Sharpening Plasmon Resonances in Gold Nanorods

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Although seeded-growth methods have made available to us an extensive library of anisotropic metal nanoparticles [1], the chemical complexity of the growth solution, often involving organic additives [2], and the structural instability of the seeds hinder the quest for high quality products. For the sake of synthetic simplicity, merging different synthetic protocols by finding common growth routes, is a mandatory step to reach a universal growth mechanism and reproducible fabrication.[3] This communication will introduce two recent discoveries, related to improving the optical quality of both pentatwinned and single crystal gold nanorods.

We recently demonstrated that a thermal treatment of small seeds results in extensive twinning and a subsequent drastic yield improvement (>85%) in the formation of different types of pentatwinned nanoparticles, including nanorods, with a high monodispersity and tunable aspect ratio [4].

On the other hand, although single crystal Au nanorods can be readily obtained with very high quality directly from optimized seeded growth methods, polydispersities below 10% are still difficult to reach, which leads to some broadening of the longitudinal LSPR band. We show here that irradiation with a femtosecond laser, at selected conditions of fluence and surfactant concentration, may lead to significant narrowing of the LSPR band, even to the limit of the single particle, as calculated from theoretical models, meaning pure "optical monodispersity".

All together, these results represent a paradigm shift in anisotropic gold nanoparticle synthesis.

References

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[2] A. Sánchez-Iglesias, N. Winckelmans, T. Altantzis, S. Bals, M. Grzelczak, L.M. Liz-Marzán, J. Am. Chem. Soc., 139 (2017) 107

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Figures

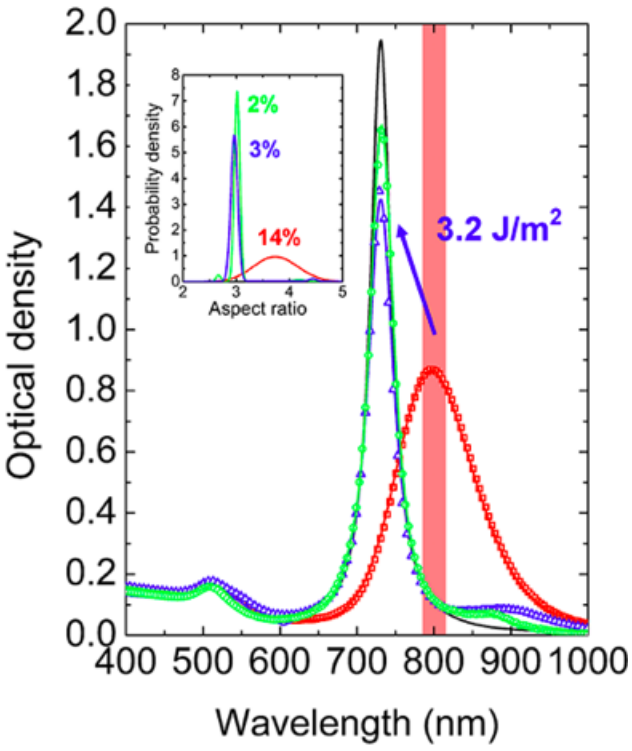

Figure 1: Experimental (symbols) and fitted (lines) optical density spectra of Au nanorod colloids, before (red) and after (blue) irradiation with 800 nm 50-fs laser pulses (represented by the red vertical band) and a fluence of 3.2 J/m2, for 1 h. The normalized spectrum (optical density of 0.15 at 400 nm) of the purified irradiated colloid (green) nearly matches that calculated for a single particle (black). The inset shows the aspect ratio probability densities derived from optical fits.