Complex Liquids/Nanostructure/Macromolecules

Technion-Israel Institute of Technology

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Will talk on

"The Local and Global Molecular Orientation of Electrospun Nylon-6 Nanofibers"

Electrospinning is a unique approach using electrostatic forces to produce fine fibers, with diameters ranging from a few nanometers to several micrometers, from polymer solutions or melts. The mechanical and thermodynamic properties of electrospun polymer nanofibers show a remarkably irregular pattern in comparison with their bulk-related properties. These properties vary sharply when the object scale drops below a critical threshold (e.g., fiber diameter). They are commonly attributed to confinement of non-equilibrium supermolecular structures, formed during electrospinning when the polymer solution jet is exposed to rapid and significant elongation (up to 10^5 accompanied by a strain rate of the order 10^3 sec^{-1}). Such extreme processing conditions results in a non-equilibrium stretched state of nanofiber polymer matrix, which can be "frozen" due to massive solvent evaporation and polymer solidification. In this study the microstructure of electrospun nylon-6 (polyamide 6) nanofibers with diameter ranging between 50-250 nm was examined as a function of the polymer solution viscosity, flow rate, and the strength of the electrostatic field. Single fibers were studied using Selected Area Electron Diffraction (SAED) and Small-Angle X-ray Scattering (SAXS), and compared with cast film and non-woven fiber mat that were analyzed using Wide-angle X-ray Scattering (WAXS) and SAXS.

The diffraction patterns of the fibers show existence of the two known phases, α and γ. SAXS measurements imply that there is no long term order in the fibers. Both diffraction methods indicated that the crystals are aligned with the long molecular direction parallel to the nanofiber axis. Interestingly, when examining a single fiber using SAED, a distribution of orientation with a sub group of crystalline showing a highly preferred orientation was observed. The degree of orientation may slightly vary with the change of the fiber diameter, as the fiber diameter increases the degree of orientation increases. In comparison, WAXD analysis shows the cast film is rich with α-phase while SAED analysis suggests the presence of α-phase solely. SEM image proof the existence of spherulites in the cast films.

Tuesday, 10 May 2016

11:00, Room 108, Chemical Engineering Building