Wolfson Department of Chemical Engineering Seminar
Lecture Hall 6, Wolfson Department of Chemical Engineering,
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From Electrospinning Poly(ionic liquid)s to Conductive Carbon Fibers

Conductive carbons are used as additives to provide electrical conductivity to otherwise high-resistance materials, such as electrodes for batteries and fuel cells, plastic packaging, aircraft materials, and medical devices. An ideal conductive carbon should possess a continuous structure; one-dimensional fiber-type carbon materials obtained by electrospinning are particularly promising for this purpose. Electrospinning is a scalable and inexpensive technique to produce fibers with diameters from micrometers to tenths of nanometers. Electrospun fibers are long and continuous, have a defined architecture and high surface area, and produce a free standing sheet; properties which can be translated to the carbon. However, current precursors yield carbon fibers possessing an electrical conductivity too low for some applications. This roadblock may be overcome by the development of new spinnable polymers that yield more conductive carbons.

Poly(ionic liquid)s (PILs) are a class of polymers composed of ionic liquid monomers. PILs combine the useful properties of ionic liquids, such as ionic conductivity and carbon-forming abilities, with the processability and mechanical stability of polymers. PILs have been examined for use as ion conductors, CO_2 sorbents, dispersants, gas separation membranes, nanostructured functional materials, and more. The carbonization of some PILs has been shown to be an efficient route to produce N-doped carbons possessing high electrical conductivity. PILs, like other polyelectrolytes, can be challenging to electrospin, due to their high conductivity and the low mobility of the polyion, causing instabilities in the electrospinning jet. While a few groups have electrospun PILs, any attempt to carbonize the fibers resulted in complete loss of structure.

In this context, we developed conductive carbon fibers by electrospinning PIL. We found that by changing the solvent composition, electrostatic interactions between polymer chains were screened, which could assist in favoring fibers formation over beads. An ionic crosslinking step proved to be a key to maintain the fibrous structure during carbonization. Carbonization at 950°C resulted in conductive carbon fibers, evidenced by their performance in electric double-layer capacitors (EDLCs). Carbon fibers were utilized as the current collectors instead of the standard metal collectors, where they outperformed the established carbon-coated aluminum foil and showed performances comparable to platinum. Carbon fibers were free-standing and light-weight, making them a promising inexpensive and metal-free alternative for EDLCs applications. In the future, these fibers could be implemented for other fields, such as electrocatalysis, composite materials, and CO_2 reduction.

Refreshments will be served at 1:15pm