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Plasmon-enabled processes: new opportunities in cross-cutting science and emerging technologies

NAOMI HALAS, Rice University

Metallic nanoparticles, used since antiquity to impart intense and vibrant color into materials, have more recently become a central tool in the nanoscale manipulation of light. This interest has led to a virtual explosion of new types of metal-based nanoparticles and nanostructures of various shapes and compositions, and has given rise to new strategies to harvest, control, and manipulate light based on these structures and their properties. By assembling metallic nanoparticles into useful building blocks, a striking parallel between the plasmons of these structures and wave functions of simple quantum systems is universally observed. [1] Clusters of metallic nanoparticles behave like coupled oscillators or antennas, introducing coherent effects such as Fano resonances and electromagnetically induced transparency, originally the domain of atomic physics, into designable, light-driven nanoscale structures. [2] Their unique light-controlling properties can be put to use in a multitude of ways: for generation of hot electrons for color-specific photodetection[3], for photothermal cancer therapy, currently in clinical trials, and most recently, for high-efficiency solar steam generation poised to tackle our planets energy and sustainability challenges.[4-6] [1] E. M. Prodan, C. Radloff, N. J. Halas and P. Nordlander, Science 302, 419-422 (2003). [2] J. A. Fan, K. Bao, J. Bao, R. Bardhan, N. J. Halas, V. N. Manoharan, P. Nordlander, G. Shvets, and F. Capasso, Science 328, 1135-8 (2010). [3] M. W. Knight, H. Sobhani, P. Nordlander, and N. J. Halas, Science 332, 702-4 (2011). [4] O. Neumann, A. S. Urban, J. Day, S. Lal, P. Nordlander, and N. J. Halas, ACS Nano 7, 42-49 (2013). [5] O. Neumann, C. Feronti, A. D. Neumann, A. Dong, K. Schell, B. Lu, E. Kim, M. Quinn, S. Thompson, Nl Grady, P. Nordlander, M. Oden, and N. J. Halas, Proceedings of the National Academy of Sciences, 110, 11677-11681 (2013). [5] N. J. Hogan, A. S. Urban, C. Ayala-Orozco, A. Pimpinelli, P. Nordlander and N. J. Halas, Nano Letters 14, 4640-4645 (2014).