CERAMIC TECH CHAT

Episode 29

Title – "Discovering the magic in ceramic science and art: Ryan Coppage (E29)"

INTRO

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

Science can often feel like magic when conducting an experiment for the first time, especially before you know the physics and chemistry that give the results. The same can be said for ceramic artists developing new glazes in their workshops."

Coppage: "A lot of people assume a kiln is just a magical box of hot fairies. And the fairies come in, and they wave their wands around, and different colors show up. But, if you pick it apart, if you like seek to understand it, you can start to control everything that you have and then get a larger range of options when you go to glaze something. You can kind of imagine what you want it to come out as in the end and then probably have a slightly higher success rate to get there."

De Guire: "That's Ryan Coppage, director of introductory and inorganic laboratories at the University of Richmond in Virginia. And he's also a ceramic artist! Ryan is drawn to the Venn diagram overlap between science and art, and he currently works on research projects that are frequently split between the University of Richmond and the Visual Arts Center of Richmond, developing low metal-loading color alternatives for ceramic surfaces.

What are the benefits and challenges of researching and publishing about ceramics from both an art and science perspective? And, in this podcast, we also talk about the book he just published with The American Ceramic Society's International Ceramic Artists Network, titled 'The Anatomy of a Good Pot.'"

(music)

SECTION 1

Coppage: "I was one of those really obnoxious kids that needed to know how and why everything worked. You know, like the ones that all the teachers hated in elementary school. You know, the one kid like, 'How does that work?' or 'Why?' And the teacher would just be like, 'Be quiet. Let me finish talking. …. I don't actually know.' And so then, when I was a kid, Wikipedia didn't exist, and so my parents would just turn me loose on encyclopedias. And so, I would just pick up a volume of R or of J, and I would just sit and look things up. And I feel that if that is your nature, you have no choice but to be a scientist.

De Guire: “Good point. Or maybe a librarian.”

Coppage: “Yeah! Yeah, but I just always wanted to know how everything worked.”

De Guire: “Right. So, growing up, did you anticipate a career in academia?”

Coppage: “I had no idea. Because I’m from rural Kentucky. My mom’s family are farmers in Missouri. My mom was a 4H agent. And then my dad’s grandfather was a coal miner. And so, I was this really curious kid in rural Kentucky, and I had absolutely no idea. I was actually certified to teach high school. I was a high school teacher first. And it was real rough. There was just such a substantial amount of apathy in the class. Like ten percent of the class actually wanted to be there, and I was like, ‘Man, it would be great if I could go teach and ninety percent of the class would want to be there.’”

De Guire: “Given that was your background, what drove you to go all the way through a Ph.D. program?”

Coppage: “Well, a lot of mistakes. Not, you know, the Ph.D. wasn’t a mistake, but I’m from rural Kentucky, and no one in my family had done a Ph.D. before. My mom switched from ag to elementary school education. So she taught fifth-grade math and science. And I’ve always been like slightly teacher oriented. If you like looking up how things work, then you typically like explaining how things work to other people, and you’re excited about it, right? And you can kind of see light in your eyes. And it makes you a good teacher because you want to explain like the full context and the background, and you kind of watch people’s faces, and you can see when they like you and when they’re done listening to you.

So, I taught high school. I was like, ‘Man, this is rough. I should go back to school and try to figure out something else.’ And so I didn’t know any better, and so I did an unnecessary master’s degree. And I did really well in it. And then I was like, ‘Well…’ And one of my advisors said, ‘You can teach community college now.’ And I quickly thought that that would have about the same apathy rate as teaching high school. So it’s like, ‘Well, maybe I should keep going.’ And so I applied to the University of Kentucky and got accepted.

You know, I was coming from a very humble background, and I had gone to Murray State University for a bachelor’s and a master’s, which is the cheapest state school in the entire United States. Yeah, and so, a lot of humility showing up there and applying.

But since I’d done an unnecessary master’s degree, it was very easy. Because, you know, a lot of people there, I think only one person out of our class of nineteen had also got a master’s. So everyone was straight out of undergrad. And I had taken these classes from some mildly insecure professors that the highest degree that they taught was a terminal master’s, right? So they had just whipped me into the ground in course difficulty. And so I showed up to my Ph.D. and the courses were actually easier than the professors that I had for my master’s degree.

And then my advisor got poached by the University of Miami. And so I went with him to Miami. It was interesting because the University of Kentucky has a large engineering program, and so they had a substantial nanomaterials, materials chemistry research group. And then we could use the entire microscopy suite that was owned by engineering.

So, UK [University of Kentucky] was wonderful. Then I went to University of Miami, and we were going up in rank, right? But then we got to the University of Miami, and there's no microscopy suite. And instead of five NMRs in the basement, there are two. So it, you know, the ranking is, as far as I'm concerned, number of publications divided by number of professors. Except we went from University of Kentucky, which is huge and massive and has an engineering program attached to it, to the University of Miami, which is private and elite and wonderful education, but in terms of materials chemistry, we had to travel to FAU [Florida Atlantic University] next door to use their TEM."

De Guire: "FAU is?..."

Coppage: "Florida Atlantic University. I think it was like an hour and a half drive. But, so, I love teaching. Love teaching. I knew that I could get hired in industry and probably do well and then go home and cry into my money. But that wouldn't make me happy, right? I wouldn't get as much value out of it."

De Guire: "So, even though you love teaching, what is your approach to teaching undergraduates, to mentoring students?"

Coppage: "So, if you are a chemical educator, you probably know about POGIL? Process oriented guided inquiry learning. Formal POGIL is when you separate people into groups and then you ask questions and the group has to kind of like get together and work out the answer. And so I do a course, or I guess, an entire classroom question.

So, if I have a one-hour block of time, I will propose new theory information for the day. That takes about fifteen minutes. So the students like me for about fifteen minutes. I have, 'Hey look. Here's this new equation. Here's where it comes from. Here's how we do it.' And then about five or six minutes, I do an example problem on the board. I will show you how to use these new tools that you have.

And then after that I propose a new problem, and it has a twist to it that they don't know how to do. And I don't tell them how to do it, and we haven't gone over how to do it. And they don't like me, right? And so they're frustrated because then they have to figure out how to do this new problem without technically enough information. But if you have twenty or thirty minds in a room, one person will suggest something, another one will modify it, and they'll figure out how to do that problem. Oh, that's great, that's wonderful! Here's another one that's harder.

And so I keep hitting them with harder problems for about thirty minutes. And at the end of the class, they completely understand the material, and they've created their own learning pathways in their head, and then they like me again. And so then I ask them, 'Okay, what did we learn today? How was it significant? How could you use this?' And then they tell me, and then they're like, 'Oh my gosh. I learned so much. This was awesome.'"

De Guire: "That's interesting that your measure of success is that each kid in the class goes through this cycle of like, dislike, hate, back to like."

Coppage: "Yes."

De Guire: "When you see that negative reaction, you know you're hitting your mark."

Coppage: "Yeah. Like, they will tell me, 'I don't like you.' I'm like, 'Good. I'm doing this right.'"

De Guire: "The other nice thing about the approach is that you're not just learning chemistry but like you said, it's a process oriented guided inquiry. So, that's a tool for life because really when you get an undergraduate degree, what you're learning to do is learn about a topic area that you have an aptitude for. So that learning phase never ends. People hire you because you can solve problems, not that you come in with a packaged answer."

(music)

SECTION 2

De Guire: "So, let's switch gears just a little bit and talk about materials science, and in particular, ceramic science and engineering. You come at it from a different direction. You've published in our art magazine, *Ceramics Monthly*. I've seen some of your articles on chemistry glazes and how to do the calculations. So, let's start with your origin story in the ceramics field. Was it art? Science? Little of both?"

Coppage: "So it's both. I've actually published in *JACerS* [*Journal of the American Ceramic Society*] as well."

De Guire: "Oh! Excellent."

Coppage: "I'm a nanomaterials chemist, and so I've actually developed gold nanoparticles that actually grow during the firing. Actually, last year I had a gold/silver nanoparticle blend glazes that was published.

So, in undergrad, I did a major in chemistry and a minor in art. And so I had had, I think, four ceramics courses, and I was just in love with ceramics.

If you ever go in a glaze room, everything is chemistry. Right? There's copper carbonate, copper oxide, cobalt carbonate, cobalt oxide, different valences of every metal imaginable.

And then if you have all these different valences, you have different firing oxidation states, right? You have an oxidation kiln, and you have a reduction kiln.

And I went in there after having a couple chemistry courses, and I looked around and everything was just these brilliant bright colors because, you know, copper carbonate is basically ground up malachite. So you have this beautiful aqua green. And then your cobalt carbonate is just a soft, medium-like lavender purple. So you take that, and then you apply that to crystal field theory, and you have pigments being surrounded by silicons and oxygens. And it is just such a perfect manifestation of inorganic chemistry.

And so I started picking things apart. If you take a scientist, any classically trained scientist, and you turn them loose in an art, we're just going to start picking things apart. We're going to start dissecting, 'Now why didn't they do this? Now why did they do this? Why is there only this much copper here?' And I don't think that what I have done is super, super special, so much as just I am a scientist who has been turned loose in art for long enough to start poking and prodding.

And then, I would argue with other potters. So, six or seven years ago, I got in a handful of arguments about oxidation and reduction. A lot of people think that reducing a kiln is reducing the amount of oxygen. Like that's the entire mechanism. They think that oxidizing is increasing the amount of oxygen. And so, from an organic chemistry perspective, they're not wrong. But from an inorganic chemistry perspective and oxidation states and valences and charges, that's just horrible.

And so, I had this argument a handful of times and got aggravated. And then I looked up the editor-in-chief of *Ceramics Monthly*, which is Holly Goring, and I sent her an email. 'Hey! I've had this argument a lot. I think I could write an article that would clarify this.' And she said yes.

And so I worked on an article. I had a Bunsen burner, and I had four different examples of flames on the Bunsen burner with more and less oxygen. And it gave me an orange, sooty flame with the least amount of oxygen and it gave me a bright, blue, clear flame with the most amount of oxygen. And I argued that the one with the least oxygen is reducing, but that's not actually reduction. That's just what we see. And then I talked about oxidation states of metals.

So, if I had to have the same argument, that means that someone needed to write an article on it. And every time I would have an argument with someone, I would write a new article. Now it's happened…eighteen times? Seventeen times? I argue a lot. And *Ceramics Monthly* was willing to put up with me.

You cannot be super technical in *Ceramics Monthly*. If you've noticed, I don't write in complete passive voice. I kind of flip around. I'll go from first person back to passive voice when I go technical, and then I'll crack a joke or make a comment. They let me name my glazes silly things. I made one glaze out of praseodymium, and they let me name it 'nucular' green after George Bush, instead of 'nuclear.' So, they let me get away with really silly things that ceramic engineering journals might not let me get away with. *Ceramics Monthly* wants lighthearted, right? If I can name my glazes silly things, and I can crack a joke or two, then people are actually more willing to kind of like wade through the few sentences of technical.

And then, I get emails from all over the world from people asking me to fine-tune their glazes or fix their problems or how did I do this. And I think that's wonderful. You know, because it's people figuring things out for themselves."

De Guire: "Right. It sounds like your POGIL process in the studio."

Coppage: "Yeah."

De Guire: "Well, your articles in *Ceramics Monthly* are actually pretty rigorous. You don't back down from any of the chemistry. But do you find that artists respond well to it once it's laid out to them in a way that's accessible?"

Coppage: "Yes, absolutely."

De Guire: "And what difference does that make to them, then, in the studio?"

Coppage: "So, to me, I'm going to say things again that aren't necessarily brought up typically in the field. I grew up poor, right? And the prices of commercial glazes kill me. Like a little, tiny, actually like a pint of underglaze or glaze is typically sixteen dollars. And I can mix a five-gallon bucket of glaze for thirty or forty dollars. And if you do the math on that, there is a really large upcharge. It's packaging and it's marketing, and I think a lot of it comes down to people being afraid to actually dive in and develop things themselves. Because the information is out there, people are just intimidated by it. It's daunting. And so I figure that if I can publish this information for free, then I save everyone some money."

De Guire: "Yep."

Coppage: "I'm also going to say something that isn't talked about a lot. Almost all of these proprietary recipes, they have to be published under MSDS [Material Safety Data Sheet], especially in New Jersey state law. And so you can look up the MSDSs of proprietary glazes, and everything has to be listed in decreasing order of prevalence. And you can figure out the recipe! And then you can make it yourself."

De Guire: "Especially if you know how to write the equations."

Coppage: "Yeah! And then tools like glaze calc. So, Linda Arbuckle basically turned glaze chemistry into elemental composition by percentage. And so you can break everything down into elemental composition and find out where it fits on a silica to alumina graph. And it will tell you whether it will be clear; it will tell you what temperature it vitrifies; it will tell you whether it will be crystalline, matte."

De Guire: “I see.”

Coppage: “And this intimidates people. But, you know, things are broken down into what component, what row on the periodic table they’re in versus oxygen. And if you break that down for chemistry, it makes glaze science very, very reasonable. And there are online tools that let you type in a recipe and hit a calculate button, and it will give you the same recipe with different materials just based on elemental composition.”

De Guire: “Wow, that’s great. Plus, I know for artists, the creative process involves a form, of course, but the color is a very important part of it. And if you can kind of really just fine tune and tweak that color, I bet that really appeals to the artist’s soul.”

Coppage: “It does.”

(music)

BREAK

De Guire: “The International Ceramic Artists Network is the membership organization of The American Ceramic Society that serves the international ceramic arts community. Its website, CeramicArtsNetwork.org, provides a wide array of tools for learning about and improving ceramic art skills, and it’s a place for artists to share ideas and perspectives. Learn more and join ICAN at CeramicArtsNetwork.org.”

SECTION 3

De Guire: “So, do you maintain a studio yourself?”

Coppage: “I have a studio in my backyard that I built. I have a glaze lab upstairs on the second floor where I will take a student and we’ll work on glaze stuff and then publish with *Ceramics Monthly*.

So, I had a student last summer, I think we got three publications over the summer. And then the one before that, we got four *Ceramics Monthly* publications, and then we wrote an ACS book chapter on introduction to ceramic glaze chemistry and color mechanism. So, if I get a student, I publish a lot with them. But if I don’t, I’m fine with that as well and I’ll do it myself.”

De Guire: “Okay. So, the work you’re doing with glazes, obviously we’ve already talked about how that impacts artists and craftspeople. What about industrial applications?”

Coppage: “So, the nanomaterials stuff that I did is actually wonderful for industrial scale because you can get color at one one-thousandth the amount of pigment. There’s a huge difference in color efficiency between d-orbital splitting and nanomaterial plasmon resonance. So if something is being manufactured, and if they need to be mindful of materials cost, then that’s a wonderful way to go.

I don't do that as much as I used to just because the deadlines that show up for reviewing papers, sending them back in the middle of teaching full time. Like I had one that came back in the middle of February, and they were like, 'You have one week to make all of these unrealistic changes with the instruments that you don't have.' And so that's rough.

And I'm also a little bit of a weird bird. I make my own pots to make the glazes look good. And then I publish in ceramic engineering journals, but I use a lot of my own pots to kind of showcase the glazes and the tech that I make. And I also come at it from a make-my-own-glaze formula direction, and a lot of the people that are gatekeeping those journals don't like that. You know, I will provide a recipe, and it will have Gerstley borate in the recipe as an additive, and they'll ask me why I didn't use a borosilicate glass when it already is a borosilicate glass, they just aren't used to everything being presented in pottery format.

So, of all the ceramic journals that I publish in, I have a letter to reviewers that basically is almost always the same thing. It's a copy-paste format letter to reviewers that explains the context, that explains where everything is coming from because I am publishing as a chemistry Ph.D. in a ceramic engineering journal from a pottery background."

De Guire: "Yeah, right. So yeah, it's important to help people understand like how to understand you and your mindset of what you're trying to do."

Coppage: "Yeah."

De Guire: "So, does your knowledge and understanding of art help you with the science teaching?

Coppage: "So, have you heard of knowledge hooking? So, a good example, you've seen 'Lilo and Stitch'? Are you familiar with that?"

De Guire: "Yes."

Coppage: "Alright. So, Stitch is experiment 626. And so Planck's constant is 6.626×10^{-34} joule seconds. So if I can bring that up when I talk about 'Lilo and Stitch,' and I get the entire class to say 'Experiment 626,' they never forget Planck's constant. And so if I can find anything to relate to for whatever I'm teaching that is already in their mind that they can kind of like attach that memory to, it's wonderful.

And so ceramics are kind of low-hanging fruit. Everyone uses pottery, everyone loves bright colors. When I teach inorganic chemistry, I have dichroic glazes with neodymium and holmium. The neodymium will shift from blue to purple to red, and the holmium will shift from yellow to pink. So I can have students, you know, take this outside. And they walk it outside, and the shift from fluorescent light to sunlight, it will color change. It will go from bright pink to bright yellow. And they'll come back inside, like, 'It changed colors! What happened?' And so then I can get out a reflectance spectrometer and bounce light off the surface, and they see the reflectance profile of f-orbitals splitting in the glaze. Students, they just, 'Oh my god, this is crazy.'

And so anything like that, where you have something practical in front of them that they're already comfortable with, and you can attach that to what you're teaching, they're mine. I can teach them anything."

De Guire: "Right, right. So, what does the future look like for you, Ryan, as both a potter and as an educator?"

Coppage: "Well, I had a book come out in October."

De Guire: "Oh, that's wonderful. So what's the name of the book and where can we get it?"

Coppage: "So, this is a different vein. This is just purely aesthetics. It's not science at all. It's called 'The Anatomy of a Good Pot.' It's published by The American Ceramic Society.

I've made pottery for twenty years. I noticed after ten years that I was still really bad at it. Pottery is very…it's difficult, right? The people who are really good at it, they make it look really easy, and that is very deceptive. And you sit down and you're like, 'I could do that.' And you sit down and try, and you're like, 'I can't do that. I was mistaken.' And so, I got aggravated, and I started looking at all these invitationals and looking at what everyone does. And I made like this checklist of aesthetics. Bevel, contour, undershadow, visual cues. And I looked at, I don't know if you've heard of ClayAKAR?"

De Guire: "No."

Coppage: "It's a huge invitational. They curate, I don't know, the top one hundred, two hundred ceramic artists in the world, and they show their work, and it is just absolutely beautiful. And it's global! And so I went through four or five years' worth of their invitationals, and I made a statistical frequency list for success. If you do these five things, and you do them in balance with one another, you can make good pots.

And so I pitched this to a couple editors, and *Ceramics Monthly* picked me up. And then I chased down fifty of the top artists, and I said, 'Hey, can I have pictures of your work to discuss that you're doing these five things?' And then I talked to some really big names in the pottery world, and they're like, 'Yeah, I just, there's no book about this, I just do it.' These are things that their mentors told them to do. And so I was like, 'Ah, this is crap. I don't have access to these mentors. I don't have access to these fellowships or residencies. Why can't everyone have this?' And so I wrote a book that breaks down individual aesthetic components. None of my work is in it, right? Because otherwise that would just be hubris. It's all these top people in the world, and I made the argument that, 'Look, if these top people are doing the exact same things, you should do them too.' Because there's apparently a formula for really good pottery. I mean, it's like the Fibonacci spiral in classic painting, right? Everyone's doing the same thing. Have something that visually directs your eye in a circular motion, and your painting is going to be a lot better. Hmmm. How come nobody argues with that? No one debates the Fibonacci spiral."

De Guire: "Or in photography, the rule of thirds."

Coppage: "Yeah! Law of thirds. No one argues with that, but everybody knows about it. But yes, it's a thing. And so I stumbled upon a histogram-supported checklist of pottery aesthetics, and it has done pretty well."

De Guire: "Ryan, that's great. Again, it's that scientific approach to observing, being curious, quantifying, and analyzing the data. Any final thoughts?"

Coppage: "I highly recommend throwing pottery because it teaches you patience that you do not get other places. It's infuriatingly hard and wonderful at the same time."

(music)

CONCLUSION

De Guire: "Whether you approach ceramics from a scientific or artistic route—or both!—pottery has lessons to teach everyone. So go out and explore the sometimes challenging but always wonderful world of ceramic arts—and keep your eye out for those f-orbital splitting dichroic glazes!

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

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"Visit our website at ceramics.org for this episode's show notes and to learn more about Ryan Coppage and his work. Ceramic Tech Chat is produced by Lisa McDonald and copyrighted by The American Ceramic Society.

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