Modulation of hot electron injection in plasmonic photocatalysts through thermal control of interparticle spacing

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Reconfigurable plasmonic assemblies represent a novel class of nano-entities whose chemical and physical properties can be reversibly controlled. In the present work, we introduce a hybrid nanocomposite in which Au nanorods and TiO$_2$ nanoparticles are combined with a thermoresponsive polymer allowing the reversible formation of plasmonic hot spots as a simple means to activate a photocatalytic process. In this manner, a variation in temperature induces a strong modification in the interparticle coupling of the plasmonic component that leads to the activation of the photocatalytic activity of the semiconductor through a hot electron injection mechanism. Interestingly, this feature is fully reversible and can be externally activated, thus leading to a new paradigm in the development of a novel generation of plasmonic photocatalysts.

Figure 1. Representation of the collapse-swelling transition experienced by the Au-TiO$_2$/pNIPAM nanohybrids leading to, (i) the control of the electron injection on TiO$_2$ by tuning the interparticle distance between the semiconductor and the plasmonic material, and (ii) the reversible formation of interparticle hot spots.

References
2- P. Zhan; P. K. Dutta; P. Wang; G. Song; M. Dai; S.-X. Zhao; Z.-G. Wang; P. Yin; W. Zhang; B. Ding; Y. Ke, ACS Nano 11, 1172 (2017).
3- Q. Liu; Y. Cui; D. Gardner; X. Li; S. He; I. I. Smalyukh, Nano Lett. 10, 1347 (2010).

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