Stability and Performance of Cu-doped Sr(Ti,Fe,Ru)O3 Systems

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Jakob working in the Rosen Lab

The Northwestern University – Tel Aviv University Nanoscience and Nanotechnology Initiative Grant which paid for me to travel to Tel Aviv and conduct research in the Brian Rosen Group at Tel Aviv University had a major impact on my research. While the initial plan was for me to travel to Tel Aviv from June 1, 2024 – August 29, 2024, this was unfortunately cut short due to the security situation in Tel Aviv and Israel more broadly, resulting in my return on August 5, 2024. Nevertheless, I continued conducting research for the project I began in Tel Aviv remotely until the end of August.

The initial goal of this project was to investigate the stability and performance of Cu-doped Sr(Ti,Fe,Ni)O3 for solid oxide cell electrode applica- -tions. Based on the evolving research interests of the Rosen group, it was decided in early June to shift to Cu-doping in Sr(Ti,Fe,Ru)O3 systems instead. Due to delays in precursor procurement (likely related to the Israel-Hamas war), a significant portion of my time in Tel Aviv was spent on the synthesis of phase-pure Sr0.95Ti0.2Fe0.65Ru0.05Cu0.1O3-δ in the perovskite phase using atypical precursors. This included wet synthesis of Sr(OH)2 from SrNO3 and other techniques that I have not generally encountered in my work at Northwestern.

Characterization of the synthesized materials was generally conducted via x-ray diffraction (XRD). While this was a technique I have used frequently at Northwestern, I generally only use XRD qualitatively. While in Tel Aviv, I was taught how to use Rietveld Refinement, a quantitative tool for use in XRD. Rietveld refinement can be used to calculate lattice parameters, lattice strain, and phase fractions in XRD patterns. I very frequently work with multi-phase materials where there is a need for characterization of phase evolution. As such, Rietveld refinement will be invaluable in my future research. By the end of my stay in Tel Aviv, I had synthesized a relatively phase-pure perovskite. The synthesis of the relatively pure perovskite allowed for the reduction of the powder to produce a Sr(Ti,Fe)O3 backbone with immiscible Ru and Cu nanoparticles with unique nanostructuring that are stabilized through a process known as exsolution. An initial powder reduction at 700°C for 12 hours was undertaken directly before my departure. XRD and Rietveld refinement showed definitive signs of an elemental Cu phase. At Northwestern, I confirmed this finding through energy dispersive x-ray spectroscopy and scanning transmission electron microscopy. Simultaneously, I undertook efforts to replicate the synthesis of the material synthesized in Tel Aviv using standard techniques I use at Northwestern.

Overall, it was certainly unfortunate that this visit was so significantly affected by the Israel-Hamas war, as well as the escalation of tensions along the Israel-Lebanon border and in the West Bank. Nevertheless, I was able to enjoy my time in Tel Aviv, and take day trips to sites such as Caesarea and the old city in Jerusalem.

Both in the lab and personally, this opportunity has allowed me to grow significantly through new experiences and understanding. Despite my unfortunate and premature return, I believe in many ways I got the most out of this experience and will carry the improved understanding of myself and my research with me as I move forward in my PhD and in my profession beyond.