Synthesis of stereostructured iron phosphate crystals as novel heterogeneous Fenton/ heroxidase like catalyst

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The synthesis of inorganic materials with controllable morphology and structure has gaining expansive research interest due to some fascinating structure and shape dependent properties with respect to applications, especially in catalysis. Iron phosphate compounds are a large family of inorganic materials with good catalytic activity, abundant resources and environmental friendliness. Most importantly, they can be endowed with variety of stereostructure and crystalline structure. These are of great importance for wide application and stable catalytic performance. However, the report on the synthesis of stereostructured iron phosphate crystals is limited and research on developing such material with unique structure as novel heterogeneous catalyst is highly desirable. Herein, two kinds of stereostructured iron phosphate crystals, (single-crystal dendritic iron hydroxyl phosphate $Fe_{1.18}\square_{0.82}(PO_4)(OH)_{0.54}(H_2O)_{0.46}$ (□ representsvacancy) and hierarchical iron hydrogen phosphate $Fe_3H_9(PO_4)_6(H_2O)_6$ consisted of nanosheets) were successfully synthesized through a facile one-step hydrothermal procedure. The products were systematically characterized in terms of morphology, crystal structure and composition. The formation mechanisms for the two unique stereostructured iron phosphate crystals were proposed as self-template process for the former and self-assembly process for the latter with informative evidence. Then, single-crystal dendritic iron hydroxyl phosphate was tested as a heterogeneous Fenton catalyst for the degradation of phenol, which presented numerous advantages including remarkable catalytic activity in a wide pH range (e.g., pH= 3-8), outstanding cycle performance (no observation of activity loss in five runs), and extremely low leaching iron concentration (below 0.5 mg L^{-1}). Moreover, hierarchical iron hydrogen phosphate crystals were first found to own peroxidase-like activity in pure chemically stable iron (III) salt crystals through colormetric reaction of 3,3',5,5'-tetramethylbenzidine (TMB) in the presence of

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H_2O_2. The property was further used for the detection of H_2O_2, which showed particular good reproducibility (RSD= 1.95% for 10 independent measurements), long-term stability (no activity loss after 10 cycles) and easily of recovery (by simple centrifugation).

Keywords: stereostructured morphology; iron phosphate; crystals; Fenton catalysis; peroxidase mimic; hydrothermal method