Plenary Talk PV II Mon 9:15 HSZ 01

Plasmonics: Photons at the Nanoscale Yield Physics, Metamaterials, and Devices — •Harry A. Atwater — Thomas J. Watson Laboratories of Applied Physics, California Institute of Technology MS 128-95, Pasadena, CA

Plasmonics is a rapidly emerging photonics discipline that enables unusual dispersion engineering and mode localization, and which is having an impact in the development of metamaterials and active nanophotonic devices. Dispersion control and active materials integration have yielded plasmonic components, including i) three-dimensional single layer plasmonic metamaterials ii) all-optical, electro-optic and field effect modulation of plasmon propagation iii) plasmon-enhanced absorption in solar cells. We expand upon recently re-ported work on direct observation of two-dimensional negative refraction in the visible fre-quency range to develop a general approach to realization of three-dimensional single-layer, all-angle, polarization-independent plasmonic metamaterials exhibiting negative refraction. Full wave simulations and dispersion calculations are used to demonstrate that metal-dielectric-metal plasmonic structures are characterized by negative wave vectors and negative refractive indices. Metal-dielectric plasmon waveguides can serve as active switching elements when the dielectric refractive index can be actively modulated. We demonstrate elec-tro-optic refractive index modulation in metal-dielectric-metal plasmon waveguides using low-voltage electro-optic modulation of both silicon and perovskite oxide dielectric layers. The efficiency and cost effectiveness of photovoltaic cells can both be increased by reduction of the active semiconductor absorber layer thickness and ability to fabricate ultrathin absorber layers opens up new possibilities for solar cell device design. The strong mode localization of surface plasmon polaritons at metal-dielectric interfaces leads to strong absorption in semi-conductors thin films, enabling a dramatic reduction in the semiconductor absorber physical thickness needed to achieve an optically thick film. Modal analysis in full wave simulation allows us to determine the fraction of power absorbed by the solar cell for both dielectric and plasmonic modes.