Control synthesis of Pd nanocubes

via replacement reaction with etching process

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Abstract:

The properties of metal nanostructures are determined by their size, shape, composition, crystallinity and structure. As a noble metal, Pd nanoparticles play an important role in many industrial applications. They serve as the primary catalyst for low temperature reduction of automobile pollutants and for organic reactions, such as Suzuki, Heck, and Stille couplings. The ability to control and fine-tune the shape of Pd nanostructures has been modestly successful but it still remains a grand challenge to deterministically generate a specific shape. Recently, etching process in the presence of polymer has been demonstrated as an effective method of generating Pd cubeoctahedra and twinned nanoparticles. Here we describe a new polymer-free procedure where Pd nanopyramids and nanocubes could be selectively synthesized by manipulating the reduction kinetics of the Cu/Pd(II) replacement reaction with etching process. More specifically, the reduction rate was substantially reduced through the introduction of Fe(III) species and the O_2/Cl^- pair, two wet etchants for Pd(0). The etching power of the O_2/Cl^- pair could be further enhanced by adding an acid to lower the pH of the reaction solution. The experiment displayed the changes of size of Pd nanocubes with pH value and Fe(III) concentration. Concentration of Pd(II), Na(I), Cu(II) and temperature could generate different shapes of Pd nanomaterials.