The ultimate success of photovoltaic (PV) cell technology requires great advancements in both cost reduction and efficiency improvement. Advanced light management, including both anti-reflection and light trapping, is essential for such a success. Anti-reflection ensures that all incident sunlight can enter the solar cell. While efficient light trapping allows one to use an active semiconductor layer that is much thinner than the material’s intrinsic absorption length. This then reduces the amount of materials used in PV cells, which cuts cell cost in general. In addition, light trapping can improve cell efficiency, since thinner cells provide better collection of photo-generated charge carriers.

In recent years, nanophotonic structures such as plasmonic structures and photonic crystals, where the minimal feature sizes are comparable or even substantially smaller than the wavelength of sunlight, have been extensively explored for light management purposes for solar cell applications. Nanophotonic structures represent an exciting frontier in optics because of the new level of control that such structures provide over the flow of light. Combining advanced nanophotonic structures with novel device physics, we are investigating the most possible ways for both break fundamental physics limitation as well as economic possible.