Optical Microscopy of Discotic Organic Semiconductor Crystalline Films

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With technological advances keeping pace with Moore's Law, and the "Green" movement in full swing, the need for better, and smaller, electronic components is more prominent than ever. An integral part of these components, semiconductors such as silicon are used in everything from computer chips to solar cells. Organic semiconductors, though poorer conductors than silicon, are much cheaper to produce, and thus much more cost effective for large area applications, such as photovoltaics or LED displays. For the past year, the goal of my research has been to study thin films of discotic organic molecules that form crystals when deposited on a substrate.

In such films, the molecules self –assemble face to face in quasi one-dimensional arrays (columns), and form crystallites as large as 200μm in size. This is a typical example of a complex material system where the emergent electronic properties are highly anisotropic and distinctly different from those of individual molecules. I investigated the correlations between the columnar orientation and the optical properties, using linear dichroism microscopy and polarized luminescence which measure the change in molecular stacking angle across grain boundaries between adjacent crystallites, while probing the local electronic states at the boundaries. A sharp feature was observed in the emission spectrum, exclusively associated with the grain boundaries. Surveying different samples, a correlation was established between the relative orientation of molecular columns and the feature intensity at the grain boundaries. The energy associated with this feature represents a direct measure of the potential barrier for electronic transport.