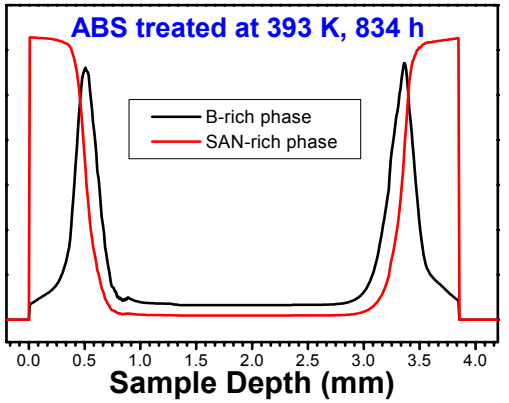
Shulamith Schlick, University of Detroit Mercy

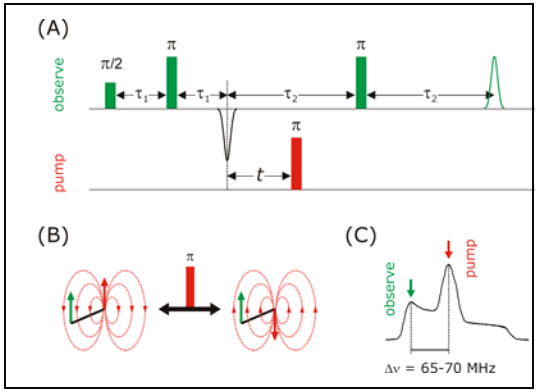
DMR – 0105622

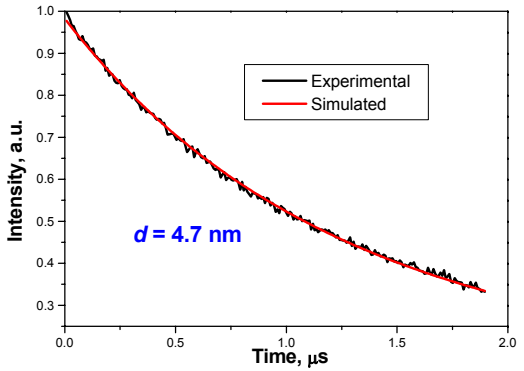
Visualizing Polymer Degradation on mm, µm and nm Scales

Spatially-resolved degradation in heterophasic polymers has been studied in our laboratory using ESR imaging (ESRI). In the case of poly(acrylonitrile-butadiene styrene) (ABS) stabilized by a hindered amine, ESRI of amine-derived nitroxides has provided information on degradation processes in each of the two microphases (B-rich and SAN-rich), on the scale of mm and µm (top figure).



The length scale of the information has been extended to the nanometer range during the sabbatical stay of the PI at the Max-Planck Institute for Polymer Research in Mainz, Germany. The method is based on combining ESRI with four-pulse double electron-electron resonance (DEER, middle figure). Simulation of the echo decays (bottom figure) assuming a bimodal distribution of nitroxides has provided details on the spatial distribution of, and distance between, nitroxides (*d* in the range 1.5-8 nm), and on the stabilization mechanism.





Some results will be presented at the 27th International ESR Conference in Denver, CO, 1-5 August 2004.

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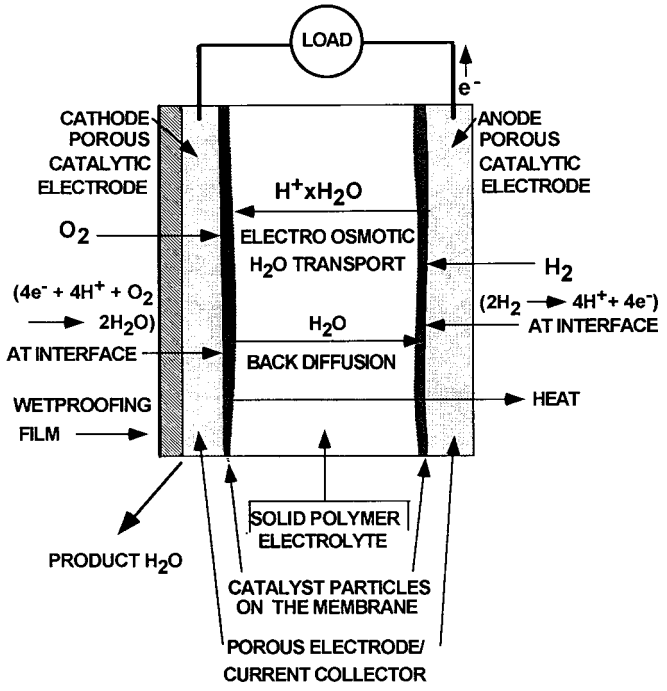
Education and Outreach

- Our experience with polymer degradation and oxygen radicals led to a research contract with the Fuel Cell Activity group of General Motors Corporation in Honeoye Falls, NY. The topic: **Chemical stability of proton exchange membranes (PEMs) used in fuel cells**.

- The NSF grant has supported two graduate students who have completed their theses, two graduate students at present time, and one REU student. In addition, two postdoctoral fellows, one visiting scientist and one visiting professor have worked in our laboratory.

- The 2004 Encyclopedia of Polymer Science and Technology includes a Chapter entitled "**Electron Spin Resonance Spectroscopy in Polymer Research**" by S. Schlick (UDM) and G. Jeschke (Max-Planck Institute).

Fuel Cell and Electrode Reactions



$HO\cdot$, $HO_2\cdot$, and O_2^- are lethal reactive intermediates formed during the two-electron oxygen reduction, and in the presence of hydrogen and/or oxygen crossover; these radicals attack the membrane and reduce its lifetime.