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Radiografted track-etched polymer membranes for research and application

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The XPnano group at LSI (Ecole Polytechnique, France) synthesises nanoporous polymer membranes using ion track technology in collaboration with the CIMAP (GANIL). The zone of defects along the ion-trajectory, namely the latent track, is rich of radicals in numerous polymers and may be directly modified chemically by radio-induced grafting (Ion-track grafting). Latent tracks may also be etched to obtain either cylindrical pores of monodiperse radii ranging from 10 nm to few microns or other geometries like biconical shapes with an aperture of only few nm. The remanence of radicals after etching in a semi-crystalline PVDF membrane was proven in our group by EPR for pore diameter inferior to 100 nm and the subsequent radiografting was localized by Confocal Laser Scanning Microcoscope. This property allows us to radiograft, very locally, a hydrophilic polymer in a hydrophobic matrice from nanopore walls. Using controlled radical polymerization (i.e. RAFT mechanism), the grafted layer can be tuned very accurately from nanometric coverage of nanopore walls to complete blockage of the pores and appearance of radiografted chain protusions at the membrane surface. Ion-track grafting have permitted the fabrication of many devices in our group. Some achievements were obtained in proton-exchange membrane fuel cell (automotive application) and in water quality sensors for toxic metal ions at the trace level (sub-ppb sensitivity). Track-etched membranes are also routinely used as template to grow metallic nanowires (NWs) by electrodeposition. It opens the field of research to composite membranes. Non-conventionnal behaviour of embedded Ni NW magnetoresistance have been registered when biconical NWs are contacted. An experimental set-up at LSI allows contacting only one NW over billions. Combined to electroactive polymers such as piezoelectric β-PVDF, recent results have shown a giant magnetostrictive effect in a single Ni NW induced by mechanical stress.

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