Recent advances in nanofabrication technology have enabled unprecedented control over the behavior of light at the nanoscale, allowing us to construct novel material architectures with precisely-tailored optical properties. In this talk, I will present three different nanostructured materials and their applications in solar energy conversion. Firstly, I will discuss self-assembled surface nanotextures with sub-50 nm feature sizes that can impart broadband and omni-directional antireflection to polished silicon surfaces. By implementing the theoretically-optimal refractive index taper in dense arrays of nanoscale cones, we are able to reduce surface reflections from silicon solar cells to less than 1% over the entire visible spectrum, even at large angles of incidence. Secondly, I will describe how creating such antireflective nanotextures on both the front and rear surfaces of a glass slide results in extremely high transmission ( > 99.6 %), which renders the glass practically invisible. Glass treated in this manner provides an immediate benefit for a solar cell encapsulation layer that does not degrade the device performance. Finally, I will demonstrate that, by harnessing the excitation of surface plasmons in nanostructured metal films, we can construct material architectures that are simultaneously optically transparent and electrically conducting, out-performing indium tin oxide as a material for solar cell electrical contacts.

Andreas C. Liapis
Brookhaven National Laboratory, Upton, N.Y.

Nanophotonics for energy applications: black silicon, invisible glass, and transparent metals