

Copper-and chloridemediated synthesis and optoelectronic trapping of ultra-high aspect ratio palladium nanowires

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We present a scalable hydrothermal synthesis of one-dimensional palladium nanostructures from palladium(II) chloride precursor, mediated by the introduction of low concentrations of copper(II) ions and/or sodium chloride. Adding Cu at a molar ratio of $\sim 1 : 12\,500$ relative to Pd increases the yield of 1D nanostructures from 10% to 90%. Furthermore, NaCl enhances 1D nanostructure growth such that high yields of long Pd nanowires (PdNWs)—featuring the highest aspect ratios yet reported for solution-grown Pd nanocrystals, with diameters of 20 nm and lengths up to 7 μm —can be achieved in a third of the time required for the synthesis with Cu alone. X-ray diffraction, electron microscopy, and X-ray photoelectron spectroscopy measurements confirm that the as-synthesized nanowires are indeed metallic crystalline Pd with a 5-fold twinned cross-section. It is hypothesized that the Cu ions scavenge oxygen to suppress etching of the twinned Pd seeds that eventually grow into elongated structures, whereas NaCl improves the solubility of PdCl₂ and lowers the reduction rate via formation of the PdCl₄²⁻ complex, promoting diffusional growth. The high aspect ratio of the PdNWs facilitates their manipulation in an optoelectronic tweezers (OET) device, which we demonstrate as a way to enhance their applicability for catalysis and hydrogen sensing.