Rationalization of interparticle hot spots in plasmonic photocatalysis

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Upon optical excitation, metal nanoparticles exhibit localized surface plasmon resonances, collective oscillations of the conduction electrons and intense, confined electromagnetic near fields. When applied to drive photochemical transformations, these phenomena can produce new reactivities compared to conventional heterogeneous photocatalysts, notably providing unprecedented control over efficiency and chemical selectivity.

In this seminar, I will discuss how collective plasmonic effects arising in nanoparticle assemblies shape and enhance photocatalytic activity. It will be shown that the rational design of these assemblies amplifies near-field interactions, maximizing photocatalytic performance and enabling entirely new photochemical features. A particular emphasis will be placed on plasmonic supercrystals, which emerge as highly efficient catalytic platforms that outperform their colloidal counterparts due to their uniformly distributed interparticle hot spots, as well as their enhanced structural robustness and recyclability. In a complementary study, it will be demonstrated that chiroptical responses in chiral plasmonic assemblies can be harnessed to induce polarization-dependent reactivity through the asymmetric generation of hot carriers under electromagnetic excitation, opening new directions for the development of advanced photocatalytic and optoelectronic systems. Ongoing efforts in our group are focused on enabling asymmetric photoreactivity driven by plasmonic excitation through the deliberate use of chiroptical effects.