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Near-infrared Harvesting Surfaces Using Gold Nanoplate Thin Films

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Nanoplates are bulk-synthesized metal (typically gold or silver) nanoparticles in the same family as nanorods, core-shell nanoparticles, nanoshells and nanospheres. Recently, we have developed a facile dialysis-based synthesis protocol for producing large amounts of gold nanoplates (GNP) as a stable dispersion. We have demonstrated that changing the reaction temperature, dialysis membrane surface area to reaction volume ratio, and MWCO of the dialysis membrane allows production of nIR GNPs of increased purity compared to other methods and tunability of the LSPR peak to be tailored to a desired wavelength. The GNP can further be modified with polymer coatings such as poly(ethylene glycol) and polyvinylpyrrolidone for compatibility with amine functionalized surfaces. A few of the major advantages of GNPs are their ability to generate intense plasmon fields at the plates' sharp edges, the ability to tune the LSPR wavelength in the near infrared (nIR) region primarily due to plate geometry, and the availability of flat surface area on the particles allowing for increased contact with other surface layers. By exposing GNPs to light with a wavelength that matches the plasmon resonance wavelength of the particle, electron oscillations (plasmons) are launched by the incident light, the particle heats up, and the heat is transferred to the surroundings. Thus, when GNP solutions are dispersed and allowed to dry on a surface, the flat triangular plates orient parallel to the plane and present a large surface area to the incoming light; thereby, increasing the rate of thermal transfer to the substrate. In addition, the GNP can be selectively patterned onto substrates as polymer/GNP composite thin films for specific absorption of different nIR wavelengths on selected areas of the substrate. We are currently developing coatings and techniques for patterning thin films on silica and silicon surfaces to generate surfaces that are capable of strong nIR absorption at multiple discrete wavelengths and will present current applications being explored including energy harvesting and plasmonic induced mechanical actuation.

Keywords: Near-infrared; Gold Nanoplates; Thin film; Energy Harvesting