Development of High Performance Organic Semiconductors for Organic Electronics

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Abstract

Printed Electronics has attracted significant attention due to their wide range of applications such as flexible and portable solar panels, smart labels, wearable electronics, large-area flexible displays, and ultra-low-cost RFID tags. The most important component technology in printed electronics is organic thin film transistors (OTFTs). In the past two decades, significant progress has been made in the development of printable organic semiconductors, which have achieved charge carrier mobility in some cases comparable to amorphous silicon-based transistor (charge mobility 0.5 - 1 cm^2/Vs). However, most of the printable semiconductors suffer from technical difficulties, e.g. air stability, or insufficient mobility, or short lifetime limitations. In this talk, I will present our effort in the development of high charge mobility polymers, showing field-effect mobility in the range of 1 to 10 cm^2/Vs, which is the highest mobility reported so far. The polymer thin film transistors without any encapsulation demonstrated excellent shelf-life and operating stability in ambient conditions. In addition, high gain inverter devices and high performance oscillator circuits have also been fabricated from the air stable semiconducting polymers, demonstrating its high potential for broad range, high value technological applications.

Another important application of polymer semiconductors is organic solar cells (OSCs). OSCs are thin, light-weight, and can possibly be fabricated into flexible and translucent panels. These features offer OSCs a wide range of new applications that are currently unachievable with conventional silicon solar panels, e.g. integrated into building as windows, used for urban architecture and portable shade structures, or used as renewable power sources both indoors and outdoors. In the second part of my talk, I will present the design and synthesis of a series of low bandgap light harvesting polymers for OSCs. Through manipulating the light absorption spectrum, the energy levels, the charge mobility, and the solubility of the polymers, we are able to optimize the device parameters, e.g. V_{oc}, J_{sc} and fill factor, and achieve the device power conversion efficiency of 5% to >8%. The polymers showed excellent processability and can be fabricated into devices through spin coating, spray coating or blade coating, which showed great potential for commercialization.

References:

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