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Resolving Morphology-Dependent Optical Properties with Momentum-Resolved Reflectometry[1]

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The propensity of organic materials to self-assemble into highly ordered structures leads to strong morphology-dependent optical properties. These optical properties, in turn, reveal important qualities of the underlying electronic excitations and have a significant impact on device performance and design. We present a novel model-blind, momentum-resolved reflectometry technique for determining accurate and precise optical constants, with quantifiable error estimates, for organic thin films. Unlike ellipsometrywhere spectral data is fit to unknown multi-oscillator models with dozens of free parameterswe use Fourier imaging techniques and Fresnel models to determine optical constants wavelength-by-wavelength without any input assumptions. We demonstrate this technique on the n-type polymer P(NDI2OD-T2) which is deposited with distinct edge-on and face-on morphologies depending on processing conditions. We show that this approach produces exceptional agreement with UV-Vis-NIR absorption measurements, while simultaneously avoiding the need to construct complicated dispersion models. Finally, we use this procedure to resolve subtle differences in optical anisotropies of different film morphologies that were previously obscured in ellipsometry measurements.

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