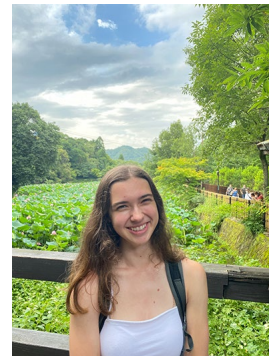


Madison Miller

An interview with 2022 CNF iREU participant, Madison Miller

Madison, please tell us a bit about yourself.

I am a first year PhD student at Vanderbilt University studying interdisciplinary materials science. I graduated in May 2022 with a bachelor's degree in materials science and engineering from the University of Florida. During the summer before my senior year, I had my first research experience working with electrospinning at Georgia Tech for the SENIC REU. I also participated in research at UF during my senior year studying ferroelectric thin films. I am interested in nanofabrication and characterization and am now working in a lab that focuses on metalens optics. I had never been out of the country before the iREU, so it was an exciting opportunity for me!



Thanks. Can you tell us a bit about your iREU research experience?

My iREU was a 10 week summer program at the National Institute for Materials Science (NIMS) in Tsukuba, Japan. My PI was Dr. Takeo Ohsawa, who works with the electroceramics research group at NIMS.

What did your research project entail?

The goal of my research project was to fabricate antiperovskite Ca_3SiO thin films using plasma-assisted molecular beam epitaxy (PA-MBE). Antiperovskites have very narrow, direct bandgaps that allow them to function as near-infrared semiconductors, which are useful in many biomedical and imaging applications. Current materials used for these devices are toxic, so Ca_3SiO would be a great nontoxic alternative. However, thin film fabrication of this material must be improved before it can be implemented in these devices. Throughout my project, I was able to gain experience with a number of techniques besides PA-MBE, including atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), X-ray fluorescence (XRF), and profilometry. Through XRF measurements, I was able to characterize the composition of the thin films I had deposited and determine the Ca/Si ratio to see if the films had the desired stoichiometry. These results showed that the ratio between the Ca and Si pressure used during PA-MBE could be used to tune the Ca/Si composition ratio in the films produced. After conducting XRD on the films, the 3 primary compounds that were formed in the material were Ca_3SiO , Ca_2SiO_4 , and CaSiO_3 . Out of the 20 samples I made, only one showed the Ca_3SiO stoichiometry that we wanted despite multiple samples being made at the same conditions. Future deposition processes can be conducted at different substrate temperatures, Si flux, or different oxygen content to better tune the composition of the final films. Another area of interest is optical and electrical transport characterization for these films.

You lived in Tsukuba for 10 weeks. Can you tell us about the laboratory and your experience living in Tsukuba.

A normal workday at NIMS is typically 9am-5pm, although your PI may be more flexible with the hours you are there. For my project, I had to do a fair amount of equipment training so I worked closely with my PI for the first few weeks as I got familiar with the deposition and characterization processes. Ohsawa-san's group is small, so I worked directly with him rather than a mentor. There are some issues that you will run into, the most major one

probably being that the computers run Windows in Japanese. Most of the software I used had an English option when it started up, but going through file directories and saving things was more difficult at first before I memorized what folders I needed to use or created my own. Both NIMS sites also have a cafeteria where you can eat lunch every day for pretty cheap, and the menu changed regularly. Some groups ate lunch together every day, but I usually ate on my own. I was working at the Namiki site, which was about a 10-15 minute bike ride from Ninomiya House. Ninomiya House was great and the staff there were always helpful if you ran into any issues. There is a bulletin board that they update with any events or things like Japanese classes that they are offering, but there were not many things happening when we were there due to COVID. In general (other than getting through the airport), COVID did not impact too much; masks are generally expected to be worn everywhere. Tsukuba also had lots of good restaurants, my favorites were TonQ for tonkatsu, Takakuramachi Coffee for fluffy pancakes, Kubus Bakery (on the way to Namiki!), and Tonkatsu Wako for katsudon (at Aeon Mall).!



Please tell us about your weekend travel experiences.

Over the course of the summer, I was able to visit many parts of Tokyo and take weekend trips to Kyoto and Osaka. A few of us also took a weekend to visit Tokyo Disneyland and DisneySea. You can get to Tokyo in about an hour taking the Tsukuba Express line, which makes it easy to take day trips on the weekend.



For places like Osaka and Kyoto, getting there is a bit more complicated since you have to take the subway to Tokyo and then transfer to the Shinkansen (Bullet Train--which was super cool). We would split up into smaller groups for the weekend trips and coordinate what we wanted to do/when we wanted to leave before reserving Shinkansen tickets online and booking a hotel. There is a good chance your PI will let you leave early on Friday/take an extra day off if you are traveling for the weekend; they want you to explore Japan too!

Osaka and Kyoto were both fun weekend trips, with the former having Osaka Castle and Universal and the latter having the Imperial Palace, bamboo forest, and Kinkaku-ji (a temple coated in gold). Kyoto has a good bus system that you can take, which is nice because Kyoto is very spread out. We happened to visit Kyoto on the weekend of Gion Matsuri, one of the biggest festivals of the year. It was awesome to see the festival activities and get street food there, although it was very crowded.



In terms of day trips, some of my favorite places in Tokyo were Asakusa, Shibuya, Harajuku, Odaiba, Shinjuku, and Akihabara. Shibuya and Harajuku are very "trendy" parts of Tokyo where you can find just about anything you would like to do, and the street fashion is awesome! Shibuya also has a quieter side with Yoyogi Park and the famous Meiji-Jingu Shrine. Asakusa was a great place for street food and experiencing more traditional Japanese culture with the shrines and street markets there. Akihabara was a super fun place to visit, especially if you are into video games and

anime; there are tons of arcades and hobby stores there. Odaiba was a more laidback area along the water but was beautiful and reminded me a lot of home. There is also a huge Gundam statue at the mall in Odaiba which was cool.

Can you share any overall impressions of your experience?

My experiences in Japan were very influential for me both in my academic and personal life. Being able to see what lab/work culture was like in another country was very interesting and also eye-opening in that it reinforced that science has the ability to transcend language barriers in a way. The fundamentals of how materials behave and how equipment works are understood the same way regardless of what language you speak and drawing a simple diagram can bridge possible gaps in understanding most of the time. I also was able to grow as a more independent researcher and gain a greater depth of knowledge in MBE and antiperovskites specifically, as well as become more well-versed in different types of materials characterization. Socially, this experience was extremely enriching. I loved seeing Japanese traditions and culture by visiting shrines and going to events like the Gion festival in Kyoto. Even smaller experiences stick out in my memory, like going to a restaurant in Ueno where we watched them make soba as we ate. I really enjoyed my time in Japan and would love to go back one day and visit more parts of the country.



Other random comments

I would definitely get a Pasmo card (Subway Debit Card) as soon as you can, it lets you load money onto a card for subway travel instead of having to pay for an individual ticket each time and searching for the station.

The bento boxes at 7-Eleven are a lifesaver on nights you do not feel like going out or cooking, but also you can do EVERYTHING at 7-Eleven. You can print pictures, get cash from ATM, print tickets (ex.: for Disneyland), pay for online orders, and so many other things.

There are so many random events and pop-ups, and the stuff you did not plan on doing can end up being some of the best memories. Giving myself time to wander and explore different parts of Tokyo let me take advantage of that.