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The role of interfacial electronic landscapes in converting light to charge in organic photovoltaic materials

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Organic semiconductors offer advantages for photovoltaic devices, yet their entry into the clean energy market has been limited to niche applications, largely hampered by low efficiencies compared to competing technologies. As excitonic solar cells, the generation of electrical energy occurs only when the optically generated bound electron-hole pair is separated into free charges, usually at an interface between an acceptor and donor material. This energetic landscape at interfaces drives exciton separation but also gives rise to loss pathways and is crucial to device function: the interface is the device. To gain a molecular-scale picture of the energetic landscapes that drive charge separation at organic heterojunctions, we have applied low-temperature scanning tunneling microscopy, scanning tunneling spectroscopy, and atomic force microscopy to determine the local structure and energy level alignment at interfaces. By examining a variety of interface types and morphologies, we have found that the energies relevant for charge separation and transport are dramatically influenced by the local molecular structure and surroundings. I will describe our work on these different types of junctions and the influence of the local electrostatic environment on these energetic landscapes.