Multifunctional Fibers via Manipulation of Nanoscale Phenomena

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Abstract

In this seminar we will discuss our research work on understanding complex phenomena at the nanoscale that are of fundamental relevance to fiber and polymer science.

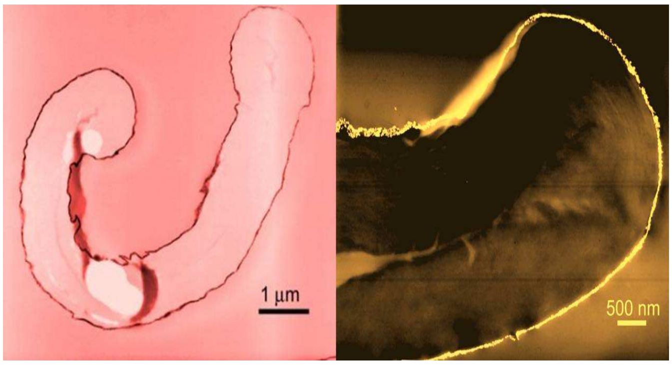

Figure 1. Transmission Electron Microscopy TEM images of cotton fibers coated with gold (L) and palladium (R) nanoparticles. Potential applications include catalytic mantles, structural coloration (color without dyes) and antibacterial flexible substrates

A second thrust of our research efforts is concentrated on using external fields, transient plasticizers and associative polymers to induce self-assembly at the nanoscale during the electrospinning process. **The manipulation of the viscoelasticity of the precursor solutions allow for precise position control of embedded nanoparticles or active compounds inside and outside of polymeric fibers. Magnetic, photocatalytic and inorganic nanoparticles have been successfully encapsulated so far as well** (Figure 2)**.**

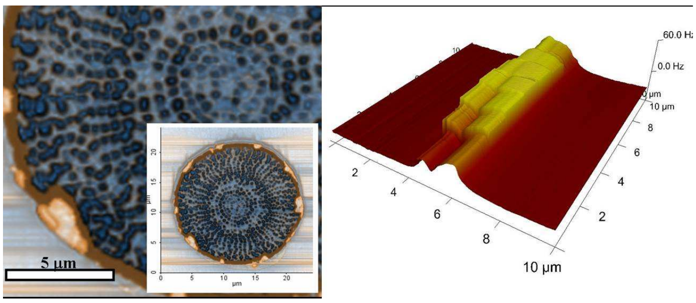

Figure 3. Acoustic Force Atomic Microscopy image of a conjugated fiber (Islands on the Sea) containing 1120 nanofibers of polyester in a sea of polyethylene (L). Topography and Electric Field Gradient Images for a polypropylene electret fiber obtained via Electrostatic Force Microscopy

Initially we will present our use of **self-assembly phenomena to tailor the barrier properties of conventional textile materials**. We had successfully used electrostatic self-assembly techniques to deposit, for the first time, fully conformal nanolayers over irregular and heterogeneous natural fiber surfaces achieving a **significant increase in chemical selectivity due to the carefully controlled molecular architecture of the nanolayers. We use self-assembly to develop novel selectively permeable materials for protective clothing applications as well as active filtration**. Our group has also used atomic layer deposition ALD techniques to **covalently attach inorganic and metallic moieties to natural fibers opening a new avenue for the development of flexible electronic and smart textiles**.

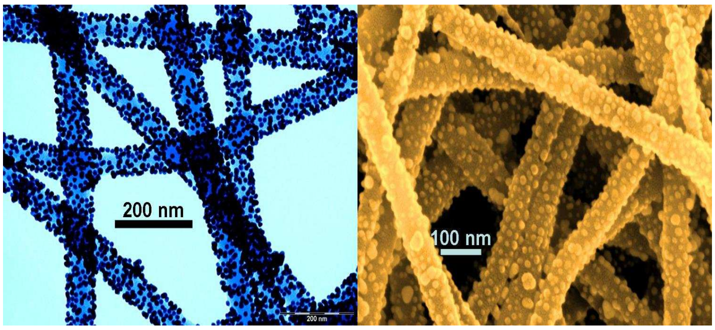

Figure 2 TEM and FESEM images of nylon nanofibers coated with gold (L) and silver (R) nanoparticles. Potential applications include active and catalytic filtration of hazardous gases and industrial toxic chemicals as well as anti-counterfeiting devices

Finally we will present our developments on **using of scanning probe microscopy based techniques to probe nanoscale phenomena in fibrous systems.** We will present our use of electric force microscopy as a probing tool to quantitatively determine the electrical charge degradation on electret fibers media (Figure 3). We will also present the use of lateral force microscopy to probe lubrication phenomena in complex interfaces as well as acoustic force atomic microscopy to measure the mechanical properties of nanofibers.