

## CERAMIC TECH CHAT

Episode 21

Title – “Holistic academia—teaching, research, mentoring: Beth Dickey (E21)”

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### INTRO

De Guire: “I’m Eileen De Guire, and this is Ceramic Tech Chat.

Being a professor requires you to wear many hats, including being a teacher, a researcher, a mentor, possibly more. How does a person balance all the responsibilities that come with this position?”

Dickey: “I think one of the things that I certainly advise newer faculty on and try to do myself is to be as synergistic as possible between the different facets of the job. And also choosing things that I enjoy doing and, again, where I feel like I can uniquely contribute.”

De Guire: “That’s Beth Dickey, this year’s president of The American Ceramic Society. She is the Teddy & Wilton Hawkins Distinguished Professor of materials science and engineering at Carnegie Mellon University and also the chair of the department. Beth’s research focuses on the use of electron microscopy to understand the microstructure and properties of ceramic materials, such as ferroelectrics. She has been very active as well working to attract and retain the next generation of materials scientists through various methods, including incorporating data science into university materials science curricula, developing new faculty mentorship programs, and in a variety of leadership roles in The American Ceramic Society.

As we begin navigating a third year of the COVID-19 pandemic, how does Beth plan to continue and expand on her goals?”

(music)

### SECTION 1

De Guire: “So, let’s talk a little bit about your origin story. How did you find your way to ceramic engineering?”

Dickey: “So I grew up in central Kentucky and knew nothing about materials science and engineering, let alone ceramics and glass. My father trained horses. That was a big part of my life growing up. But my mother was in nursing. So, yeah, actually, engineering is pretty new to my family.”

De Guire: “Well, that’s great.”

Dickey: “So I was first introduced just to the area of materials science and engineering during high school. I was very fortunate that the University of Kentucky had programs with my public high school where they interacted with our physics and our chemistry classes in the high school. And really through outreach events from the university I first got exposed to materials science and engineering, and through that exposure ended up choosing that as my major when I went to college. And, I did go to the University of Kentucky and got my bachelor’s degree from there, and got enamored with the discipline, and it’s clearly stuck with me through my entire career.

A very eventful, I think, moment, and influential thing that I did was after my freshman year in college, I went to Oakridge National Laboratory and did an internship there in what was the high-temperature materials lab, HTML. And there was a very sizable ceramics group at that time, and there still is a lot of ceramic activity. At that time in the late 80s, it was focused on high-temperature ceramics for ceramic engines and those sorts of things. So that was really my first exposure to this specific discipline.”

De Guire: “Okay. When you started off, did you anticipate you would go as far as a PhD?”

Dickey: “No. I am the first PhD in at least my close family. So, it was not something that I had thought about specifically. It was probably junior year of undergraduate school that I started to think about what I was going to do next. And I was enjoying learning and was, you know, inclined to go to graduate school, so I started exploring graduate school opportunities and chose that path and went to Northwestern University for my PhD. And so then, I continued to be involved actually in ceramics during my PhD, and that’s when I became first a member of The American Ceramic Society, was as a graduate student.”

De Guire: “Great. What was your PhD subject?”

Dickey: “So, I studied ceramic composites but was very focused on characterizing interfaces in those composites. So, really I think my expertise is in electron microscopy because electron microscopy, specifically transmission electron microscopy, lends itself well to studying things like grain boundary and interfacial phenomena. That’s where I’ve kind of married my expertise in microscopy with ceramic science. A lot of what I do is very much focused on defects in materials and understanding structure and chemistry of those defects, things like grain boundaries and interfaces, and then connecting that to properties of those interfaces.”

De Guire: “I think a lot of your work right now is also in the area of electroceramics. And so, how did you get interested in the electroceramics? From the High-Temperature Materials Lab to the composites to electrical ceramic seems like a kind of unusual pathway.”

Dickey: “So I became increasingly involved in electroceramics as a faculty member. And in particular, I spent 10 years in my career at Penn State University on the faculty there. And there is a large emphasis on electroceramics at that university, and so through collaborations with colleagues there, my research became more focused and directed on electronic ceramics. I still work in that area quite a bit. So, dielectric materials used for

applications like capacitors or electrostatic energy storage devices for a number of applications is where I've focused my most recent efforts. And it's been a great community that I've connected with, both academic community and industry community. So, I felt like I've been able to bring some unique contributions to the research and development of those types of materials. Again, that's very connected to electron microscopy and being able to understand chemistry, chemical segregation to grain boundaries, even smaller length scales, understanding where dopants go in the crystalline lattice and being able to measure issues or phenomena, such as a segregation of those dopants, and most recently, connecting that local chemistry to local atomic structure and also local polarization."

De Guire: "What are some of the bigger industrial challenges that exist in the electroceramics area, like dielectrics, that academics are working to help solve?"

Dickey: "There's several trends, one of which is miniaturization. So, a lot of these materials are used in electronic devices and commercial electronic devices or aerospace where there's definitely a driving force to miniaturize things. And some of the physics starts to get very different when you get to very small length scales, and that is something that the community is trying to understand. Also, the processing can become quite different and challenging as you miniaturize devices. So, there's significant processing science that's going on and how you do things and make devices at much smaller length scales.

So, those are a couple of large challenges I think that face the industry. And we try to contribute, from my perspective, very fundamental science and understanding that helps guide thinking in the engineering of those materials."

De Guire: "You've also been of the leaders in identifying the role of data science in materials science, and I think you had a program when you were at North Carolina State University in that area. So, can you talk a little bit about this emerging role and need for materials scientists to understand how to work with data?"

Dickey: "Yeah, this is...even though my background is not in data sciences, certainly I recognized, I think it's about six years ago when I wrote this proposal to the National Science Foundation to develop a traineeship program that brought together materials scientists with applied mathematicians and statisticians to really think about how we do teach students in materials science and engineering, ceramic science and engineering, about the data sciences and how it influences what they do.

And some of the motivations for that were that data is a lot more freely available. And that can be at the academic level where you're using state-of-the-art microscopes or diffractometers or beam sources, let's say the Advanced Photon Source, where you're just generating very large volumes of data. And so, you need a certain level skill set just to be able to handle that data and to know how to analyze it and extract useful information from it. But even in industry, right now, we can put sensors on things and be collecting data at a very high rate and making the most use of that data to inform us on quality control or process control, a number of issues.

So, it's a growing trend, and I think that having basic data science and statistics skills is part of the toolkit that we need to have as material scientists. So, integrating those concepts into our curriculum at both the undergraduate and graduate level is really quite important. And, you have to do that in a really efficient way because you can't just keep adding classes and years on to the curriculum. Fortunately, even at my current institution at Carnegie Mellon University, there's I think broad recognition of the significance of this issue and there's a lot of innovative educators and leaders who are really changing and modernizing the curriculum for students, and I think it's quite important."

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## SECTION 2

De Guire: "So how did you choose a career in academia? Had you anticipated that?"

Dickey: "It wasn't completely by chance, and actually, I usually give this advice to graduate students who are a bit unsure about what they want to do for the next step in their career. I tried to always just keep my options open. As a graduate student, I definitely tried to inform myself about what the options were for a career, and actually that's where The American Ceramic Society was quite helpful, because it gave me a way to engage with not only other academics but industry, you know, primarily through the meetings.

So, I didn't have a definitive idea of exactly what I wanted to do after graduate school. I was actually planning on doing a postdoc, and I got an email from the dean of the College of Engineering at the University of Kentucky where I did my undergraduate studies telling me that there was a faculty position open and I should apply for it. So, it was a little bit by chance that that happened. I thought, 'Well, I'll apply. It will be a good exercise. I'll learn a lot from it. And then maybe after I do my postdoc, I'll come back and do it for real.' Well, I ended up getting an offer for the position. What to do? So, I decided it was a smart thing to take the offer, so I did, and I started my academic career back at my alma mater at University of Kentucky and spent four years there.

It was great. It really helped launch my academic career. So, it wasn't designed to happen that way, but it did, and, you know, again, I think it's positioning yourself to take advantage of what opportunities come your way is kind of how I've navigated my career."

De Guire: "So I've heard you speak in other venues about the importance of mentors, mentors you've had. Can you talk a little bit about what mentoring has meant to you, how you've benefited from it, and then how you pass that forward as a mentor yourself to other people that are part of your life?"

Dickey: "Yeah. I certainly have benefited from a number of people. There's the more obvious mentors, who are your teachers or your dissertation advisors, who are clearly, part of their responsibility is to help not just advise you but to mentor you. And I've had many, many informal mentors over the years that pop up in different places. Some of them through The

American Ceramic Society. Some through even personal connections that maybe aren't in our discipline, but they may be leaders in different technology spaces. But you just get to know them and you develop relationships with them and can learn things from them.

So, I view mentoring as kind of a network thing. There's not just one specific person. I think need to be cognizant of who actually is in your mentor network, because if you think about who's influencing you and who you're learning from, if you step back, you kind of see that there's a large group of people probably that are in some way helping you and mentoring you. So, I try to be aware of and thankful for those people who have influenced my career. On the other side of things, I work to try to be a good mentor with undergraduate students, graduate students as a whole. I've had some opportunities in my career to provide leadership at the departmental level for the entire graduate student body. And that's been great, you know, where you get 100 PhD students and serve as a resource for them. And certainly, my own PhD advisees, there you really have an opportunity for a lot of hands-on mentoring of those students. But I also am very open to and encourage people who may be at other institutions, young faculty for sure, to know that I'm a resource for them if they need advice on particular things. So, I've tried to serve in that role myself personally.

But also, through The American Ceramic Society, I think we have an opportunity to do a lot more around mentoring. There's a lot with our students, and a very robust mentoring program with the PCSA [President's Council of Student Advisors]. But, as you know, part of the strategic plan moving forward is to really provide more opportunities for mentoring through people's careers, not just as they're students but as they're young professionals or mid-career professionals. And I think connecting people, and The American Ceramic Society playing an active role in connecting people through mentor-mentee programs, is really important, and one of the things that we'll be working on this next year in particular."

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BREAK

De Guire: "ACerS Mentor Programs aim to connect members in an impactful way to help them grow personally and professionally. ACerS currently offers a mentorship program aimed at students and also a new program aimed at young faculty. Learn more at [www.ceramics.org/mentorship](http://www.ceramics.org/mentorship)."

SECTION 3

De Guire: "So how did you first hear about The American Ceramic Society?"

Dickey: "So, I became a member in graduate school, and I can remember my first meeting, actually, professional meeting was as at an American Ceramic Society meeting, and I think it was in Cincinnati, Ohio, if I'm remembering correctly. But I had done internships before then, at Oak Ridge National Lab, and worked with a couple of different ceramics

groups there. And they were all very involved in The American Ceramic Society, and I knew that it was important to them. And actually, I do remember at my first meeting at The American Ceramic Society as a graduate student seeing the people that I had interned with at Oakridge National Lab and being able to reconnect with them. And I think that was my first realization, is that the meetings themselves are that connection point. So, people that you meet in the industry or in academia from all over the world, there's this focal point at the meetings where you actually get to see them and talk to them and network in person, and that's really important."

De Guire: "So you are the incoming ACerS president, and you already mentioned one of the goals that relates to the strategic plan. So, why don't we talk a little bit now about what your goals are for your presidential year?"

Dickey: "Yeah, I think one of the largest objectives is to continue to work with the staff and the Executive Committee and the Board of Directors to make sure that the Society stays and remains operationally and financially healthy as we go through another year of having to adapt what we do in the Society and be responsive to what's happening with the global pandemic. We've done a great job over the last year, and the Society is extremely healthy, but I think we're still learning from that experience and probably still going to be reacting to certain situations that come up through the year that we can't predict. Fortunately, we've got a great group of people who now have experienced navigating these issues and being pretty nimble. So, I have to recognize that we will most likely still be spending time thinking and navigating through the rest of the pandemic.

Then the next big goal is to move from the strategic planning process that we've spent the last year on, and hopefully many of our members who may be listening participated in that process, and operationalizing that and really putting into action that strategic plan and also monitoring our progress. So, we're going to think a lot over the next couple months about connecting with our Division leaders and our Section leaders on how to implement the strategic plan and then think about what data we want to monitor to assess how effective we're being in the strategic plan.

So, broadly speaking, the strategic plan first has goals about increasing membership and membership engagement, so that we are connecting with everyone who could really benefit from being part of the Society and who should be having a voice in what we're doing in education, research & development, and manufacturing around glass and in ceramic materials. We also, and I know you've very involved in this, Eileen, in developing programming and content that really meets industry's needs. I think one of the strengths of The American Ceramic Society is it really brings together academic research and education with industry, and it's a super important interface between those two communities, and that's a real strength of the Society. And so, meeting the needs of industry, but also calling on industry to help, getting back to mentorship, help having them play a role in mentoring our students and our young professionals and being involved in their professional development.

A third focus area of the strategic plan is to expand our global culture of inclusion. We've placed a lot of emphasis on diversity, equity, and inclusion and really making sure that that is being addressed at all levels of the Society. So we're going to continue to make sure that best practices are well integrated throughout the structure of the Society. And another initiative that we started this year that we want to continue is to partner with other organizations, especially minority serving organizations and institutions, so that we're working with them and supporting them and, hopefully, attracting new people into our community.

Educational programs is another important key area, and you've led the effort, Eileen, over this past year to really develop and enhance our online learning program and that has been a great success. Industry certainly has taken advantage of it. I have taken advantage of it with my students. And there's I think a real need in the community to have more content and learning opportunities around ceramic and glass. That's going to be a growing effort in this coming year and from then on.

And then finally working with the Ceramic and Glass Industry Foundation is another goal of the strategic plan. To work with them to bring in the newest people into our community and just broadly increasing the awareness of the importance of glass and ceramic industry to this country and to the world, and to attract new people into the profession.

Part of that will be taking advantage of the fact that 2022 is the International Year of Glass, as designated by the UN. That is a real opportunity for us to share with the very broadest community what glass science, engineering, and art does for us and to share that and teach, you know, people about what we do in glass and glass-ceramics."

De Guire: "Right. And this is the first time that the United Nations' year designation has been for a material. So, even beyond glass, it really draws attention to materials science and engineering that, you know, we can engineer materials for certain applications, and they have huge impacts on how we live. So, I think it's even bigger than glass."

Dickey: "Yeah, absolutely. And the opportunity to share with people the real science and engineering behind something that they're familiar with on a daily basis but may not have an appreciation for all of the engineering that goes into designing glass for a specific product. That's what's really, I think, I'd say even magical about what we do, is all of the science and engineering that goes behind even a product that may seem fairly mundane, it's fairly remarkable, and I think sharing that with people will be enlightening for a lot of people."

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## CONCLUSION

De Guire: "While many jobs can require that you wear multiple hats, identifying the areas that you enjoy and where you can uniquely contribute can help you to make the most of the opportunities.

I'm Eileen De Guire, and this is Ceramic Tech Chat.”

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Until next time, I'm Eileen De Guire, and thank you for joining us.”