DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering

Ph.D. Defense

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Surface Properties, Modifications, and Application of Low-Dimensional Titanates

Adam D. Walter
Advisor: Prof. Michel Barsoum

Abstract

In 2022, the Barsoum group reported on a simple, scalable method to synthesize a new form of titanate nanomaterial; one-dimensional lepidocrocite titanate nanofilaments (1DLs). With only 1 dimension measurable on the nanoscale, and a base unit cross-section of 5x7 $Å^2$ or 2x2 TiO_6 octahedra – 1DLs are truly 1D. As suspected, such extreme dimensionality is accompanied with unique confinement and surface area effects that enable 1DLs with remarkable activity and versatility. Somewhat surprisingly, making them is quite simple: cheap and abundant Ti-containing precursors (borides, carbides, oxysulfate, etc.) are reacted with tetramethylammonium hydroxide (TMAOH) under ambient pressure and at temperatures below water's boiling point for tens of hours and convert them fully to 1DLs. However, the potential does not stop at the synthetic route, as the applications of this material are wide. Since 1DLs are essentially all surface, they easily support applications from adsorption, catalysis, and as battery electrode materials. This defense supports the development of 1DLs from a surface science perspective. Herein, the 1DL surface fundamentals, aggregation, and select surface-driven applications (adsorption and photocatalysis) are discussed in detail.