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Silver and Gold Nanostructures: Engineering their Optical Properties for Biomedical Applications.

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We have focused on shape-controlled synthesis of silver and gold nanostructures. While the synthetic methodology mainly involves solution-phase redox chemistry, we have been working diligently to understand the complex physics behind the simple chemistry – that is, the nucleation and growth mechanisms leading to the formation of nanostructures with a specific shape. Polyol synthesis of silver nanostructures provides a good example to illustrate this concept. We discovered that the shape of silver nanostructures were dictated by both the crystallinity and shape of nanocrystallite seeds, which were, in turn, controlled by factors such as reduction rate, oxidative etching, and surface capping. We also exploited the galvanic replacement reaction between silver and chloroauric acid to transform silver nanocubes into gold nanocages with controlled void size, wall thickness, and wall porosity. We were able to engineer the optical properties of resulting gold nanocages with optical resonance peaks ranging from the blue (400 nm) to the near infrared (1200 nm) simply by controlling the molar ratio of silver to chloroauric acid. Thanks to their exceptionally large scattering and absorption coefficients in the transparent window for soft tissues, this novel class of gold nanostructures has great potential emerging as both a contrast agent for optical imaging in early-stage tumor detection, and a therapeutic agent for photothermal cancer treatment.