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Nanophotonic interactions between organic excitons and plasmonic metasurfaces

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Thin-film organic semiconductor materials are emerging as energy-efficient, versatile alternatives to inorganic semiconductors for display and solid-state lighting applications. Additionally, thin-film organic laser and photovoltaic technologies, while not yet competitive with inorganic semiconductor-based analogues, can exhibit small device embodied energies (due to comparatively low temperature and low energy-use fabrication processes) which is of interest for reducing overall device cost. To improve energy conversion efficiency in thin-film organic optoelectronics, light management using nanophotonic structures is necessary. Here, our recent work on improving light trapping and light extraction in organic semiconductor thin films using nanostructured silver plasmonic metasurfaces will be presented [1,2]. Numerous optical phenomena, such as absorption induced scattering, out-of-plane waveguiding and morphology-dependent surface plasmon outcoupling, are identified due to exciton-plasmon coupling between the organic semiconductor and the metasurface. Ways in which these phenomena can be controlled and optimized for particular optoelectronic applications will be presented. Work done in collaboration with C. Petoukhoff and Z. Shen. [1] C. E. Petoukhoff, D. M. O'Carroll, Absorption-Induced Scattering and Surface Plasmon Out-Coupling from Absorber-Coated Plasmonic Metasurfaces. Nat. Commun. 6, 7899-1-13 (2015). [2] Z. Shen, D. M. O'Carroll, Nanoporous Silver Thin Films: Multifunctional Platforms for Influencing Chain Morphology and Optical Properties of Conjugated Polymers. Adv. Funct. Mater. 25, 3302-3313 (2015).