Colloidal Metal Nanocrystals: Moving from Academic Studies to Industrial Applications

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Although the first documented synthesis of colloidal metal nanocrystals can be traced back to the beautiful work on gold colloids by Michael Faraday in 1856, only within the last decade have methods become available for generating samples with the quality, quantity, and reproducibility needed for a systematic study of their properties as a function of size, shape, and structure, and for exploration of their applications. Of particular importance is to control the shape of colloidal metal nanocrystals, which may initially seem like a scientific curiosity but with implications going far beyond aesthetic appeal. For nanocrystals made of noble metals, the shape determines their chemical, plasmonic, and catalytic properties, as well as their relevance for electronic, photonic and catalytic applications. For more than 20 years, we have been working diligently to understand the nucleation and growth mechanisms leading to the formation of nanocrystals with specific shapes and structures. We have discovered that the shape of metal nanocrystals are dictated by surface capping and the crystallinity and structure of seeds, which are, in turn, controlled by factors such as reduction kinetics and oxidative etching. In this talk, I will discuss some of the recent developments in this field, with a focus on the shape-controlled synthesis of noble-metal nanocrystals under steady-state kinetics. The success of these syntheses has enabled us to tailor the properties of metal nanocrystals for a broad range of applications in photonics, sensing, imaging, medicine, catalysis, and fuel cell technology.