DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering,

PhD Defense

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Tailoring Perovskite Functionality with Fluoridation Topochemistry

Benjamin M. Lefler
Advisor: Prof. Steven May
Co-Advisor: Prof. Aaron Fafarman

Abstract

Topochemistry is the chemical modification of a material while preserving its crystalline integrity. In instances where bottom-up synthesis of a complex material may be difficult or impossible to control, topochemistry offers a precise route of engineering properties through post-synthesis treatment. My work applies fluoridation topochemistry to perovskite materials for spatial chemical and physical property modifications. Perovskite oxides – with the formula ABO_3 in which *A* tends to be an alkali, alkaline earth, or rare earth metal, and *B* tends to be a transition or post-transition metal – offer a wide variety of tunable optoelectronic and magnetic properties. Lateral structuring of these properties can enable new architectures in oxide-based electronic, magnetic memory, spintronic, and ionic devices. I show that lateral patterning of such properties in perovskite film $SrFeO_3$ can be achieved through spatially defined topochemical modification through reduction/oxidation and fluoridation chemistry by combining vapor topochemistry with photolithography to fabricate laterally-heterostructured films of $SrFeO_3$, reduced $SrFeO_{2.5}$, and fluoridated phase $SrFeO_2F$. I also demonstrate that the chemical stability of $SrFeO_2F$ enables dynamically-control patterned properties through selective reversible redox chemistry of oxide phases. I then apply fluoridation topochemistry to another class of materials, the lead halide perovskites, which are of great interest for next-generation solar cells. Issues in these materials arise from the weak bonding at crystalline surfaces and interfaces. I investigate the hypothesis that translating the motif of strong fluoride bonding to lead halide perovskite films can improve their surface chemistry, and I find that the tunability of fluoridation treatment parameters can optimize the photophysical properties of these materials