Photo-catalysis nanostructures for photochemistry

(Suljo Linic, Department of Chemical Engineering, University of Michigan, Ann Arbor, MI)

I will show that composite photo-catalysts combing plasmonic metallic nano-particles of noble metals (Au or Ag) and semiconductor nanostructures (for example TiO2) exhibit significantly improved photo-chemical activity compared to conventional photo-catalytic materials.[1] The critical feature of these composite photo-catalyst is that they couple excellent optical extinction properties of shaped metallic nanostructures (Au or Ag), manifested in the formation of surface plasmons in response to a UV-vis photon flux, and photo-catalytic potential of semiconductors, therefore enabling more efficient conversion of solar flux into electron/hole pairs. The advantage of the composite photo-catalysts will be discussed in the context of photo-catalytic conversion of solar energy into chemical energy of solar fuels by photo-electro-chemical splitting of water to form H2 and O2. I will illustrate how plasmonic metallic nanostructures can concurrently use low intensity visible light and thermal stimuli to drive catalytic reactions at lower temperature than their conventional counterparts that use only thermal stimuli. The results open avenues towards the design of more energy efficient and robust catalytic processes. The experimental findings will be supported by molecular models, developed using first principles approaches, for the photo-chemical transformations on plasmonic nanostructures.

1. S. Linic, P. Christopher, D. B. Ingram, “Plasmonic-metal nanostructures for efficient conversion of solar to chemical energy”, **Nature Materials**, (in press).
2. P. Christopher, H. Xin, S. Linic, Visible light enhanced catalytic oxidation reactions on plasmonic silver nanostructures, **Nature Chemistry,** 3, 467, 2011.
3. D. B. Ingram, P. Christopher, J. Bauer, S. Linic, “Predictive model for the design of plasmonic metal/semiconductor composite photocatalysts”, **ACS Catalysis**., 1, 1441, 2011.
4. D. B. Ingram, S. Linic, ‘Water splitting on composite plasmonic-metal/semiconductor photo-electrodes: Evidence for selective plasmon induced formation of charge carriers near the semiconductor surface”, **Journal of the American Chemical Society,** 133, 5202, 2011