Electrospun Molecular Sieve Composite Nanofibers

Sudha Madhugiri, John Ferraris, Kenneth Balkus, Jr.*

University of Texas at Dallas
Department of Chemistry and the NanoTech Institute,
Richardson, TX 75083-0688, United States

We have developed an electrostatic deposition process for the fabrication of molecular sieve fibers. Mesoporous molecular sieves such as the all silica DAM-1 and SBA-15 materials as well as the TiO_2 (Figure 1) compositions are templated using the micelle forming molecules Vitamin E TPGS and Pluronic 123, respectively. The precursor gels to these nanoporous materials were loaded into a syringe, which was positioned horizontally, 23 cm from an aluminum foil electrode. Upon the application of 20kV a fine jet of molecular sieve gel is formed that deposits as a non-woven fibrous mesh on the foil or substrates positioned in front of the foil. This represents the first time such inorganic materials have been electrospun. Additionally, various guest molecules have been included in the micelles such as organic dyes and carbon nanotubes. The templates containing these guest molecules were employed to electrospin modified DAM-1 and SBA-15 fibers. Details of the deposition process and characterization of the fibers will be presented.

The application of these materials in smart papers and textiles would be enhanced if the molecular sieve fibers could be composited with polymer fibers. Therefore, a setup was designed so that a molecular sieve gel and a polymer solution could be simultaneously electrospun, generating an intimate mesh of fibers. Examples of SBA-15 composites with polyethyleneimine (PEI) and polyethyleneoxide (PEO) will be described. In these cases spider webs are formed appear as a fine tissue paper, such that they can be physically handled. Further examples, include composite fibers of the conducting polymer MEH-PPV and SBA-15 as well as TIO_2. In this case the mixture of inorganic and organic fibers leads to dramatic changes in the optical properties of the polymer. In particular a blue shift of as much as 60 nm in the emission spectrum for MEH-PPV was observed. This is proposed to arise from a reduction in polymer aggregation during electrospinning with the molecular sieves. Complete characterization including photophysical properties will be presented. Additionally, preliminary results for the application of these composites in solar cells and as scaffolds for cell growth will be described.

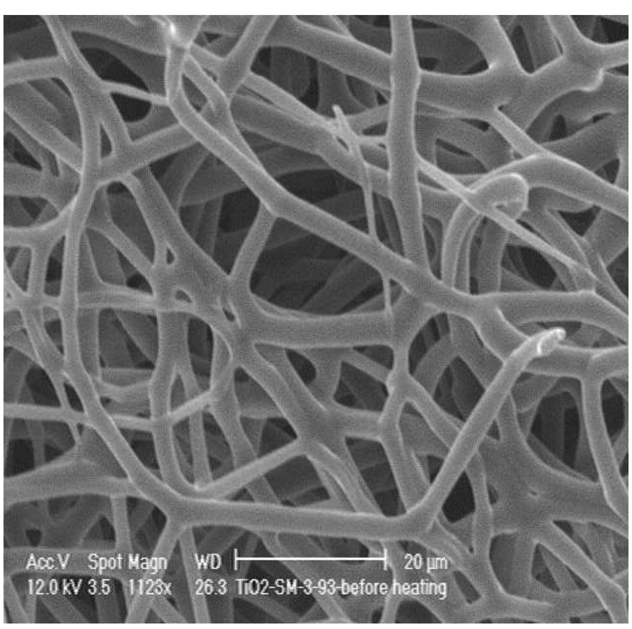

Figure 1. Pluronic 123 templated TiO_2 molecular sieve fibers