CERAMIC TECH CHAT

Episode 64

Title – "Research experiences support next-gen scientists: Mario Affatigato"

INTRO

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

Patience is one of the most important but also hardest skills for students to develop when conducting scientific research. Successful experiments typically do not happen on the first try, but through dedication, determination, and discipline, students can experience the joy of making their first significant discovery."

Affatigato: "I had a young student two summers ago that was attempting to make this very difficult glass to make, and after many, many trials, she was able to make it. I remember hearing the scream when the glass worked, and that was because they were so excited that finally after 50, 60 hours of various attempts and things, it had finally worked."

McDonald: "That's Mario Affatigato, the Fran Allison and Francis Halpin Professor of Physics at Coe College in Cedar Rapids, Iowa. He is also this year's president of The American Ceramic Society.

In today's episode, Mario will share how his initial experiences with glass research as a student at Coe College came full circle when he returned to Coe as a professor, describe the fundamental and applied glass science that his research group conducts, and discuss his plans and goals for the Society this year."

(music)

SECTION 1

Affatigato: "I did grow up in Venezuela. My parents are both from Italy, they were both Italian immigrants that had come from Italy to Venezuela. I was as a child exposed, I guess, at some level to glass in the sense that I had the opportunity to go with my parents to a hot glass shop and see some of the glass art being made, which was fun. But I honestly at that time never thought it would play any role in my life. I just thought it was kind of a fun thing to see.

When I went off to college, by that time I had already decided that I would be studying physics. How we got there, not that important, but when I was in high school, I was undecided between maybe pursuing something that involved foreign language and maybe diplomacy or a career like that—or, physics. And after some, you know, experiences in high school, like I said, physics was the thing I enjoyed the most.

And so, already by the time that I was sort of wrapping up high school, I already knew that if I wanted to study physics, I probably would have to come to the U.S. because training in physics that you could receive at that time in Venezuela was not necessarily at the level that I wanted to be at. And so, I had to start looking at what the possibilities would be about coming to the U.S. to study.

And, you know, in one of those life coincidences, I was studying in something called the Colegio Internacional de Caracas, the International School in Caracas, and that was essentially an American high school that had been transplanted to Caracas, Venezuela. And while I was there, they did an old-fashioned college fair, and just like an old-fashioned college fair, they had college representatives sitting at little booths discussing their schools. And would you believe that one of those booths was Coe College. They were apparently part of a tour that was hitting multiple Latin American countries, and they have stopped in Caracas for just that college fair. So, I was able to chat with one of the admissions counselors, and eventually, felt good enough about Coe College that I said, 'Okay, I'm going to apply.' And next thing you know, there were a couple of other adventures in between involving money, but a couple of years later, I ended up at Coe.

As it just so happens, when I started as a young undergraduate at Coe College, we already had one of the physics professors there, Professor Steve Feller, who was not only a physicist but was studying glass. And his story was connected in turn to the Ph.D. work that he had done at Brown University involving NMR [nuclear magnetic resonance] of glasses. And so, when I got there, basically there was a built-in glass research effort, mostly dealing with the relationship between properties like density to the atomic arrangements in the glass. And as an undergrad, I dove into that world and began to learn, slowly at first, about the role that glass plays in our lives but also about again the structure, how do you study it, how do you research on it, how do you make some of these measurements, etc.

I was also at that time able to attend my very first scientific meeting, which was an ACerS conference that was in Tucson, Arizona, if I remember right. And so that already began to get me exposed to not only the world of glass but the world of The American Ceramic Society.

So, that's kind of how we started, and then again, when I went off to grad school, which I went to Vanderbilt for my Ph.D. in physics, I was lucky enough to have an advisor who gave me a fair amount of freedom, and I decided that I would continue my work on glass by studying light scattering from rough glass surfaces. Some work on sol-gel films, again to sort of change the glass surfaces and the roughness of those surfaces. So, I was able to then continue a little bit with my passion, if you would, for glass research. And then finally when I came back to Coe College, which I did as a professor, then at that point I was able to sort of start my own research effort, implement my own ideas and my own sort of creativity on what I wanted to study involving glass."

McDonald: “That’s really funny how it goes full circle sometimes. You went to Coe, and you ended up right back there.”

Affatigato: “Yes. I enjoyed that, and I think part of the reason I did go back is because I had myself a very good experience as an undergrad, and I felt like I could perhaps contribute to making that experience available to other undergrads. So again, the idea was could we do something, could I do something personally, that would have an impact by having the students once again experience research in the form that I did.”

(music)

SECTION 2

McDonald: “Can you give us a little bit about how the history of the undergraduate research started at Coe and kind of how it’s evolved to today?”

Affatigato: “Yeah, I mean, I think it existed for decades, but I think if I can focus again on sort of the glass research, I think that started with Professor Steve Feller when he came to Coe, as I mentioned earlier. He was coming from his Ph.D. at Brown working on NMR of glasses. And I think that’s really when a certain type of transformation occurred, where we went from being sort of a, if I can use this analogy, sort of a mom-and-pop operation to starting to get grants and professionalizing the undergraduate research effort at Coe.

By the time I joined in ’95, Steve had already built up a very successful research effort. What I viewed as my job was to grow that through further grants and other sorts of funding, but also, you know, at some point, for example, believe it or not, you have to start thinking sort of strategically about this: What’s missing from the education of the students as researchers? And one of the things that we noticed, for example, especially something we noticed in great part by coming to ACerS meetings, that when we observed many of the presentations by some of the well-known universities that was doing glass and ceramic research or even companies was that they were able to give a well-rounded picture of their work because they of course had access to a myriad of instruments.

And so, at some point in the early 2000s, we made a concerted effort to grow our equipment base in such a way that the students would have more experiences but also so that the science we were carrying out would benefit by enabling our students and our faculty to tell stories that were more well rounded. In other words, to say here is what’s really happening to the glass when we do this. Why? Because we have XRD data, we have calorimetry data, we have data coming from our Raman or FTIR measurements of properties, density, refractive index, contact angle, I mean, you name it, again, electrical conductivity, hardness, whatever. And so, by combining tools and therefore getting a broader set of data, now our students are able to tell a much more complete story.

And I think that’s valuable for them, valuable for the science in general that we’re doing at Coe. But that comes through many hours of effort writing proposals to get equipment, maintaining the equipment, making sure the students are trained on it, etc. So, yes, it is indeed a labor of love that requires many hours."

McDonald: "So, you mentioned that you actually got to dabble in quite a little bit during your undergraduate and graduate years in kind of different areas. So, nowadays you do quite a bit of research with laser-based manufacturing, also conductivity research. So, can you give us a bit of an idea of how you decided to focus in on these areas, what some of the experiments are?"

Affatigato: "Yeah, I think that one of the freedoms that you have when working in academia, certainly working at a small college, is that you get to pick the projects. Obviously they have to have a good rationale because typically the projects have to be funded through grants, and therefore that means that you have to undergo a review process for your proposals. But in general, though, I like to dabble in areas, especially as I get older, where I feel not enough has been done or not enough of an explanation has been done. But I also retain a practical streak, I guess, in some of what I enjoy doing, and therefore some of the research is very fundamental, but some of the research is also very applied. And so, in my research group, I have multiple students who enjoy one or the other. Some of them dive deeply into some fundamental research work, and then others prefer a more compact but also more applied.

So, to give some examples, we have as you pointed out for many years now, going on, I don't know, 15 years or so, we've been doing work on electron motion in glasses, which is an important property as you are designing detectors of various types for calorimetry or calorimeters. Here I don't mean calorimeters as in the calorimeters we use for glass characterization but rather the calorimeters that are used in particle physics. Those calorimeters essentially require the ability to convert a subatomic particle that is going through the material into essentially a current, which therefore means the motion of electrons through the material.

And so, in my group, we've been doing research on this type of vanadium-based, vanadate glasses, trying to look at ways to sometimes set the conductivity higher. Other times, it's a matter of hitting a specific target for conductivity because for certain high voltage detectors, if you go too high, you end up shorting the material. So, sometimes you want to have a high enough conductivity that the detector can have a high duty cycle, but at the same time, not have it too high so that it creates issues with again shorting.

So, that's again a combination that's kind of fun because we can have a student studying the very fundamental impact of structure on the conductivity, for example, while another student might be actually trying very hard simply to make a glass that conducts within a certain band or working very hard at having a glass that has a very high conductivity. And so, they are not necessarily relying on understanding why a certain additive or a certain glass former is working a lot better. They just want to get the high number, the high value, for that property. So, it's kind of nice to have students collaborating, somebody's making the practical glasses and somebody's studying the effect at the atomic level of certain additives.

Other than that, in my group, we also have an effort of manufacturing glasses using laser levitation, which is also kind of a nice niche technique for making glasses that are sometimes either difficult to make or require high temperatures or crystallize, perhaps through heterogeneous crystallization. And so, laser levitation can allow you to bypass some of these issues. Right now, we just got a new grant to attempt to make some pure silica glass at very high temperatures, for example. So that's possibly a new sort of maybe polyamorphism or a new state of silica that might form at very high temperatures. So, that is another set of projects going on in my lab.

Another set of projects, again spanning both practical and fundamental, is the study of surface hydrophobicity, which in turn means determining wetting angles, contact angles, and being able to observe or even develop glasses that have hydrophobic behavior. This could be very practical in the sense that you can think of windshields or even just plain windows, self-cleaning windows, and things of that nature. But also again, it's a very interesting question of the fundamentals. Why is it that when you add certain additives to a glass, say a rare earth, the glass becomes more hydrophobic? What is that doing to the structure? What is that doing to the electronic sort of shells of the atoms such that they are becoming more likely to repel water molecules? So, that's another project.

And again, there are several more in my lab. We also look at bactericidal glasses. We've done that for many years, in which we develop glasses that intrinsically kill bacteria. Sometimes we make them as a composite, so mix the glass with a polymer or epoxy matrix to have a composite material that can be shaped for things like, say, a silicone matrix that could give you perhaps a nice and flexible bactericidal iPhone case, for example, or combining the glass with a tougher epoxy that might make for a wonderful kitchen cutting board, or mixing it with something else, for instance, to create maybe a more cushioned material that is bactericidal to be used in prosthesis. So, all of these are again practical on one side but also very fundamental if you want to understand better what is the mechanism that causes the bactericidal action and so on.

McDonald: "And I think that this side of your research group you've been emphasizing—some are really focused on the fundamentals, some are really focused on the application—is so useful for these students because at Coe College, it's an undergraduate institution. So, all these students who are doing the research are undergraduate students. And as we know, one of the things that can be challenging is understanding what you've learned in the classroom, those fundamental basics and the mathematics and the equations, how does it apply to applications. So, having these two groups of students working side by side, some more on the fundamental, some on the application, can really help them work together and see, 'Oh, this is how this translates from here into application over there.'"

Affatigato: "Correct. Undergraduate research is well understood. I mean, there are many, many best practices studied that show that undergraduate students who get involved in undergraduate research, whether it's in physics or chemistry, materials, medical, anything, tend to stay in the field, tend to go to grad school in higher numbers, tend to have a deeper understanding of the concepts that they've learned in class. So, there are many, many well-understood benefits to doing undergraduate research.

I think that for those of us who work in materials, in particular again ceramics, glass, I think that the exposure to undergraduate research has many benefits. One of them is that undergraduate students are rarely exposed to high-tech, high-end, research-grade equipment. And when they are exposed, sometimes it's very briefly in a laboratory, but oftentimes it is rare for undergraduates to get to play with a half-a-million-dollar machine, a TEM, an SEM, X-ray diffractometer, or whatnot. And so, what you want is for the students to begin to discover the world of high-end instrumentation, but at the same time also get over the fear of using high-end instrumentation. Many undergraduates, when they find out that that instrument that they are learning is worth half a million, quarter million, three quarters of a million, there is a lot of nerves: They are nervous about damaging it. But as we all know, that's a fear that you must get over because you often cannot do materials research without utilizing these research-grade instruments. And so again, for me, that's one benefit right away. The student gets over quickly the initial impact of handling these very expensive tools, and then they become quite good. And I've had reports of some of our students who've gone off to grad school, and the professors will send me an e-mail saying, 'This was incredible. The student was able to walk in the lab, pick up the manual, start reading, and start making measurements. We've never seen that from a young grad student before.'"

McDonald: "So, out of all this different equipment at Coe, do you have a favorite thing that you like to use for experiments?"

Affatigato: "Well, certainly the levitator is, in my mind, very cool. But I think if I ask the students which one their favorite was, I think the scanning electron microscope because the students have been very creative. So, to give one example, they one time had an assignment in their calculus class to determine the volume of a Tic Tac, you know, the little candy. And of course, there are many ways to do that, but there was certainly at least two teams of students that came to me and used a scanning electron microscope to get an accurate image of the Tic Tac. And then once they had the ellipsoidal outline of the Tic Tac, they were able to use calculus to rotate it and do a revolution around one of the axes and then get the volume from that.

So, my point is the students love the instrument and they can sometimes come up with any excuse to try it, to use it, whether it's to look at something they found in the outside world, whether it's a butterfly wing or a plant leaf or a petal, it's amazing to me, but they want to satisfy genuine childlike scientific curiosity, and they love to do that with a scanning electron microscope. So, I think the students would like that one, whereas I really like the levitation setup."

(music)

BREAK

McDonald: “Want to support the next generation of ceramic and glass materials scientists? ACerS offers a number of ways for both members and nonmembers to support the Society, through volunteer opportunities, various professional networks, and the Ceramic and Glass Industry Foundation. Learn more about these opportunities by visiting www.ceramics.org/volunteer-opportunities.”

SECTION 3

McDonald: “So, you’ve really had involvement with The American Ceramic Society for many years of your career at this point. You started as a student member, you are now editor of our *International Journal of Applied Glass Science*, and coming in as our incoming president for 2025–2026. So, can you talk to us a little bit about what you’re looking forward to during your presidential term?”

Affatigato: “We have already seen the year 2025 be very challenging to the politics of science or science politics in the United States in particular but even internationally. None of us right now can be sure of what the next year—the next few months, for that matter—will bring. So, we are going to have to keep a very close eye on the situation nationally and internationally having to do with science funding because we as a scientific society are quite dependent on the well-being of our members. And so, one of my goals for the next year is certainly to keep a close eye on the finances of the Society and try to anticipate and overcome any financial challenges or financial difficulties that we may encounter due to this, again, what we have now started to call within the Society ‘the geopolitical situation.’

However, trying to be a bit more optimistic, we still have a fantastic mission to accomplish, which is to try as best we can to continue to be a hub for ceramics and glass worldwide, to try to present to the world the importance of ceramics and glass. And to accomplish that, we have to continue doing the things that we do best. So, we are of course going to continue to have many of our very important and key meetings. But also we’re going to, for example, create a task force to look at our Young Professionals Network and see whether there are things there that we can do better. It’s a very important transition between the ending of a degree, whether it’s an undergraduate degree or a graduate degree, and entering the world of work: industrial, corporate, academic, governmental workforce. And so again, this is a very important part of our mission, is to try to help our members through transitions of this kind.

We’re also going to create a task force to look at AI. I don’t think anyone listening to this podcast is going to be surprised by that. I think literally every company, university, and perhaps entity within, certainly within the United States, that deals in any way with technology is looking at AI, and we are no different. And so, the question would be is there anything we can do with AI to again benefit our membership or create perhaps some revenue opportunities for the Society. What that involves, it’s a bit difficult to say right now. It could involve perhaps looking at some of the intellectual property our journals have, or just again, be more creative with providing, for example, access for databases, the way we provide access to the phase diagrams. There are many possible ideas, but again, we’re going to create a task force that involves a variety of our own experts, ceramics and glass experts, perhaps even go out of the Society to see what other opportunities we may have.

So, those are a couple. The last thing I would mention is we continue to grow our educational opportunities with things for the hypersonics workshop. That has been renewed for the next two years. But I think it's always important for the Society to also try to think of new things, new ways of doing things that might be different and unique. And so, one of the things we're going to explore, possibly create sort of a seed innovation fund that would provide reasonable amounts of money that would perhaps enable certain Divisions of the Society or certain committees of the Society to perhaps implement some new ideas as long as those ideas prove that they will have a return on that investment. Of course, it's not about doing things that just simply cost money but about doing things that benefit the Society, benefit the members, but also again give us a return on that investment of money.

So, those are a few of the plans that we have for next year. Again, I'm sure there'll be some new challenges and new things we have to tackle, but those are definitely some of the more concrete ideas that we're going to start working on."

McDonald: "And it is going to be exciting to see what happens because, like you said, there is a lot of unknowns about what's going to be happening during these next 12 months, but there is still so many opportunities for growth, for optimism. And that's what ACerS is all about, is helping to find these opportunities and make it possible for our members."

Affatigato: "You're absolutely right. And so again, I think that one should always end this with the positives of what we're well and of the work of our volunteers, the involvement of our students.

Let me say one thing I hope will resonate with students. Sometimes students have the idea that to get to this type of position, whether it's an editorship of a journal or, in my case, the presidency of ACerS, that somehow that has to be something extraordinary, miraculous, you know, these are only the pinnacle of the pinnacle. And honestly, in my experience, it has been much more organic.

I think in part the reason I can say that is because ACerS, above any other society that I've belonged to and meetings I have attended, is certainly considered among the most collegial of societies, among the friendliest of societies. When you belong to a society like that, the opportunities to get involved, and in my case, I started by getting involved in my own Division, the Glass & Optical Materials Division, came somewhat naturally. And so, I began to help by organizing symposia, sessions at meetings, and then I sort of graduated, if you would, to being part of the executive leadership of the Division. And once I had become chair of the Division, I kind of thought that that was it, only to then, within a couple of years, I was asked, 'Hey, do you want to serve on this committee that's Society wide?' And I did. And again, when that was done, I thought, 'Okay, once again, I think like I'm finished with where I'm going,' only to then again sort of have people say, 'You know, we think you'd be good in the Board of Directors because you've had all this experience or whatnot.' So, I joined the Board of Directors, which was a very eye-opening and very educational experience. And I genuinely mean this, when I finished with that, I really felt that that was it. I felt that that was going to be the pinnacle of my leadership sort of experience with ACerS. And then I had multiple colleagues, including some former presidents, say, 'You know, we think you'd be good, and we're going to put in your name into the Nominations Committee for the presidency.'

But again, my point is that my story is not unique. I know of many other colleagues for whom this is an experience similar to mine. They were not necessarily, you know, having to do something extraordinary to be considered, they simply served in the best sense of the word 'service,' and then the opportunities followed because people appreciated the service that the person has provided, that the colleague has provided.

So again, for students or for young professionals, don't think for a minute that you would not be in the running, so to speak, for any and all of these positions in there.

McDonald: "You know, I think that is such a great point to make, that it's really not about…you don't always have to win a Nobel Prize to get somewhere; it's about perseverance and the dedication. If you have the dedication and you really are honest about your feelings and wanting to serve, you can really work your way up step by step and suddenly, it's not like you're aiming for something here, you're starting here, and little by little it builds up to where you are today."

Affatigato: "Absolutely, absolutely. My last piece of advice for a young person would be, however, when you get tapped on the shoulder to participate in one of these leadership opportunities, take it seriously, but also speak. Sometimes people are again a bit intimidated. You know, you join a committee, you are at some kind of conference table. And again, you might feel, 'Wow, there are all these wise old people.' And so they speak, and they sound so intelligent and knowledgeable, and at times it can be a bit intimidating. But my advice is simple: speak. Listen, think about what you're talking about, and proffer your own opinion on these things. Don't for a second think that just because you are maybe younger or maybe less experienced that your ideas may not be valid. So, that would be my last bit of advice on that."

(music)

CONCLUSION

McDonald: "Sometimes it can be difficult to see how far you've come when you only take small steps each day, but perseverance will ultimately help you achieve even the biggest dreams.

I'm Lisa McDonald, 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 Mario and the Society’s plans for 2026. Ceramic Tech Chat is produced by Lisa McDonald and copyrighted by The American Ceramic Society.

Until next time, I’m Lisa McDonald, and thank you for joining us.”