Because the ways in which materials are made, used, and recycled can affect fields as diverse as medicine, energy, transportation, and manufacturing, Materials Science & Engineering (MTE) research plays a key role in helping advance these important areas.

Cutting-edge research currently being conducted at WPI's Metal Processing Institute and Integrative Materials Design Center includes work in these areas:

- Casting, powder metallurgy, and heat treating—helping some of the nation's most important industries stay up to date and competitive
- Advanced technology for recovering metal from the waste stream—reusing it in the most effective and economical manner
- Efficiency and reusability—designing and manufacturing products to optimize performance, reliability, and recyclability

# Research Topics in the Polymer Lab

## Electrospinning of Carbon Nanotube Reinforced Polymeric Materials

The electrospinning process will be used to embed multi-walled carbon nanotubes (MWCNTs) in a Polyvinylpyrrolidone (PVP) matrix, forming composite nanofibers. Initial dispersion of MWCNTs in water will be achieved by the use of surfactants. Different surfactants will be used in order to achieve the highest amount of MWCNTs being dispersed in the polymer solution.

The efficiency of the surfactants will be examined as well as their effects on the electrospinning process. After electrospinning, the morphology of the electrospun nanofibers and the distribution and conformation of the MWCNTs in the nanofibers will be studied by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). The elastic modulus of the electrospun composite fibers will be measured using AFM. It is expected that the presence of aligned and unagglomerated MWCNTs will improve the mechanical properties dramatically.

### Effects of Molecular Weight Distribution on the Formation of Fibers of Electrospinning Polystyrene

It is widely recognized that molecular weight distribution (MWD) is an important factor affecting the rheological behavior of polymer solutions. The objective of this research is to study the effects of MWD on the formation of electrospun polystyrene fibers in THF. The results will be compared with the monodisperse system.

A quantitative relationship between chain entanglements attributed to high molecular weight component and the rheological properties of the polydisperse system will be established. Concentrations for the incipient as well as stable fiber formation in a polydisperse system may be predicted.

The objective of this research is to analyze the drug release kinetics between drug-coated stents. The stents are coated by different methods. A polymer-drug is electrospun onto the stent mesh to form a coating composed of submicron sized polymer fibers.

Another non-polymer drug attachment is achieved through anodization. SEM is used to analysis distribution and morphologies of the coatings. Spectroscopy is then used to analyze the drug release kinetics. The release profiles of both methods are obtained. The releasing efficiencies achieved from different coating methods are compared.

# Completed Research Projects in the Polymer Lab

For more information on completed research projects, click on the links below.

**Electrospinning of Polystyrene**

- Flight path of electrospun polystyrene solutions: Effects of molecular weight and concentration (PDF)
- Solvent Effects on Jet Evolution during Electrospinning of Semi-dilute Polystyrene Solutions (PDF)
- Bead-to-Fiber Transition in Electrospun Polystyrene (PDF)

**Electrospinning of Biopolymers**

- Electrospinning of Biopolymers (PDF) (Project research by Chen-Ming Hsu and Jing Tao)
- Submicron-scale poly (E-caprolactone) fibers produced by electrospinning (Project research by Chen-Ming Hsu)