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Tailoring of organic heterojunctions

Structure and properties of organic/organic and inorganic/organic interfaces for organic optoelectronics

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Heterojunctions are inherent and essential in all organic electronic devices. In organic solar cells, heterojunctions play a role in all three of the major processes: charge separation relies on effective organic/organic interfaces; charge transport is critically determined by the structure of the thin film, controlled by the organic/inorganic and organic/organic interfaces with substrates; and charge extraction can only occur at high quality inorganic/organic interfaces at the electrodes. To foster the next generation of devices, it is critical to understand the connections between heterojunction structure and morphology, and device performance.

The Organic Thin Films group is focussed on structural investigations of small conjugated semiconducting molecules. The research is based on the intimate interconnection between film synthesis, structural research and functionality, with two main thrusts. The basis is an intense interest in the fundamental understanding and control of growth dynamics to affect the functionality of molecules; the other direction focuses on the tailoring of heterojunction structure and growth to gain insights into the behaviour of organic devices.

By combining atomic force microscopy with surface-sensitive x-ray diffraction, we have been able to get detailed *in-situ* insight into the microscopic processes that take place during the growth of donor/acceptor heterojunctions. A major strength of our research is the ability to perform *in-situ* diffraction measurements in real time at various synchrotron facilities, using our portable high vacuum growth chamber. We have also had success in controlling the growth of one and two dimensional nanostructures to form interconnected bulk heterojunctions through coevaporation and surface modification. A newer direction for our group examines the role of structure on the extraction of charge carriers at electrode/organic interfaces to improve efficiency. In order to reach that goal, UHV *in-situ* scanning probe microscopies, including Kelvin probe microscopy, are being used to complement diffraction measurements. By examining the growth behaviour and electronic properties of model systems, this direction aims to render accessible the determination of the electrode structure, the near-interface ordering and the link between structural changes and device performance.

Our research aims to bridge the gap between the fundamental study of the structure of organic molecules with applied research on devices by using as many technologically relevant components as possible. Though some investigations with polymer materials are also of interest, the overall intention of this research direction is to produce small molecule solar cells with improved power efficiency achieved by modification of the heterojunction interfacial order.