MASTER'S THESIS

Synthesis and characterization of Prussian red derived microparticles for the heterogeneous photo-fenton oxidation of azo-type textile dyes as pollutants

Lai, Joshua

Date of Award:
2020

Abstract

Inorganic colloidal synthesis, without a doubt, lies at the foundation of many contemporary areas of nanoscience and nanotechnology. At the advent of the 21st century, much progress has been made in the size, shape / morphological control and surface engineering of metal oxides resulting in a diverse library of macroscopic crystal architectures with well-defined surface properties. In this thesis, we start by introducing the self-assembly of the iron(oxy-, hydro-)xide while briefly reviewing some fundamental concepts of solid-state chemistry. Specific information on the family of iron oxide and iron(oxy-, hydro-)xide, as relevant to crystalline phase control, has been highlighted to direct our discussion of the synthesis of diverse crystal morphologies. Furthermore, we briefly underline and discuss the kinetic and thermodynamic control of colloidal crystal morphologies through reasonably established knowledge of anisotropic growth rates in the perspective of iron oxides' facets or crystalline planes. Lastly, we review the state-of-the-art wet chemical synthetic approaches, while using different iron(oxy-, hydro-)xide crystals as examples, for the purpose of explaining our synthetic work of choice.

The main work of this thesis is entirely focused on the "facile synthesis and fine morphological tuning of branched hematite (α-Fe_2O_3) crystals for photodegradation of azo-type dyes". We would discuss the crucial parameters for fine morphological tuning in the context of controlling the anisotropic growth rates of branched α-Fe_2O_3 crystals instead of phase transformation. In our work, we have significantly improved the synthesis of dendritic "*feather-like*" and "*starfish-like*" for their size reduced variants for use in photocatalysis.

Table of Contents

Declaration i
Abstract ii
Acknowledgement iii
Table of Content iv
List of Tables & Figures v

Chapter 1: Introduction 1
1.1 Background of Crystal Structure 1
1.2 Morphological Control of Crystals 7
1.3 Wet Chemical Synthetic Methods 10
1.4 Chemistry of Fenton Oxidation 11
1.5 Expected Findings of Study 13
1.6 Outline of the Thesis 13

Chapter 2: Facile Synthesis & Fine Morphological Tuning of Branched Hematite (α-Fe_2O_3) Crystals for Photodegradation of Azo-Type Dyes 15
2.1 Introduction 15
2.2 Results & Discussion 16
2.3 Experimental Procedure 54
2.4 Summary & Future Work 59

List of References 60
Curriculum Vitae 65