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Device modeling for organic solar cells[1] LUNMEI HUANG, ROBERT KRASNY, Department of Mathematics, University of Michigan, KYLE RENSHAW, Department of Physics, University of Michigan, STEPHEN FORREST, Department of Physics, Department of Electrical Engineering and Computer Science, and Materials Science and Engineering, University of Michigan — Organic solar cells (OSCs) are expected to play an important role in addressing our future energy needs due to their low cost and low processing requirements compared to inorganic solar cells (ISCs). However the efficiency of OSCs is still too low in comparison with ISCs for widespread applications. The biggest loss of quantum efficiency (QE) in OSCs is due to the limited free carrier generation occurring at the donor-acceptor (D-A) interface. Excitons (bound electron-hole pairs) are generated in the bulk by photo-absorption, but only a portion of them reach the D-A interface where they can dissociate into free charge carriers. Therefore, better understanding and control of exciton diffusion, free carrier generation and recombination are critical in order to improve QE for OSCs. To elucidate the physics of OSCs and aid in experimental studies, we developed a drift-diffusion model to describe the dynamics of excitons and free charge carriers. Our model predicts the performance of OSC devices by calculating their QE and current-voltage curves (I-V), as well as many other important physical quantities, such as the internal electric field, and the concentration and flux of excitons and free carriers. The effect of exciton and free carrier mobility, device temperature, and layer thickness, will be discussed. Furthermore, the exciton dissociation mechanism widely described by Onsager's model, will be investigated in detail.

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