Carbon nanotubes and graphene polymer composites for optoelectronic applications

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Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av filosofie doktorsexamen framläggs till offentligt förvar i KB3B1, 01 juni, kl. 10:00. Avhandlingen kommer att förvaras på engelska.

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Abstract
Carbon nanotubes are carbon based structures with outstanding electronical and mechanical properties. They are used in a wide range of applications, usually embedded in polymer in the form of composites, in order to affect the electronic behavior of the matrix material. However, as the nanotubes properties are directly dependent on their intrinsic structure, it is necessary to select specific nanotubes depending on the application, which can be a complicated and inefficient process. This makes it attractive to be able to reduce the amount of material used in the composites.

In this thesis, focus is placed on the electrical properties of the composites. A simple patterning method is presented which allows the use of extremely low amounts of nanotubes in order to increase the electrical conductivity of diverse polymers such as polystyrene (PS) or poly(3-hexylthiophene) (P3HT). This method is called nanoimprint lithography and uses a flexible mold in order to pattern composite films, leading to the creation of conducting nanotube networks, resulting in vertically conducting samples (from the bottom of the film to the top of the imprinted patterns).

In parallel, X-ray diffraction measurements have been conducted on thin P3HT polymer films. These were prepared on either silicon substrate or on graphene, and the influence of the processing conditions as well as of the substrate on the crystallinity of the polymer have been investigated. The knowledge of the crystalline structure of P3HT is of great importance as it influences its electronic properties. Establishing a link between the processing conditions and the resulting crystallinity is therefore vital in order to be able to make opto-electronic devices such as transistor or photovoltaic cells.

Keywords
carbon nanotubes, polythiophene, electrical conductivity, crystallography, graphene, nanoimprint lithography, synchrotron diffraction