Green synthesis of Fe^0 and bimetallic Fe^0 for oxidative catalysis and reduction applications

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Abstract

A single-step green approach to the synthesis of nanoscale zero valent iron (nZVI) and nanoscale bimetallic (Fe^0/Pd) particles using tea (Camellia sinensis) polyphenols is described. The expedient reaction between polyphenols and ferric chloride ($FeCl_3$) occurs within a minute at room temperature and is indicated by a color change from pale yellow to dark green/black as the iron nanoparticles are formed. Tea polyphenols form complexes with metal ions in solution and reduce them to nanoscale iron. The synthesis of bimetallic catalysts, with $PdCl_2$ acting as a co-metal which coats the outer layer of the nanoscale iron particles, increases both catalytic oxidative and reductive potential for environmental treatment applications. The green synthesis method is general and single and bimetallic catalysts may be extended to other noble metals such as gold (Au) and platinum (Pt). Specific examples using hydrogen peroxide and sodium persulfate to generate free radical oxidant species indicates that these green synthesized nZVI and Fe^0/Pd catalysts provide significantly more efficient contaminant degradation compared to Fe-EDTA and Fe-EDDS.