Controlled Preparation of Tungsten Oxide Nanostructures: Nanoparticles, Nanowires and Hierarchical Structures

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We report a facile one-pot solution-phase route to synthesizing a novel composite hierarchical hollow structure without the requirement of catalysts, surfactants, or templates. The as-prepared products consist of discrete WO_2 hollow core spheres and $W_{18}O_{49}$ nanorod shells (urchin-like structures). SEM and TEM studies suggest the following possible growth mechanism: i) amorphous WO_2 solid spheres are generated under a thermodynamically controlled growth stage; ii) $W_{18}O_{49}$ nanorods are deposited on the surface of WO_2 solid spheres under a kinetically controlled growth stage; iii) the WO_2 core spheres dissolve via inward Ostwald ripening, and the dissolved materials may be recycled into the growing $W_{18}O_{49}$ nanorods, yielding $W_{18}O_{49}/WO_2$ hollow urchins. We also demonstrate that the morphology of the hollow urchins is readily tunable through the control of the reactant concentrations from nanowires to nanoruchins. The hollow urchins show a very high BET surface area, suggesting that they are ideally suited for chemical sensor or effective catalyst applications.