Kent State University Physics Colloquium

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Abstract

The discovery dye sensitized and bulk heterojunction solar cells in early 1990s introduced a new class of PV technology that rely on (i) distributed photogeneration of excitons, (ii) dissociation of excitons into free carriers by the heterojunction between two organic semiconductors (OSC), and (iii) collection of free carriers through electron and hole transport layers. The success of the approach is undisputed: the highest efficiency OPV cells have all relied on variants of BHJ approach. Yet, three concerns related to the use of a pair of OSCs, namely, low Voc, process sensitivity, and reliability, suggest that the technology may never achieve efficiency-variability-reliability metrics comparable to inorganic solar cells. This encourages a reconsideration of the prospect of Single semiconductor OPV (SS-OPV), a system presumably doomed by the exciton bottleneck.

In this talk, we use an inverted SS-OPV to demonstrate how the historical SS-OPV experiments may have been misinterpreted. No one disputes the signature of excitons in polymer under narrowband excitation, but our experiments show that exciton dissociation need not be a bottleneck for OPV under broadband solar illumination. We demonstrate that an alternate collection-limited theory consistently interprets the classical and new experiments, resolves puzzles such as efficiency loss with increasing light intensity, and voltage-dependent reverse photo-current, etc. The theory and experiments suggest a new 'perovkite-like' strategy to efficiency-variability-reliability of organic solar cells.

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1:30 PM
SMITH HALL 111
REFRESHMENTS: 1:15 PM – SMITH HALL LOBBY