AN INTERVIEW WITH DR. VICTORIA "TORI" MILLER

From left to right, top to bottom: Dr. Victoria Miller, Assistant Professor of Materials Science & Engineering at the University of Florida; Dr. Jonathan Bennett, BSS Faculty Advisor; Melody Lee, BSS Editor-In-Chief; Linden James, BSS Editor-In-Chief; Jane Shin, 2023 BSS Essay Contest Winner; Allison Zhang, BSS Publication Editor-In-Chief;

Hello! Thank you so much for joining us today – can you introduce yourself?

Sure! So, my name is Victoria, or Tori, Miller, and I am currently an assistant professor at the University of Florida in the Department of Materials Science and Engineering.

I joke that what I do is I heat and I squish metal – that's my research: I study how you manufacture things out of metal, how we can manufacture things more efficiently out of metal, and how we can use metal and make metals stronger.

That's pretty cool! You also direct the Monster Research Lab, what is a typical day like?

It depends whether you're asking you about me or about my students! I love it all – I love my job, but my students get to have the real fun.

So my job is mostly mentoring PhD students. Right now I've got eight PhD students that I directly supervise, and then a number of other PhD students where I'm on their graduate committees, but the students do all the real work. They go in the lab, they might do mechanical testing, or run heat treatments, or go use electron microscopes, so that's lots of fun. A lot of what I do is coming up with new ideas for what is going to be the next project, planning for a couple years down the line, and I write proposals to try to get the funding to do those projects.

What inspired you to pursue material science, specifically, recrystallization in texture development?

I had decided that I was going to pursue material science, and more specifically metallurgy material science, when I was roughly a sophomore in high school. I was very lucky, I went to this Eisenman Material Science summer camp. They bring you to Materials Park, Ohio – which is the headquarters of one of my main professional societies – with all of these experts, and you do failure analysis investigations. We did a week-long failure analysis investigation of a piece of railroad steel, where the rail had broken on a train and derailed, and we figured out what went wrong. I absolutely loved it.

I decided then and there that I was going to be a metallurgist, and then I went in, and I did it. As far as to why I study recrystallization and texture development, I think that that was a happy accident. My very first job when I was in high school was at Ford Motor Company. My boss had me working on a magnesium project. One of the big challenges in the magnesium field has to do with recrystallization and texture development, so it was the first problem I was ever introduced to and it seemed to go well so I stayed with it.

Speaking of these opportunities, including traveling to different places and experiencing different things, you very recently visited Japan for the Japanese Institute of Materials Conference. What was that like? What was something interesting you learned during that?

That was a wonderful trip. The trip was sponsored by one of my professional societies – it was part of a Young Leaders International Scholar Award. I represented the professional society– The Minerals, Metals, and Materials Society (TMS) – at the Japan Institute of Materials (JM) fall meeting, and then JM also sent a representative to the TMS spring meeting.

It was an absolutely wonderful trip, but five days was not enough time to get over the jetlag (laughs). In terms of stuff that I learned, I got to see some absolutely incredible processing facilities. So I visited Kumamoto University, which was wonderful. They have a magnesium research center that is world leading and have really unique facilities for making magnesium ribbon for extruding magnesium, a lot of facilities that just don't exist in the United States. I was really excited, and I'm hoping that I can collaborate with them in the future.

It seems like you had an amazing experience at the conference! You published a research paper, "Nucleation of recrystallization in magnesium alloy grains of varied orientation and the impacts on texture evolution" just this past year. Could you summarize this research for us in layperson's terms?

I think the place to start is with the fact that metals and most materials are anisotropic. That is, they have different properties based on the direction of observation. The really classic example of this would be a popsicle stick: if you pull it along the grains, it's much stronger than if you pull across the grains. So, it turns out that metals might have a microscopic texture. When I say texture, I mean anisotropic, like that popsicle stick. What we discovered is that when you process the material, some grains with certain rotations, or orientations, evolve faster than other grains, especially depending on the temperature you heat treat it at. So when you heat treat the metal at high temperatures, everything goes at about the same speed. When you heat treat at low temperature, certain grains grow much faster than other grains, so you get undesirable properties. The big takeaway was that we might be able to improve the properties of magnesium alloys if we choose different temperatures to heat treat them at.

Speaking of making research more accessible, you won the National Science Foundation Career Award and American Society for Metals Bronze Medal over these last few years for your work turning your research into educational outreach kits for younger children, including middle school students. Why did you decide to turn your attention towards these students?

I've always been, you know, a very hands-on person, despite the fact that I became an academic. I wasn't necessarily that great in the classroom, but I was good at playing with experiments and building things. So I know personally how important it is to have hands-on activities and concrete things to play with. I was also able to discover my passion for material science really early. I'm hoping that if we expose more students to the concept of material science earlier and earlier, then maybe we'll be able to grow the field even more, because right now, material science and engineering is a lot smaller than, say, mechanical or aerospace engineering.

So you've done a lot of research throughout your career, what are some challenges you've faced while researching? And how do you overcome them?

I can tell you about a challenge that we're facing right now. What happens when your research approach flat out does not work? It has been a really humbling experience, because things have gone wrong before, but it's never been catastrophic where, no, it just doesn't work at all. It's been a lot of sitting and thinking and collaborating and trying to come up with new approaches. The thing that is most important for me, at least with science, is sitting and talking about it with other scientific or engineering peers, getting different perspectives, figuring out, you know, new approaches, because eventually, you're going to run into some problem where your original approach is just completely wrong.

Even when you are faced with these difficulties, it is clear you have the motivation to continue working at the problems. Were there any individuals or women in STEM who really inspired you to get to work towards where you are now?

It wasn't necessarily a female scientist in the industry. It was really some high school teachers, Mrs. Miller and Mrs. Hensley. They always asked me to go a step further than I probably would have gone on my own. For instance, Mrs. Miller told me that I should take AP Physics instead of regular physics, even though I technically didn't have the prerequisites for it. And Mrs. Hensley is the person that told me about this material science camp that I went to.

I found both of them to be wonderful role models, and just very inspiring. Actually, I am still in touch with Mrs. Hensley – we keep in touch on Facebook, and I nominated her for an award last year. So it's great. Now her daughter, who was just just a little kid when I was one of Mrs. Hensley students, is now about to graduate high school. It's crazy how time passes!

You have worked in so many places in both academia and industry – which was your favorite and why?

I'm going to cheat a little bit and say two, because the first one is what I do now. I can not imagine a more interesting job than what I do right now. Whenever I have ideas, I get to go and chase them down – I just need to find some funding to make it happen. I love that aspect of my job.

As far as other places that I've worked, my first job at Ford was completely unbeatable. I loved it in particular because I had a wonderful boss and mentor, James Boileau. When I was working at Ford, I was 16, and working with James was the first time that I had someone treat me like an adult with a job. That was really life changing, because suddenly, I was a professional and not just some teenager. The day to day work was really interesting, because it was all new to me. I got to see a new problem every day, and sometimes the problem was that, "Oh, these bolts are cracking, can you figure out why?" Sometimes the problem was, "How do we take these photos of the microscale structure of metals, and make quantitative measurements of them?" And sometimes it was, "Take this greasy car part and clean it off and figure out where the crack is." Every day was something different, and every day was learning something new. It was just a very positive environment to work in.

So from taking greasy car parts and washing them, to publishing research on interesting metallurgy concepts, you've probably been around a lot of new ideas and had some of your own. We're wondering, what do you think will be the next big advancement in the field of crystalline materials, structural evolution, and metallurgy research?

I'm most excited about the volume of data that we can now generate and the new tools we have for manipulating that data, including things like bringing machine learning and artificial intelligence into these sort of big data streams. Now, electronic storage is relatively inexpensive, so you can put temperature probes at 12 different places within your furnace and collect temperature over time for all these different locations, all while making sure every single heat treatment of your metal is exactly the same. Similarly, the new electron microscopy tools are absolutely remarkable. They are generating terabytes of data every few minutes, and the amount of data you can generate is absolutely remarkable and more than what any human alone could process. I'm excited about the new ways to get these large amounts of data and the new ways to handle large amounts of data.

Here's a more fun question! What is your favorite alloy to work with?

I personally love magnesium alloys, just because they were the first metal I ever worked on. In truth, they're really kind of challenging to do hands-on work with and kind of a pain, honestly, because magnesium really wants to form an oxide. If you're trying to keep it as a metal because you study metals, and it's Florida and it's really humid, it just forms an oxide. Then you polish the oxide off, and it forms an oxide again, and it's very annoying. Regardless, magnesium research was my first research passion, so I still love it. Now, in terms of what I would want to work with every day, if I had to do the hands on work myself, I choose nickel, because nickel is nice and well-behaved and doesn't want a terrible oxide (laughs).

What do you enjoy doing outside of the lab?

I have two main hobbies. One of them is that I compete in powerlifting! I lift weights (powerlifting is benchpress, squats, and deadlifts), so I love doing that constantly at my home gym. The other thing that I enjoy is I crochet. I really like making little stuffed animals for people. Sometimes it's an animal, sometimes it's a Pokemon, and sometimes it's a video game character. They're all sorts of fun!

We're talking right at the start of 2023! Do you have any goals or hopes for this year?

One of the things I'm looking forward to for 2023 is that my very first PhD student is graduating! I am so proud of him, because his undergraduate GPA was not great, but he was a brilliant researcher. People told me that I was taking a risk when I hired him, but I thought he was going to be awesome, and he is awesome. I am absolutely hoping for the best for him in his new job at the Naval Surface Warfare Center! As far as other things I'm hoping for in 2023, I just hope my dog will stop jumping so much. I'm still working on getting him to behave because he is three years old and still has puppy energy. I'm hoping I can get him to calm down a little bit during 2023!

From hearing you talk about your first PhD student graduating, it is clear you really do care about your students and about young people who are interested in pursuing material science. Our final question is this: do you have any advice for students interested in material science and engineering?

I think the best advice I could give would be to learn about professional societies, and that goes for a lot of different sorts of STEM fields. There will be professional societies, and they have college scholarships, they have summer camps, they have outreach events, and they've got all sorts of stuff going on. While I think professional societies do a really good job gathering resources, sometimes they don't do the best job of actually finding the students that want those resources. If students are interested and are proactive, they can go to the professional societies website and see what scholarships are offered or maybe send an email. There are a massive amount of resources that are out there that can help you get into the degree program, into the job, or into the internship that you want. The resources are there – it's just a problem of matching the resources to the people that want to use what is available.