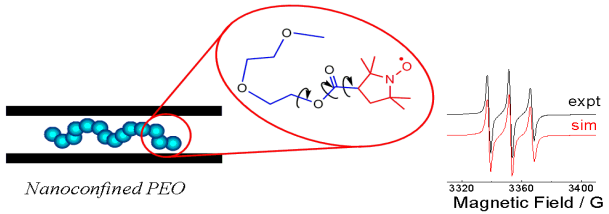
CF_2HCOOH : Two sites

↑ ↑

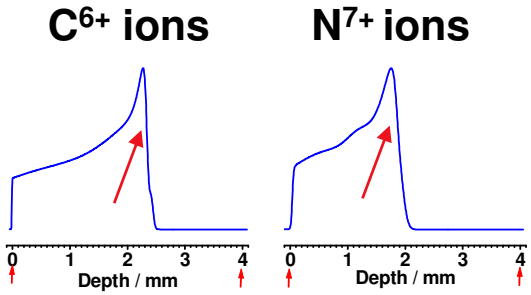
$CF_3CF_2OCF_2CF_2SO_3H$: Two sites

↑ ↑

(B) Poly(ethylene oxide) (PEO) intercalated in 0.83 nm wide galleries of a fluoromica inorganic clay has a lower activation energy for segmental motion compared to bulk PEO, a result assigned to the low segmental density and reduced cooperative motion with neighboring segments.[2]



(C) 1D and 2D spectral-spatial electron spin resonance imaging (ESRI) can visualize dose distribution and linear energy transfer (LET) in a potassium dithionate, $K_2S_2O_6$ (PDT), dosimeter irradiated with the heavy ions C^{6+} and N^{7+}. The clear Bragg peaks detected (arrows) are essential for radiation therapy.[3]



1. **Danilczuk, M.; Coms, F.D.; Schlick, S.** *Fuel Cells* **2008**, in press.
2. **Miwa, Y.; Drews, A.R.; Schlick, S.** *Macromolecules* **2008**, *41*, 4701-4708.
3. **Gustafsson, H.; Kruczala. K.; Lund, E.; Schlick, S.** *J. Phys. Chem. B* **2008**, 112, 8437-8442 (Letter).

Broader Impact Activities

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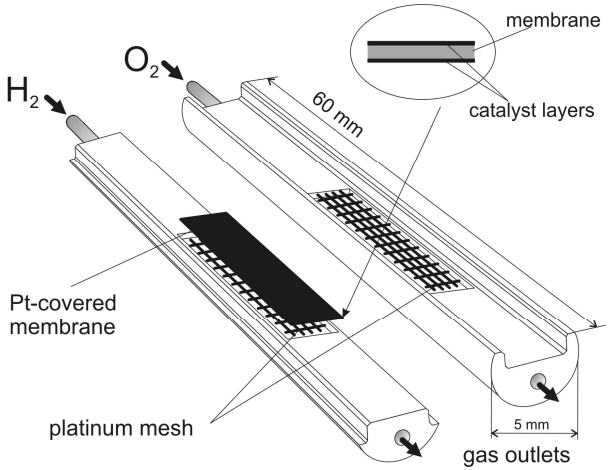
A fuel cell that can be inserted in the ESR resonator, designed in Detroit and built at the GM Fuel Cell Activity Center.



The ESR group at the Department of Chemical Physics, Weizmann Institute of Science, Rehovot, Israel.

• ***The Group*:** undergraduate A. J. Perkowski, graduate students Lu Lin and Peng Cong, postdoctorals M. Danilczuk, Q. Mao, and J. Ma, visiting scientists H. Gustafsson (Linköping University, Sweden), K. Kruczala (University of Krakow, Poland), Yohei Miwa (Mitsubishi, Japan).

• ***Translational Research***. *Our collaboration with* scientists and engineers from 3M, Ford Laboratories, and the Fuel Cell Activities Center of General Motors on the degradation and stabilization of membranes used in fuel cells is an example of the connectivity between fundamental research and applications: Understanding the mechanism of membrane degradation enables work on better membranes.

• ***International Collaborations*.** PI Schlick spent a mini-sabbatical (24 April-30 June 2008) as Weston Professor at the Weizmann Institute of Science in the laboratory of professor Daniella Goldfarb. Schlick learned the potential of pulse ESR for the study of ion aggregation in ionomers and performed Double Electron-Electron Resonance (DEER) experiments for poly(styrene-*co*-methacrylic acid) (SMAA) ionomers neutralized by Cu(II) cations. These experiments have the potential to complement results obtained by scattering and electron microscopy (STEM).