Department of Materials Science and Engineering

Ph.D. Thesis Proposal

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ECE Seminar Room (B302)

Synthesis and Structure Tuning of Quantum-Confined One-Dimensional Lepidocrocite Titanate Nanofilaments

Mohamed A. Ibrahim

Advisor: Prof. Michel W. Barsoum

Abstract

One-dimensional lepidocrocite (1DL) titania nanofilaments (NFs) represent a quantum-confined nanostructure composed of edge-sharing TiO_6 octahedra arranged in a minimal 2 × 2 cross-sectional pattern, resulting in filament widths of ~5 × 7 Å² and an exceptionally high theoretical surface area (~1000 m²/g). Due to this remarkable surface area, the 1DL structure exhibits significantly enhanced adsorption and catalytic properties compared to conventional TiO_2 nanomaterials, making it a promising candidate for advanced applications in environmental remediation, catalysis, and energy conversion. However, current synthesis protocols rely heavily on the toxic reagent tetramethylammonium hydroxide (TMAOH), restricting 1DLs' environmental and biomedical applicability. Moreover, its inherently wide band gap energies, E_g (~ 4 eV), arising from quantum confinement, further limits utility in visible-light-driven photocatalysis. This work systematically addresses these limitations by developing novel synthetic routes involving less toxic quaternary ammonium hydroxides, optimizing colloidal stability in organic solvents, and employing targeted chemical doping and ion intercalation strategies to finely tune electronic, structural, and catalytic properties. Particular emphasis is placed on elucidating how these chemical modifications influence colloidal behavior, E_g engineering, catalytic activity, and overall structural integrity.