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Limits of Plasmonic Nanoparticle Enhancement in Solution-Processed Solar Cells EBUKA ARINZE, BOTONG QIU, GABRIELLE NYIRJESY, SUSANNA THON, Johns Hopkins Univ — Solution-processed solar cells are particularly suited to benefit from plasmonic absorption enhancement due to their transport-limited film thicknesses, and the favorable compatibility of material integration. To date, experimental demonstrations of device enhancements via plasmonic nanoparticle-based strategies have achieved photocurrents that still fall below the theoretical predicted limits. We critically evaluate the prospects for plasmonic enhancements in solution-processed thin-film solar cells. We develop an effective medium model for embedded plasmonic nanostructures in photovoltaic thin films, evaluate the model in the context of previous results achieved in the field, and use the model as a framework for identifying the most promising avenues to realizing plasmonic performance enhancements in practical photovoltaic devices. Our model results indicate that further plasmonic enhancement gains may be possible in organic photovoltaic cells. For achieving maximum photocurrent potential, we identify fine-tuning of the concentration of embedded plasmonic enhancers within the absorbing medium as the crucial factor in achieving a balance between useful scattering and detrimental parasitic absorption losses.

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