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Plasmonic catalysis: new ways of controlling chemical reactions

ABSTRACT:

Metallic plasmonic nanostructures have emerged as an important class of optically active materials. The initial interest in these materials was based on their nano-antenna properties where these materials concentrate electromagnetic UV-vis fields in small volumes at the surface of the nanostructure. A critical problem with using these metallic materials as nano-antennas is that they lose a significant fraction of electromagnetic energy due to the formation of energetic electron-hole (e-h) pairs in the nanostructures.

There has been a growing realization that the formation of energetic charge carriers in the nanoparticles opens avenues for a number of applications, including photocatalytic chemical conversion, or any application that benefit from conversion of light energy into electric potential or heat. At the core of these applications is the need to control the rate of formation of energetic e-h pairs, the location of their formation, and their flow in the nanostructure. In particular, there has been an elevated degree of interest in using hybrid nanostructures containing plasmonic nanoparticles, where the plasmonic component controls the interaction of light with the material, while the non-plasmonic component uses the resultant energetic carriers to perform a function.

Examples of these materials include metal-metal, metal-semiconductor or metal-molecule hybrids. The use of these multicomponent materials introduces a number of fundamental questions related to the impact of the interface between the plasmonic and non-plasmonic component as well as the presence of the non-plasmonic material on the optical properties of the system, the flow of energy and excited charge carriers in the system.

I will discuss our recent work in the emerging field of hybrid plasmonic materials, focusing on the underlying physical principles that govern the flow of energy and excited charge carriers in these systems, as well as on common misconceptions and fundamental questions that deserve more attention and warrant additional studies.

BIO:

Prof. Linic received his PhD degree, specializing in surface and colloidal chemistry and heterogeneous catalysis, at the University of Delaware in 2003. He was a Max Planck postdoctoral fellow at the Fritz Haber Institute of Max Planck Society in Berlin (Germany), working on first principles studies of surface chemistry. He started his independent faculty career in 2004 at University of Michigan in Ann Arbor where he is currently Martin Lewis Perl professor of chemical engineering and energy systems engineering. He was a Hans Fischer Fellow at Chemistry Department at Technical University, Munich from 2015 to 2019.