Harvesting Nonequilibrium Hot Carriers for Carbon Fixation

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Gold nanoparticles have been shown to cleave, form, and activate molecular bonds through the absorption of visible light. This process is associated with localized surface plasmon resonances (LSPRs), which refer to the collective oscillation of electrons when metal nanoparticles interact with electromagnetic radiation of their resonant frequency. In this talk, we discuss plasmonic chemistry and catalysis for the photosynthesis of renewable energy and fuels from carbon species such as carbon dioxide and methane. We will visit how LSPR excitation of gold nanoparticles turns photons into energy-rich chemical bonds in molecules. Upon LSPR excitation, gold nanoparticles generate transient charge carriers with potentials. The LSPR-induced chemical potential serves as free energy for thermodynamically uphill reactions to occur, often resulting in different product distributions via new reaction pathways such as proton-assisted multielectron transfer processes. The free energy contribution of LSPR-induced charge carriers is elucidated along with a combined theoretical and experimental model.