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Direct Photocatalysts of Metal Nanoparticle: Not Only Surface Plasmon

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Career Level: Early Career Scientist (<5 yrs post PhD)

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Abstract:

Supported nanoparticles (NPs) of nonplasmonic transition metals (Pd, Pt, Rh, and Ir) are widely used as thermally activated catalysts for the synthesis of important organic compounds, but little is known about their photocatalytic capabilities. We investigated that irradiation with light can significantly enhance the intrinsic catalytic performance of these metal NPs at ambient temperatures for several types of reactions. These metal NPs strongly absorb the light mainly through interband electronic transitions. The excited electrons interact with the reactant molecules on the particles to accelerate these reactions. The rate of the catalyzed reaction depends on the concentration and energy of the excited electrons, which can be increased by increasing the light intensity or by reducing the irradiation wavelength. The metal NPs can also effectively couple thermal and light energy sources to more efficiently drive chemical transformations.

On the basis of the aforementioned findings and previously reported information, we propose tentative mechanisms for the photocatalytic reactions with nonplasmonic metal NPs as catalysts in Figure 1.

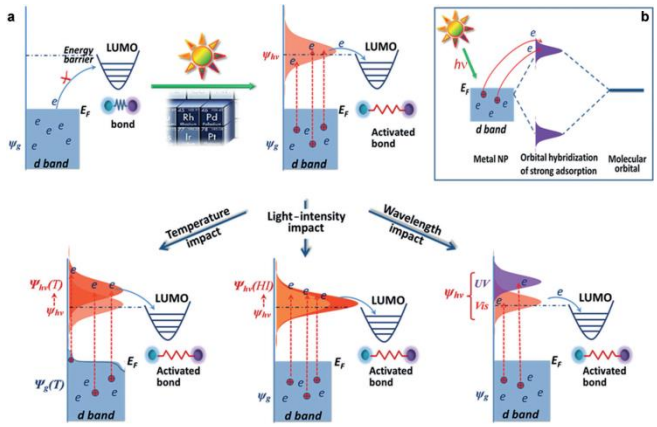

Figure 1. Proposed mechanisms of the photocatalytic reactions with nonplasmonic metal NP photocatalysts. a) Electron transfer cannot occur in the dark at low temperatures, as the energy barriers could be considerably high for physical adsorption or weak chemisorption of the reactant molecules on the NPs. b) In the case of strong chemisorption of reactant molecules on the NPs, the molecular orbitals of the adsorbed reactant interact with the electron states of the d electrons to result in bonding and antibonding orbitals of the adsorbed molecule.

Biographical Statement of speaker:

Dr Sarina achieved PhD in 2013 at Queensland University of Technology.

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