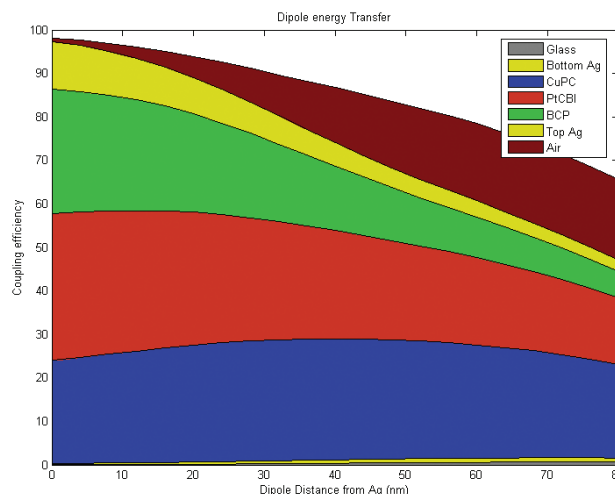
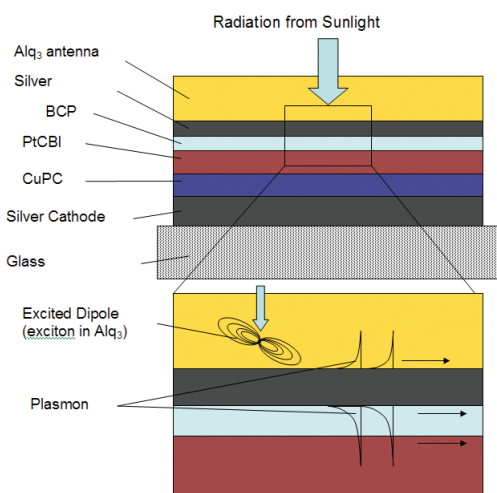


Optical Models of Organic Photovoltaic Cells

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Common organic photovoltaic devices utilize a direct energy transfer from sunlight to the excitons in the active layers. However, this direct transfer results in a trade-off between the absorption and charge generation by exciton diffusion to the interface [1]. Our group has recently demonstrated a separation of these two processes by absorbing the sunlight in an external antenna and then reemitting the energy in a near-field fashion so that very large exponential fields become possible in the active layers (Figure 1). Calculating the effect of this reemission needs near-field methods since

the thicknesses are on the order of the vacuum wavelength of the corresponding emission frequency. To solve this problem, we extend a previously established dyadic Green's functions model [2] to calculate the z-component of the Poynting vector, thus find the spatial absorption of the antenna reemission throughout the multilayer stack (Figure 2). Using these calculations we calculate optimum layer thicknesses for maximum efficiencies. Future work in modeling will concentrate on far-field emission for OLED outcoupling studies and collective dipole behavior.



▲ Figure 1: Working principle of the organic PVs with external antennas. Energy is first absorbed by the excitons in the antenna and then these excited excitons transfer their energy to the excitons in the active layers (PtCBI & CuPC) mainly through surface plasmon polariton modes. Structure used is Air/ 800Alq₃/ 80Ag/ 100BCP/ 180PtCBI/ 240CuPC/ 400Ag/ Glass (thicknesses are in Angstroms).

▲ Figure 2: Percentage of power transferred from the excitons in the antenna to different layers in the structure of Figure 1 as a function of exciton distance from the Alq₃-Ag interface. White space on the top shows internal damping in the Alq₃ molecules. As the exciton distance from silver film increases efficiency decreases due to the reduction in plasmon coupling.

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