418e Self-Assembled Conjugated Polymer Semiconductor Nanowires

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There is a growing interest in well-defined nanostructured materials such as metal, semiconductor, or polymer nanowires and carbon nanotubes because of their unique properties resulting from size confinement and restricted dimensionality. Conjugated polymers are molecular semiconductors that are finding applications in light emitting diodes for displays and lighting [1], thin film transistors [2], and photovoltaic cells [3]. In particular, conjugated polymer nanowires have attracted much recent attention due to their potential for fundamental studies of confinement effects and for applications in nanoelectronics, nanophotonics, and sensors. In this talk, we will describe the synthesis, self-assembly, nanostructure characterization, photophysical properties, charge transport, and device applications of conjugated polymer semiconductor nanowires. We have discovered that binary blends of regioregular poly(3-hexylthiophene) and our recently synthesized regioregular poly(4-hexylquinoline) [4] in dilute solutions self-assemble into crystalline nanowires with a diameter of 21 nm and lengths of order 1-10 μm. These polymer nanowires have been characterized by atomic force microscopy, transmission electron microscopy and other techniques. X-ray diffraction studies of the blend nanowires revealed that the two polymers cocrystallize into highly ordered layered structures. Ambipolar charge transport was observed in field-effect transistors based on the polymer blend nanowires. A hole mobility of up to 0.012 cm^2/Vs and an electron mobility of 0.004 cm^2/Vs were observed in the blend nanowires. The novel self-assembly approach to polymer nanowires with nanoscale cross-sections and lengths on the order of micrometers from binary blends of conjugated polymers opens up opportunity for exploring new applications of conjugated polymers in nanoscale and molecular electronic devices. [1] Kulkarni, A. P.; Tonzola, C. J.; Babel, A.; Jenekhe, S. A. Chem. Mater. 2004, 16, 4556. [2] (a) Babel, A.; Jenekhe, S. A. J. Am. Chem. Soc. 2003, 125, 13656. (b) Babel, A.; Jenekhe, S. A. Synth. Met. 2005, 148, 169. [3] Alam, M. M.; Jenekhe, S. A. Chem. Mater., 2004, 16, 4647. [4] Zhu, Y.; Alam, M. M.; Jenekhe, S. A. Macromolecules 2003, 36, 8958.