Reflection Statement

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Our faculty advisor handed six scholarly articles on the magnetic behavior of $HoFeO_3$ crystal, (also called a holmium-based orthoferrite), to his senior research student and asked her to replicate the results in order to test our new lab equipment. Given that the literature said the compound was simple to make, we used the methods described by the papers to purchase and process the chemicals necessary to make the compound. After successfully replicating the results in the literature, we wanted to branch out and do something original. Our advisor suggested that we look into "doping" the base compound, which is the process of substituting portions of the crystal stoichiometry with other atoms, which can change the physical properties of the crystal. We decided to practice doping by again referring to the literature and replicating results for $HoFe_{1-x}Cr_xO_3$ and $HoFe_{1-x}Ni_xO_3$., where x = the doping fraction. Following this success, we realized that our laboratory had a supply of vanadium dioxide, and since vanadium (V) is next to chromium (Cr) on the periodic table, we searched the literature to see if anyone had performed this doping. We were surprised to see that although $HoVO_3$ had been reported on, there was no literature showing doping orthoferrite with vanadium. We were excited to try this.

The first set of papers we had were only the beginning. We still needed more supporting and guiding literature. We found the majority of our papers by looking at the references from the first set of papers handed to us, and the rest we found on Google Scholar. Many times in needing to understand things within a paper, you need to read some of its references, which turn out to be helpful in your research. Due to the fact that

we lack certain journal subscriptions, the Interlibrary Loan was crucial in helping us collect the research literature we needed. Especially since textbooks are limited in the sense that their information is not always the most recent, research articles were crucial in the success of our experiment. Once we had our background knowledge, we proceeded to perform our chemical synthesis and physical characterization measurements. We worked out our stoichiometry, mixed the powders together, baked, and pressed to create a pellet sample. From this sample we proceeded to study the crystal structure using X-ray diffraction, magnetization as a function of temperature, the heat capacity, and the resistivity of our sample. This was an interdisciplinary study at the interface of chemistry and physics. This was a back and forth process between analyzing our data and double-checking the literature, always asking if the results proved that we created a truly new material or if we simply had a mixture of $HoFeO_3$ and an "impurity phase" of unreacted VO_2. The compared results of those two compounds, with our data suggest that our $HoFe_{0.5}V_{0.5}O_3$ really is a new material.

We experienced working as an interdisciplinary science team, and observed how everyone's experience played a role in sculpting the project. We had meetings both on and off campus, worked early morning, late nights, and on weekends. We divided up tasks and the workload both in the literature search and in the laboratory work. We sought outside help when needed, such as library tools, staff in other departments, and other professors. As undergraduates, we were anxious to work in our field of study outside the classroom. By conducting research, we experienced what is like to read up on a topic, conduct our own experiments, and think about what our data was telling us in context of what other people had already reported. We got to work with and create new

knowledge. No one has reported exploring the compound we have, and this material could maybe be used in future magnetic technologies.

Overall we utilized the library resources to find the articles and books that we needed in order to conduct our experiment and measurements. Furthermore, what we learned allowed us to piece together some dots in the pool of knowledge that is condensed matter physics and to conduct our own research in the field. As undergraduates, these resources and experiences are essential for our academic development and advancement. Having full access to these resources, remotely and off-campus, is what allows a student to make that transition to a scholar. We did exactly that in being able to create a new crystal structure.