The grass is green and the nanosilver now too

Advances in nanoscience have been accompanied by improvements in capabilities to deliver compositional and morphological control of matter. Syntheses of Nanocrystals (NCs), where material science elements are addressed with organic chemistry precision techniques, are specially challenging and often difficult to understand, hence to control. This difficulty arises from the increased complexity of the mineralization mechanisms in which molecular precursors are transformed into NCs, along with their strong susceptibility to the reaction kinetics. Therefore, the persisting question is how to correlate the morphological transformations that take place in NCs during the reaction with the number of overlapped fundamental processes and competing reactions that are involved.

Fig. 1. TEM images of Ag nanorods (dark field imaging), a colloidal sample of the Ag nanorods solution and grass.

An interesting case are silver nanowires. There is a strong interest on 1D nanomaterials due to their unique geometry and direct use as a building blocks for their assembly in complex networks of nanostructures, and their optical and magnetic polarization. Among those, Ag nanowires have been largely produced and studied for printable electronics, thermal clothing and photovoltaics. Interestingly, despite the many recipes and produced Ag nanowires, a long outstanding problem has been the lack of control of their morphology translated into the production of very long and polydisperse in length morphologies which limits their use in some applications. Making short monodisperse Ag nanorods (so many times synthesized with Au and CTAB), was never achieved previously. The morphology of NCs determines their physical and chemical properties, especially the optical plasmonic resonance of Ag nanostructures. In order to obtain them we produce the conditions to force anisotropic (1D) growth by promoting the rapid reduction of Ag ions and hence forcing a high supersaturation and a massive nucleation that deplete the reaction mixture of Ag precursor avoiding nanorods to grow into nanowires.

By doing so we succeeded in producing short Ag nanorods which strongly absorb green light. This is significant, since green is the color where the solar energy maximizes photon energy times number of photons (in the sun visible spectra, higher then green energy photons are less abundant and the more abundant ones, in the red zone of the spectra, are low energy). This is why grass (and the rest of plants) are green. This makes this Ag nanorods ideal for nanocrystal-dye sensitize solar cells.

To solve that, we propose a systemic approach to NC synthesis where not just individual recipes but the whole reaction landscape is mapped. By doing so, synthetic pathways leading to a particular successful morphology can be anticipated while unsuccessful results can be understood, thus providing concepts and strategies to address “failed” future syntheses.

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