Image Credit: Deb Grove

LVEM 25 User Profile: Dr. Kate Plass

We recently talked with **Dr. Kate Plass**, Associate Professor of Chemistry at Franklin & Marshall College. Dr. Plass has been a user of the Delong LVEM 25 for three years, won an NSF grant to fund the purchase of the instrument as a regional resource, and published work utilizing the LVEM 25. Inspired to working on earth abundant solar energy converting materials, one of Dr. Plass's recent publications illustrates how ion exchange reactions with copper sulfide nanorods enable rational design of nanoparticle synthesis approaches for heterogeneous materials, with research performed by undergraduate students. The following interview has been edited for clarity.

Hi Dr. Plass. I'm excited to learn more about you, your research, and how you've used the LVEM 25. To start, can you please tell our readers a little bit about yourself?

I have been at Franklin & Marshall College since 2008 doing research with undergraduate students. Before that, I was a postdoc with Dr. Nate Lewis at Cal Tech, studying silicon surface chemistry. Prior to that, I earned my PhD at the University of Michigan using scanning tunneling microscopy to study how molecules absorb to graphite substrates and form patterns.

I saw in a press release you won an NSF grant to help purchase this instrument. Can you tell me about it, and what winning the grant has meant for your research?

When I first got to Franklin & Marshall, they had an old TEM on campus, given to them used in 1996. It required film to capture images, and eventually it was too old to get service support anymore. Realizing having a TEM is critical for my research, I began to research options. When I found out about benchtop TEMs, I became really excited. This excitement led me to write a grant, even initially thinking the grant might not work out, and it got funded!

One of the important points in the grant is the instrument serves as a regional resource to other small colleges. Each summer, different groups come and use the instrument, including professors and their students.

People typically drive an hour or two, from other Primarily Undergraduate Institutions (PUIs). Having the instrument creates lower cost and closer access to TEM than what is available at larger research universities in the region. For these groups, they value that students can run the data collection because the instrument is so easy to use.

Why did you choose to purchase a LVEM 25?

I was really looking for something robust. I would often go to Penn State, for example, where they have lots of TEMs. Their instruments are highly complex, and you have to have a service contract because they will break multiple times a year. Recognizing up front the facts that we are a small school, I do not have time to maintain a TEM myself, there are not resources available to have a technician maintain a TEM full-time, and my undergraduates have to be able to use this. I was really looking for robustness in an instrument that undergrads could use, not abuse, nearly continuously. The instrument is so robust, we just had our first repair after 3 years of heavy use.

You recently published a paper titled "Effects of I_2 on $Cu_{2-x}S$ Nanoparticles: Enabling Cation Exchange but Complicating Plasmonics." Can you briefly describe that work, and how LVEM 25 helped in your research?

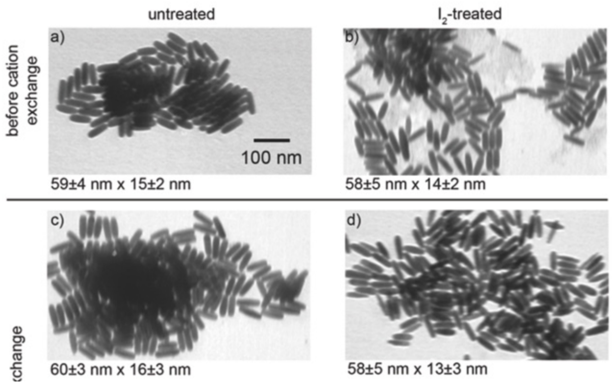
This project idea builds on our group's experience making these CuS nanoparticles (NPs). One of the things that's really cool about these NPs is that it is relatively easy to pull out the copper and put something else in its place. In this way, you can get partially exchanged particles that retain the shape and the size of the rods while opening up a range of different chemistries. For example, along the rod you could have stripes of ZnS, or perhaps you could attach blocks of CdS. You could exchange Co or Mn or In and Ga, enabling you to make a CuInS NP. As a starting material for cation exchange, it's a really versatile material.

Cation exchange itself is a really interesting method to develop rational synthesis approaches for NPs. It advances the field from the early approaches of combining many materials in a single reaction and hoping to get the desired product want.

What are other ways you utilize the LVEM 25 in your research?

When developing methods for rational synthesis, if you want to be able to prove that a reaction mechanism was due to cation exchange, you've got to monitor the size and shape of the particles. This means every step along the way you've got to do TEM.

For our last paper, we were investigating whether an oxidation step can accelerate cation exchange. This required TEM images of samples before treatment, after treatment and after cation exchange. For every sample set, we had to get that full combination. This project just wouldn't be possible if we didn't have ready access to TEM, in a way that students could do it and we can afford it. We just couldn't do the work if we had to pay for all that TEM at an outside facility.



TEM of Cu1.8S nanorods synthesized by Dr. Plass's group. (Le, 2020)

What inspired you about this work in the beginning?

Solar energy. When I first came to Franklin and Marshall, I was interested in continuing solar energy research and tailoring the research to the resources available. Materials like copper sulfide are wonderful light absorbers, but it turns out they only work if you have just the right phase and optical properties. My early entry into this field was understanding how to control the phase and optical properties of copper sulfide as an earth abundant solar energy converter. Over the years, as we have become skilled at synthesizing these materials, we've meandered into the materials science questions of how you control these materials with cation exchange reactions.

I love the inspiration of working on "earth abundant solar energy converting materials." I'm curious about where did you decide to place the instrument, and how hard was the site prep?

We have a departmental shared instrument lab, and TEM is in there. The setup and site prep were really easy. We cleared some other instruments, moved other things around and it worked out fine. The technician who visited to perform the installation was great, and went through degassing to get it up and running. As the owner, we only needed to provide a power outlet. Another benefit was that it doesn't have to be basement or require vibrational isolation; we're on third floor and we can image 5nm particles.

How many users in your group are trained on the LVEM 25? Is this a shared resource for other researchers at your institution?

In normal times, we have 5 undergraduates fully trained in my group, plus a couple others from collaborator groups. During COVID we are limited to 2 students. My group is limited by physical space, or we would have more students.

Every student in my group gets trained. Typically, other collaborators in the department will have one student trained as the primary TEM user for their group, and visiting groups in the summer bring as many as 3 students who all take turns operating the instrument.

What is some mentoring advice you'd like to give to early career women in STEM?

My advice is to consider it your job to be appropriately assertive. Early on, I read some data that revealed many of the disparities on pay, and success in general, between men and women really came down to what you asked for. Reflecting on that, I decided to make it a personal policy that if I want something, I will ask for it. I will try not to worry too much about, "Am I going to get it?" Sometimes I have conversations with colleagues and they might say things like "oh, the likelihood of getting this grant is pretty low" or "oh, you're going up for this promotion early, do you think you're going to get it." I ignore those questions, and tell myself, "I don't care if I'm going to get it, I'm going to ask for it."

Taking that attitude is against my personality, since I'm not generally an assertive or demanding type of person. This is something I had to teach myself, recognizing it feels uncomfortable but I'm going to do it. I've been benefited in so many ways that I wouldn't have predicted. Take for example the TEM grant, I was absolutely convinced that there was no way I was going to win that grant. Then I wrote it anyway because I wanted that TEM, and it ended up that I got it.

Ignore that pessimist in yourself and ask for what you want. I really believe it, and I've seen it work personally, and with other people. We all have that doubting voice in our heads.

The good thing about just making it a policy to ask for what you want is you can stop worrying about if you're good enough. You don't have to ask yourself that anymore, just 'do I want this?'

That is really good. And depending on who you are as a person you have to really practice that skill.

Yes! It really is something you have to practice, and that's something I try to emphasize with my students, "Yes, I know that doesn't feel good and normal and what you're used to, it's a skill."

That's really great advice! What is something you would like to say to someone considering purchasing an LVEM 25?

For me, a big issue when considering the purchase of the instrument was how quickly are students going to be able to use this without me watching them? In short, the answer is it has been great.

We have developed a system where students can be trained and working independently as fast as a few days, depending on their scheduling. The new students first shadow another trained student at least once, then have two or three 1-on-1 trainings with me including one when I shadow them on sample exchange and microscope operation. After the new student operates it one more time with another trained student shadowing, then they are good to go independently! This training system is fast, and it works well because the instrument is very robust. Students go from afraid of breaking the vacuum to confidently operating the system very quickly, and we've only 3 vacuum breaks in over 3 years with only undergraduate students operating the instrument independently.

That is wonderful advice, and a testament to the robustness of the LVEM 25! Thank you Dr. Plass for taking the time to share your stories about your exciting research and how the LVEM 25 is a powerful enabling tool.

References:

Le HK, Xiong H, Page BA, Garcia-Herrera LF, McAllister HP, Li BC, Wang H, Plass KE. Effects of I_2 on $Cu_{2-x}S$ Nanoparticles: Enabling Cation Exchange but Complicating Plasmonics. ACS Materials Letters. 2020 Jan 2;2(2):140–6.

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About the author:

Robert I. MacCuspie, Ph.D., has over twenty years of experience in nanotechnology and materials characterization. Career highlights include leading the team that developed the silver nanoparticle reference materials at the National Institute of Standards and Technology, the first faculty and Director of Nanotechnology and Multifunctional Materials Program at Florida Polytechnic University, and over five years of consulting at the business-science interface from MacCuspie Innovations, helping companies commercialize and educate on technologies to improve human health.