CERAMIC TECH CHAT

Episode 30

Title – "Exploring space and the future of travel: Valerie Wiesner (E30)"

INTRO

McDonald: "I'm Lisa McDonald, and this is Ceramic Tech Chat.

> It has been more than 50 years since we first went from staring at the stars to placing foot among them on the moon. Even today the work done at NASA continues to inspire children's curiosity."

Wiesner: "So I always like to have the disclaimer that you don't have to know you want to work for NASA at an early age because there are plenty of people who end up at NASA who didn't expect to.

> I always have wanted work for NASA."

McDonald: "That's Valerie Wiesner, research materials engineer at the Advanced Materials and Processing Branch of the NASA Langley Research Center in Hampton, Virginia. This summer, she served in a temporary position as acting assistant branch head of the Crew Systems and Aviation Operations Branch at Langley.

> While astronauts have some of the most public-facing roles at NASA, what other research takes place behind the scenes to make launching into space possible? And what can we likely expect from space exploration and travel in the coming years?"

> (music)

SECTION 1

Wiesner: "So, I'm one of those people who, even as a kid, always wanted to work for NASA. Absolutely mystified and fascinated by a lot of the amazing space exploration that's taking place at the agency and even really in the world. So, I've always been a big NASA enthusiast.

> What's interesting though is I kind of didn't anticipate the ceramics as a child. And so I really fully anticipated going more into astrophysics. I was a big stargazer and still am, I still really enjoy that as a hobby. And so I went into undergrad with the intent of being a astrophysics-focused physics major. And I was, but, you know, by chance I applied to a variety of summer internship opportunities and just happened to land one in materials out of my freshman year. And, looking back, you kind of see some of those decisions you take and you realize, 'Whoa, that actually did have a huge impact.' Little did I know at the

time, right? And so that internship happened to be at Purdue University in high-temperature ceramics for hypersonics and reentry vehicles more so. And so really, that's where I realized, 'Oh, there's a completely different field out there I'd never heard of or even really considered.'

That being said, though, I was right out of my freshman year. And so I was like, 'Well, I'm gonna still try out this astro stuff and see where it takes me.' And, you know, with time, I was fortunate to be able to work with some amazing researchers in astronomy for several years, basically, for almost three years of my undergraduate work. Though I couldn't shake the materials bug, if you will. So after my junior year, I took another materials-centered internship, and that really I'd say kind of made me realize, 'Yeah, materials is definitely the track I want to take to help enable a lot of the technologies at the time, and even now still that are relevant to NASA.' And so that's kind of how I ended up taking the materials route more so."

McDonald: "So after you finished your undergrad, what did you end up doing?"

Wiesner: "Yeah, so, I decided I wanted to go to grad school, and I wanted to do ceramics. I am a planner by nature, so I needed a backup plan in case I didn't get into grad school. And plus, I really enjoy learning languages. I'm part Japanese, so my mom is half Japanese and was actually born in Japan, and so we have extended family there, and I'd always had an interest in the language. And so I was able to study abroad as an undergraduate first semester at Waseda University in Tokyo, Japan. And then I decided, 'Well, if grad school doesn't work out, I'd sure like to go back to Japan and spend more time.' And there's an English teaching program through the Japanese Ministry of Education, the JET program. And so I applied to that kind of thinking, 'Well, that would be still really fun to do like if grad school doesn't pan out me making the jump.' Because at the time I was a physics major going into materials, wasn't sure how that was going to pan out.

But I was really lucky that I got grad school offers, and I got an offer to teach in Japan. And so I ended up, thankfully at Purdue, the department and the professors were really supportive of me taking that time off. And so I was able to take kind of like a gap year almost in between undergrad and graduate school to go teach English in Japan and work as a translator as well. I was in a suburb of Tokyo, Japan, working with elementary through high school students and the community with English language activities. And it was just an amazing, amazing experience. Not necessarily ceramics, but just, you know, a very, very powerful experience in my life. And one thing, what is kind of interesting, even though I was, you know, teaching English, what it helped me really realize was that yeah, research is definitely what I'm interested, in coupled with education.

And so I think bringing that full circle to where I am now, I'm really fortunate to be able to participate in outreach events still, and I use a lot of those skills, if you will, that I developed as an English language teacher to connect with K through 12 audiences."

McDonald: "What do you think some of those skills are that you've been able to take from that into your current career at NASA?"

Wiesner: “Oh yeah, that’s a really good question. I’d say being adaptable and flexible in any situation that comes at you. As a teacher in, you know, or just acclimating in another country, right? Different culture. You will be challenged in a good way and learn so much about how people approach problems and just life in general. And so I think a lot of that flexibility has helped me when it comes to work that if something happens, especially in research, as a lot of us know, right? If something comes up, sometimes you gotta roll with it and come up with a solution. And I think living abroad and teaching abroad and working with folks from different backgrounds really helped me exercise that muscle, if you will, and it’s one I regularly use today too still.”

McDonald: “So with that flexibility that you developed during your teaching English years, how has that allowed you to take on this new summer position that you’re doing right now? And tell me a bit more about how that opportunity came to be.”

Wiesner: “Yeah, definitely need a lot of flexibility and, you know, being adaptable to a lot of different situations that come your way as an assistant branch head, which is basically a supervisory role at NASA. And so, personally, I’ve always identified more as a technical person, as a researcher. And so it’s kind of, it fascinates me even still to realize, ‘Oh wow, yeah, I did kind of test the waters in a different area to really stretch myself.’ But at NASA we’re lucky that we have the opportunity to take on details, is what we usually call them. They’re basically little tours of duty, if you will, that allow us to almost try out different positions. So, for right now, I’m kind of backfilling, filling in for someone who is on a different detail in a different position. And, so, it gives me the chance to kind of explore and see what that role would actually be like by taking it on. And the nice thing, it usually has like a set amount of time, like a finite end date. So at the end, it’s like, ‘Okay, cool, I get to go back to my regular job regardless of how things turn out,’ right? And in a good case, maybe it’s something I’ll want to consider in the future. Or I can stick with research, that kind of thing. So that’s kind of the beauty of the detail.

And so, with my supervisor I’d say for research, we’ve been talking about different professional development opportunities, and I said, ‘I’m open, I’m open.’ And I think that’s kind of maybe the underlying theme of a lot of my career is being open to different opportunities. Like I said, with materials as a physics major, I didn’t really anticipate knowing where that was going to go. And similar with this, I just try to keep an open mind. And when a detail position came up, I was like, ‘Yeah, I think now, it could be, it could be a good time to try it out.’ And so, interviewed and rest is history, right?

In this role, it’s been really valuable because I’m actually in a completely different branch. It’s still researchers, but it’s not materials at all. So it’s a lot of folks doing more research related to human factors with pilot design studies and integrating future airspace concepts with unmanned aerial vehicles, those kinds of things. So it’s a completely different area, and it’s been really rewarding to learn about all of the different research outside of materials that’s taking place at NASA and specifically in aeronautics; it’s not necessarily space related. So it’s been a really eye opening and a really great experience that’s enabled me to become a lot more flexible in working with different teams.”

McDonald: “That’s just a fantastic opportunity that you’re able to do these details at NASA. So many people, you know, you start a job and that’s the job that you do, but these details allow you to actually almost get like summer breaks to explore and build on your skill sets.”

Wiesner: “Yeah, and it just so happened that mine lined up with the summer. It’s four months long. They can be any duration, any time of year, they can be multiyear for some people, depending. So they’re really great opportunities for folks to kind of try on different roles and, you know, learn some more and stretch a bit.”

(music)

SECTION 2

McDonald: “So when you are doing research, what are you studying?”

Wiesner: “Yeah, so, the beauty of materials is that they make up everything, right? And so I feel really fortunate that where I am at NASA, I work on materials for a variety of different applications. My research focuses primarily around developing and understanding materials degradation in extreme environments. And so when I say extreme environments, that could be anything from, you know, hypersonic reentry vehicle to a rover or some sort of vehicle for a lunar and planetary surface operations. So, in aerospace, there’s a lot of different areas we can play in.

The research I can speak to here with respect to some of the lunar applications we’re looking at right now, there’s a big push, obviously, hopefully folks have heard, we’re going back to the moon! Hopefully pretty soon with our Artemis 1 launch. And so it will be, with the Artemis missions, we’ve got a commitment to return to the moon in a sustainable way. And, you know, we haven’t been back there for a long time, so technology and materials have advanced quite a bit.

And so some of my research centers on identifying new materials technology specifically within ceramics that could offer benefit in those future missions. And specifically, lunar dust is a major problem that can really hinder a lot of the surface operations, whether it’s landing on the surface, establishing a human habitat. The dust is everywhere. It basically coats the moon, and coupled with being under vacuum, and being exposed to UV radiation from the sun, among other things, there are a lot of interesting and really damaging effects that can come from the interactions with lunar surface dust.

So, one of the areas, specifically a team I’ve been working with, has targeted looking at mitigation strategies to help minimize the impact of lunar dust on different material surfaces. And there’s a variety of different approaches you can take. One in particular we’re looking at specifically for ceramics is kind of leveraging some of the lesser… So, it’s fun, in my role I work with a lot of nonceramicists. So when folks might initially hear about ceramics, they’re like, ‘Wait, those? You can do what with those now?’ The ones

specifically for, you know, that we use on Earth for mining like for drill bits, body armor even, depending on the application. Part of our activity is really exploring some of these already developed ceramic systems on Earth and seeing if there might be utility in using them, say, on the moon.

So, we've been exploring different ceramic-based coatings that offer wear resistance or abrasion resistance, really, against that lunar dust to try to figure out, 'Hey, can we the improve that performance and ultimately the life and durability of a lot of the components that we have operating to enable our sustainable human presence on the moon?'"

McDonald: "That's just fascinating, being able to not just look up into the sky anymore, but the fact that we're able to launch ourselves up there and actually walk on these things that used to just be far up in the sky."

Wiesner: "Right? Fingers crossed for going back, and hopefully we'll be able to do that pretty soon."

McDonald: "So, of course, even though we are able to launch ourselves up to the moon, it's not a very easy process. So, how are we able to simulate the moon or lunar environments here on Earth to test if the materials are going to work before we get there?"

Wiesner: "That is an amazing question that we are currently endeavoring to resolve, especially on the materials side. So, actually we have a new effort we're standing up this coming fall for the next year or so to develop more testing methods. Because really, to vet these materials, it'd be great if we could send them to the moon surface and see how they perform. And in some cases, we actually are. We do have a payload coming up 2024, 2025, I can't remember right now. But we do have some materials we're sending up to expose to the lunar environment. But, you know, the turnaround time is long and so, as you mentioned, testing these on Earth is very critical before we can really send them up, even for preliminary testing.

So, a lot of the approaches we take are pretty classic materials testing approaches. We look at the mechanical properties, so we're using a variety of ASTM standards that are out there, ranging from Taber abrasion and even just mechanical properties, getting a sense of will they perform as we want them to. Microstructure, one of my favorites. We of course look at the microstructure to understand to, of course, some of those, what we'd like. So, I should take a step back. When it comes to like the microstructure, for example, there are a variety of ways when it comes to developing coatings you can get different microstructures. So figuring out is there some that lend themselves better to helping minimize adhesion by lunar dust. So, with the surface, adhesion properties, and so that's another factor we're considering. We have a unique, what we call the lunar sonic one dust test, basically, where we kind of evaluate how much dust sticks to a surface of particular material. And so we can kind of estimate, you know, what kind of adhesion forces there could be and hopefully identify material that dust doesn't really want to stick to. But that being the case there are other considerations we have to take into fact. The environment of the moon. The thermal, like the spread basically. It can range from plus 175°C-ish to

minus that, really, negative. So there's a really large temperature swing that takes place depending on if you're in the sun side or if you're in the shaded side. Depending on time. And so, with that, there's a wealth of opportunity to come up with new tasks that will help us subject materials to more representative environments.

And so, that's kind of where we're going with one of the activities I'm a part of. To develop a chamber that's going to allow us to selectively introduce lunar dust because that's the major one. Also, thermal gradient, UV radiation is another big one, and all under vacuum since the moon does not have an atmosphere, so it's basically exposed to the vacuum of space. That is a test that we are currently working. With that, there are obviously a variety of other approaches that can be taken. And so we're hoping with a lot of the work we're doing now, it'll lay the groundwork for a lot more of these really important tests that will be needed to further along a lot of these materials technologies."

McDonald: "But I know you've mentioned that, like you said, a lot of the focus for some of the moon research is on that lunar dust, how do you overcome the lunar dust. I've also heard some reports in the news that Mars, another planet that we're very interested in, has a lot of dust there as well. So, is some of that research, I guess, similar that might be developed for the lunar dust applicable to what's happening for Mars missions?"

Wiesner: "Definitely, yeah. So the approach really that I think our whole agency is taking is the moon is kind of a proving ground for a lot of the technology development that we'll employ ultimately on Mars. And so you really hit the nail on the head there with that observation, because there are, as many similarities as there are between lunar dust and Martian dust, a lot of the designs that we're coming up with are going to be relevant to those missions as well going forward. There of course are some compositional differences with Martian versus lunar regolith. But that being said, a lot of the basic ideas that we're trying to vet and utilize fully on the lunar surface, the intent is to be able to apply those to Martian exploration as well."

McDonald: "That's exciting that we basically got a built-in testing ground right next door to us that we can use for those longer out planetary travels for in the future."

Wiesner: "Definitely. The moon's a little bit shorter of a trip for us, thankfully. Just a couple or few days depending on orbit compared to, you know, months or better part of a year, really, for Mars, though. We got to take advantage of our nearby lunar neighbor."

McDonald: "Do you have any views on like the future of space research that are coming up? I know there's been lots of talk about maybe being more private involvement, pairing with the government, going all the way to Mars. Of course, James Webb just launched and we're getting some new high-res images So, what are you expecting for the future of research? What are you looking forward to?"

Wiesner: "Right. Oh my goodness, there's so many opportunities in aerospace materials. Personally, I see a lot of benefit in the private–public partnerships we're developing, right, through NASA and different company collaborations. For us, for example, I mentioned

the launch that we're going to be able to send some materials up on. That'll be with a commercial partner. They're going to be able to provide some launch services for us to expose different materials to lunar surface. And so, I think being mindful of space going forward is kind of… It's not just for, you know, governments, large countries to explore and discover. It's really opening up to I think to be a really great ecosystem, if you will, with public–private opportunities to perform different types of research. Not even just focusing on materials and ceramics, right, but beyond.

And so I'm really excited about the ability that we'll have to evaluate different materials for the moon, is obviously one that that we're working on now in my area. But also looking forward to Mars and, beyond that, within our solar system, there's a lot of really amazing science work that folks are doing now and positioning for in the not-so-distant future. And I think a lot of, for example, the probes that will be going to these places are really going to be enabled by a lot of the materials that we as ceramicists can come up with to help get there, survive in these really crazy environments, really, and enable some amazing breakthroughs to take place. And so, I'd say there's a lot of really cool opportunities coming up within our solar system for materials to really shine, if you will. Good time to be an aerospace materials person."

McDonald: "Definitely."

(music)

BREAK

McDonald: "*The American Ceramic Society Bulletin* provides an accessible and in-depth look at the latest ceramic and glass industry news and research trends, as well as updates on the Society, its members, and their activities. This December, the *Bulletin* will provide an overview of all the ways ceramics and glass are used in space applications. View the most recent issue of the *Bulletin* at www.ceramics.org/bulletin."

SECTION 3

McDonald: "So, of course I'll have to ask, how was it that you came to know about The American Ceramic Society? When along your journey of learning about materials, learning about ceramics, when did we come on your radar?"

Wiesner: "Yeah, I'd say really early on in my graduate school experience. So, I became involved in ACerS, I think that was my first or second year of grad school, my memory's a little fuzzy these days. So long time ago, long time ago. One of my advisors recommended I attend the Engineering Ceramics Division meeting in January, the International Conference on Advanced Ceramics and Composites, ICACC. That's when I first really kind of got involved, or at least more aware of what ACerS offers members. And so I started kind of with ACerS as a Material Advantage Member. And I attended conferences and then learned about PCSA, the President's Council of Student Advisors. I was able to get involved with PCSA and that kind of really set the tone, I think, for my involvement in

ACerS even after I graduated. I was able to, you know, make really great connections with not just students, like my peers, and also midcareer, further along, you know, to get a sense of what ACerS is as a community, and all the amazing research that's taking place out there in ceramics.

And so, as a result, I've been really involved with the Engineering Ceramics Division, which is related very closely to the research that I'm involved in now, and also at the Society level, several different committees. So, I've really valued my involvement with ACerS over the years. And it's been really great having kind of a home base, if you will, making the bridge from as a student to a professional, still having contacts in the area that I could rely on as I kind of started to navigate my career as an earlier career."

McDonald: "So, I know I was originally gonna ask you what your favorite material is, but I feel like it might be more interesting to ask what is your favorite planetary body?"

Wiesner: "Ooh, oh, I can't pick one, that's so hard. Oh man, yeah, so interestingly, I recently had a long conversation with my four year old about favorite planets. At least, I'm going to bound it within our solar system. Because I could start talking about one of the pulsars I worked with in, you know undergrad. You know, things like that. But I'll bound it our solar system. And I have to say, historically, Venus was always my favorite as a kid. I like really enjoyed the story of Venus being, the story about like how the name was selected. Everyone looked up at the sky and saw this beautiful, shining planet. They thought it would be a really pretty place, so they decided to name it after a Roman god, Venus, the goddess of beauty and love and romance and all that good stuff. And then come to find once we actually start sending probes up there, man, Venus is harsh, just eats them up like from a materials perspective. I think a lot of the probes that have even like made it to the surface, they don't last, you know, more than, I can't even remember, days, that might be even too long for them because of how hostile and aggressive of an environment it is. It's hot. It's got a very caustic environment atmosphere. To me, I thought that was super interesting. Like you look at it, I had a telescope when I was a kid, still do. So when you look at it, it's like, 'Oh, this shining body in the sky, it looks really nice.' But in reality, you wouldn't want to go there unless you have some real good materials technologies to protect you."

McDonald: "It's a very harsh love."

Wiesner: "Right? And then I have to say, so Venus has historically been my favorite, and I will give a shout out to Mars because I do hope we can someday go there in my lifetime. Hope we'll go, I don't know. Hopefully we'll be able to make it up there to see another close neighbor, relatively speaking."

McDonald: "So do you have a favorite story from the lab or maybe a favorite project that you've worked on at NASA?"

Wiesner: "Oh, goodness, a favorite. Ah, it's so hard, right, because there's so many really cool problems and, you know, interesting opportunities in aerospace, materials in particular,

because you can work in space and/or aeronautics. And so, I think I'll give a shout out to some of my early [work]. So I'd say when I was first starting my career at NASA, I was really lucky to work with a great group of folks over at NASA Glenn Research Center in Cleveland, Ohio. And there I got to work on developing protective coatings or environmental barrier coatings, EBCs, specifically, to coat or to cover, protect ceramic matrix composites, or CMCs, with the application being for gas turbine engine blades, basically. And so, the specific problem I was looking at involved the effects that particulates, such as sand, volcanic ash, those kinds of things have when ingested by an aircraft engine. What does that do to the materials when you're operating at so much higher temperatures? Thanks to the CMC-based engine that offers these elevated operating temperatures conditions. And so, with that, one of my favorite things I'd say, it's like so many, right? One thing I remember thinking like, 'Wow, this is so cool,' there was a volcanic eruption in, oh gosh, 20-teens, 2010-ish in Iceland that basically put a halt to all European air traffic for I think almost a week. And it cost, you know, billions of dollars. And from an economic perspective, and also from a safety concern, civilians and military personnel, it was just a no fly zone because the amount of ash that was being ejected and traveling across the European continent was just too dangerous to fly through. And so, through connections and that kind of thing and wanting to get a better assessment of like what was this ash like, what effect would it have on a lot of the materials we're investigating, I was actually able to get about a kilogram, no two kilograms I think of the actual ash from this particular volcano sent from Iceland. So, and so, when that showed up in lab, it was just like, 'Oh my gosh! This is from Iceland, from the volcano that you know we talk about all the time.' That was kind of like a 'wow.' Like if only I could go, it was like the next best thing for instead of me going up there and collecting it but still being able to use it and see it and touch it, right, was I thought pretty powerful. And so I really enjoyed that. But, you know, that being said, there's too many favorites I'd say that I've been able to enjoy with folks over my career. But that's one that stands out to me in particular."

McDonald: "Well, and when you're working at a place like NASA, there must be just so many stories, it is hard to choose just a few."

Wiesner: "Yes, right? It's like, and talking to folks around me, my colleagues and the amazing experiences and the projects they've worked on, it's pretty cool, it's pretty cool. But, again, I'm biased."

McDonald: "Do you have any final topics that you'd like to touch on and maybe say to the viewers, who are listening?"

Wiesner: "I guess, this would be more for the folks who are maybe considering a ceramics career or just thinking about it or maybe even have started their career in ceramics. And I would say the biggest thing I have I think benefited from in my career is keeping an open mind. You never know when you might find another area that is of interest to you within ceramics. For example, for me, the lunar dust work I mentioned, that was really happenstance. I happened to transfer to Langley and one of my colleagues down the hall was doing some really interesting work with lunar dust. With my background looking at

earth dust, right, with volcanic ash and whatnot, I couldn't help but 'gravitate,' pun intended, towards that problem. And, you know, we just kind of started bouncing ideas around, and, you know, one thing led to another proposal, and, you know, we got funding to really explore ceramics in this area. And so, I'd say keeping open to different research areas, as well as interactions with folks around you, I think will help you along in your career, no doubt."

McDonald: "So, leaving yourself 'space' for exploration."

Wiesner: "Exactly."

(music)

CONCLUSION

McDonald: "As we continue to push our space exploration capabilities farther into the unknown, ceramics and glass will no doubt play an integral role in our advancement."

I'm Lisa McDonald, and this is Ceramic Tech Chat."

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Until next time, I'm Lisa McDonald, and thank you for joining us."