Adam Eichhorn

An interview with 2022 CNF iREU participant, Adam Eichhorn

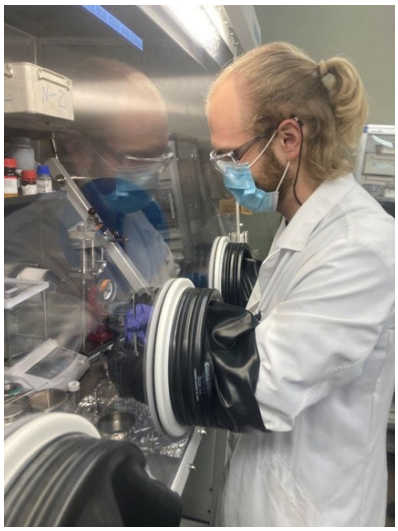
Adam, please tell us a bit about yourself.

I am a senior in Materials Engineering at Iowa State University of Science and Technology, specializing in metals and polymers. I love biking, playing trombone, and cheering on the Cyclones with obscure prop comedy. I participated in an REU at Montana State University in summer '21, in addition to participating in the Bartlett (2020) and Jiang (2021-present) labs at Iowa State during the school year. I am applying to graduate schools this fall, with an interest in nuclear energy research.

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

I attended the Japan iREU from June 1st to August 7th in Tsukuba, Ibaraki with Dr. Takao Mori.

What did your research project entail?



I worked on thermoelectric materials with Onodera-san and Tsujii-san, both of whom had experience working with my exact material, barium germanide clathrate. Thermoelectric materials have the potential to recover wasted heat into usable energy but aren't efficient enough yet to be widely used. I explored the substitution of ytterbium for the barium in the structure for the purpose of decreasing the thermal conductivity. Thermoelectric materials are more effective when heat travels poorly through them.

I synthesized 6 bulk samples of barium germanide with increasing amounts of ytterbium. First, I utilized an arc furnace to melt the base metals into the clathrate structure. Then, I crushed the solidified ingots into a fine powder using a ball mill, which I then sieved by hand down to 1/20th of a millimeter. I used a spark plasma sinter to create my bulk samples, which heated the sample to 840 °C, applied a load to the powder, and ran current through the powder for 30 min to form a small, solid cylinder of material.

The ytterbium substitution was found to be inconsistent, without a clear trend between efficiency and ytterbium content. The thermoelectric measurements for each sample showed high variation between samples. Under a scanning electron microscope, the chemical signature of ytterbium was concentrated in small regions in the microstructure, meaning that secondary phases were forming that sequestered 98% of the ytterbium. In small amounts, these secondary phases reduced thermal conductivity and increased efficiency, but at larger sizes they increased thermal conductivity and reduced efficiency. Further work can be done to identify the secondary phases that form, as well as investigate a similar material the substitutes samarium for the barium in the clathrate structure.

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

My lab was a highly international lab, with PhD students and postdocs from France, India, China, South Korea, Ukraine, Yemen, Azerbaijan, and Russia. We often ate lunch together

in the cafeteria; there were a few meetings at restaurants over the summer, and I was able to practice my final presentation in front of a number of my group members.

The Japanese language is not easy to learn, in my experience. You can learn the basic phrases and verbs enough to understand the important things and be mostly polite, but the grammar structure is completely new, and the kanji are a practice in rote memorization from a huge pool of symbols. I would recommend learning katakana and hiragana, as well as bringing a phrase book, but do not expect to become a master of the language and converse with Japanese native speakers. The people that you work with at NIMS are English fluent and katakana will be sufficient to understand the few important labels not in English, but you will need to use the google translate app with small store owners and most locals. For them, their comfort speaking in English is like an American adult who took Spanish for two years in high school and is trying to converse with a native speaker. They will often pull out their phone and ask you to speak into it or type out your words into the google translate app. The app also has the invaluable camera function, and don't forget that you can draw symbols in it, too (useful for stylized kanji in menus).

Apartment living in Ninomiya house is good; buy laundry detergent in advance of when you need it and wait half a minute or so for the water to heat up when you have the water heater running. The manuals are really helpful, and most interfaces are straightforward. Your neighbors are really kind, and there will probably be a large group chat that you can join to learn about what everyone is getting together and doing.

Please tell us about your weekend travel experiences.

This past summer in Japan, I was able to visit Tokyo, Kyoto, Nara, and Nikko. Two weekends were spent with an overnight in Kyoto, two with an overnight in Tokyo, and one with an overnight in Nikko. Prices were reasonable for hostels, but the Shinkansen is very expensive. Day trips down to Tokyo are easy, affordable, and convenient. My favorite moment of the summer was at the summit of Mt. Tsukuba, watching the mist form as it ascended the mountain. I loved all the food I tried, but I have a special fondness for Okonomiyaki, Albacore tuna, and gyudon. The night life in Kyoto and Tokyo is a lot of fun, with friendly people from all over the world, and it's great to find a hostel within walking distance of the clubs so you can crash the morning after..

Can you share any overall impressions of your experience?

Scientifically, I had an incredible opportunity to work with a well-known leader in the field of thermoelectrics and experience day to day work in a large lab group. My coworkers were years ahead of me in their careers and had very pertinent advice for me and my future. Socially, I learned a lot about Japanese culture, but also realized a lot of my own cultural upbringing and sentiments in the context of a global community. I left Japan with the feeling that people are fundamentally similar in every country, and to really know the differences between places you need firsthand experience. I felt welcomed and appreciated, and I am very thankful to have had this incredible opportunity to learn and grow.