Plasmonic light trapping for the next generation of solar cells

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Optically driven localised surface plasmons can be excited on sub-wavelength metal particles, which can strongly scatter light and concentrate fields in sub-wavelength volumes. These particles have interesting optical properties: the nanoparticle shape and size and the local dielectric environment determine the wavelength dependent scattering behaviour and the near field distribution. If these particles are fabricated on a high-index substrate, a large fraction of light is scattered into the optically dense medium. This can be exploited to couple incident sunlight into trapped modes in a solar cell, increasing the absorption in the active region.

Plasmonic light trapping is particularly interesting for the next generation of cheap, efficient solar cells. One novel material system attracting attention for optoelectronic devices is solution processed colloidal quantum dots (CQDs). In particular, solar cells fabricated from dense films of PbS CQDs have demonstrated efficiencies of 5-7%, depending on the architecture. However, due to short carrier lifetimes and diffusion lengths, the thickness of the active region is restricted to a few hundred nanometers, resulting in devices that are limited by non-complete absorption. This restriction can be lifted by employing light trapping techniques to increase the absorption in the active layer.

In this talk, I will discuss design considerations for plasmonic light trapping in solar cells and present some recent work on integrating plasmonic nanostructures into colloidal quantum dot devices.