Active and Selective Photocatalysis on Ultrafine Metal Nanoparticles

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The incompatibility of the solar energy and the light absorption band of a chemical bond prevents the use of light to activate the chemical bond for interesting chemical reactions directly. This presentation will focus on a strategy that enables the efficient coupling of photon energy into chemical bonds to selectively promote the desired chemical reactions. The strategy relies on the excitation of hot electrons in ultrafine metal nanoparticles (with size < 10 nm) upon photo-illumination and the following efficient injection of the hot electrons into specific chemical bonds. The redistribution of hot electrons in the chemical bonds dissipates the kinetic energy of hot electrons to the chemical bonds, activating the chemical bonds to promote the target chemical reactions. These sequential processes occur in a confined space, representing a series of quantum transitions, i) optical-to-electronic transition in quantum-sized metal nanoparticles (i.e., hot electron generation), ii) electronic-to-electrical transition at the nanoparticle/adsorbate interface (i.e., hot electron injection) and iii) electrical-to-electronic transition in adsorbate molecules (i.e., chemical bond activation). Selective oxidation of alcohols to aldehydes rather than ketones/acids, a class of important chemical reactions for many industrial processes (e.g., esterification), will be used as an example to highlight the use of ultrafine metal nanoparticles for photo-driven selective chemical transformation on platinum group metal (PMG) nanoparticle catalysts, which do not exhibit strong optical absorption.

Biography:

Yugang Sun is currently an associate professor of chemistry at Temple University. He received his B.S and Ph.D. degree from University of Science and Technology of China (USTC) in 1996 and 2001 respectively. In 2006-2015, Dr. Sun was a research scientistat at Argonne National Laboratory. He received the Presidential Early Career Award for Scientists and Engineers (PECASE) and DOE's Office of Science Early Career Scientist and Engineering Award. He is one of the highly cited materials scientists and chemists. His research focuses on the design/synthesis of functional nanomaterials, the development of in-situ synchrotron x-ray techniques and catalysis.