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TRACK ETCHED MEMBRANES BASED NANOTECHNOLOGIES

Among the methods of synthesis of nanostructures in solids currently under development, exhibiting various morphologies and properties, a special place is devoted to so-called nuclear technologies, which include the study of the processes of formation and of the applications of ion (nuclear) tracks. The swift heavy ion technique is based on the unique phenomenon whereby high-energy heavy ions induce latent tracks in materials such as polymers or metals containing a highly disordered zone of about 3-10 nm in diameter. The extremely high volume concentration of tracks in the solid state matrix which is achievable by adjusting the ion fluence, enables the creation of "controlled" nanostructures on the basis of the latent tracks, including the so-called "track membranes"based on polymeric thin films. This is possible because selective etching of the disordered zones in the polymer results in the formation of a set of nano sized or micron sized channels or pores having a high aspect ratio. The hollow track areas can easily be filled with materials of different compositions (metals, semiconductors, biological particles), by, for example, electroplating, electroless deposition and covalent binding. This method of template synthesis has seen wide application in the creation of unique optical, electronic and catalytic structures and nanoscale devices. This nuclear technology was applied to prepare new types of nickel-platinum and nickel-palladium nano-structured electrodes for the production of hydrogen by the electrolysis of water. The logical extension of this work has been the development of cathodes for lithium-ion batteries based on ensembles of nickel and copper nanowires modified by carbon nanotubes. Moreover, the track etched membranes are suitable for the creation of multifunctional membranes for separation processes of liquids and gases. New gas separation membranes based on polymethyl pentane, polyester and polyolefin polymeric films irradiated with heavy ions are applicable for gas separation processes, such as selective isolation of oxygen. Furthermore methods for the reactive sputtering of wide bandgap semiconductors on track-etched polymer films were developed. A range of photocatalytic track membranes were prepared and their physico-chemical and catalytic properties studied. Such new photocatalytic, self-cleaning materials are applicable for organic pollutant degradation and prevention of biofouling on membranes. The development of surface enhanced track membranes as platforms for Raman spectroscopy showed potential for the rapid assessment of water and air quality, on the basis of plasmonic metal coated composite track membranes. Ligand functionalized nanofiber track membrane composites were developed with affinity for toxic metals and are suitable for hydrometallurgical separations. Since the protocols for making these diverse nanomaterials are available at industrial scale, there is a high potential for their rapid commercialization.

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