Saturable and Reverse Saturable Scattering of a Single Gold Nanoparticle

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ABSTRACT
Last year, we reported saturable scattering (SS) in an isolated plasmonic nanoparticle for the first time, showing a great potential in bleaching-free superresolution microscopy [1]. Recently, we discovered reverse saturable scattering (RSS) in a single gold nanoparticle (GNP) for the first time. Without any optical or mathematical manipulation, the images corresponding to RSS exhibit extremely fine patterns. In our experiment, a 561-nm laser, which is on resonance with surface plasmon of 80-nm GNP, is adopted. Fig. 1(a) shows that as incident intensity increases, the scattering intensity dependency evolves from linear, to saturation, and to reverse saturation, sequentially. The slope in RSS region is significantly larger than that in linear region, implying its potential for microscopic purpose. Fig. 1(b) shows the RSS image with a ring on the periphery of GNP, and fig. 1(c) demonstrates that the FWHM of the ring is about 40 nm, which is far beyond the diffraction limit.

It is interesting to note that with GNPs, saturable absorption and reverse saturable absorption have been observed [2]. Saturation behavior comes from the depletion of ground state plasmon and reverse saturation behavior origins from excited state absorption or two-photon absorption. Since scattering and absorption correlate with the real part and imaginary part of dielectric constant, similar mechanism can be used to explain the saturation in scattering.