SES11-2011-000137

Abstract for an Invited Paper
for the SES11 Meeting of
the American Physical Society

Synthesis of nanostructures by combination of electrospinning and sputtering techniques[1]

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Electrospinning and sputtering are well known techniques for the formation of different materials in the shape of fibers and films, respectively. Both techniques offer the advantage of being able to prepare a broad range of materials, from metals to insulators, in a different range of compositions and structures. Their combined used offers then a unique opportunity to explore the fabrication of different materials with tailored compositions and nanostructures. An interesting application results when the electrospun fibers are used as templates for sputtering of palladium metal. Palladium (Pd) is one of the most prominent materials studied for the detection of hydrogen gas. Hydrogen rapidly dissociates on its surface and diffuses into subsurface layers forming palladium hydride with consequent changes in optical, mechanical and electrical properties that are easily detected. Materials with nanoscale morphologies are promising to improve sensor performance as they provide large surface areas for adsorption, and smaller crystallite size reducing the time needed for "bulk" diffusion. In this presentation it will be shown how Pd nanoribbons and nanoshells are prepared by magnetron sputtering deposition on top of the mat of polymer fibers. Sputtering is a line-of-sight deposition process and the fibers become a variable angle-substrate for the incoming Pd flux. A larger amount of palladium is deposited on top of the fiber where the incoming flux is perpendicular to the surface compared to the sides where the flux is incident at a glancing angle. The top and sides of the fibers shadow their bottom parts closer to the substrate preventing any substantial deposition there. The end result of the deposition is the formation of Pd nanostructures, thicker in the middle region than at the edges, with a large void network. The high sensitivity and response time shown to 1% or less of hydrogen in nitrogen is understood to result from the reduced dimensions combined with this unique nanostructure. A description will be given of the conductance changes with hydrogen concentration as result of the competing mechanisms of percolation and scattering.

[1]Author Acknowledges support of NASA NNX08BA48A and NSF 1002410 grants.