CERAMIC TECH CHAT

Episode 38

Title – "Specialty glasses for healthcare and more: Steven Jung (E38)"

INTRO

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

> Glass is likely one of the last materials many people would think is used for wound treatment. But the discovery and development of bioactive glasses in the 1960s by Larry Hench at the University of Florida and Delbert Day at the University of Missouri, Rolla, (which is now called the Missouri University of Science and Technology) opened the door to the use of these materials in healthcare. The following 60 years confirmed glass's great potential to revolutionize medical treatments. Specialty glass manufacturer Mo-Sci, based in Rolla, Missouri, is one company helping to realize this potential."

Jung: "So, we work with companies, we assist them, especially if FDA [Food and Drug Administration] has specific questions. If there's things that we can do from a materials perspective to help to answer those questions, we support that. We don't just sell materials. We do try to support it and get it all the way through the process."

McDonald: "That's Steve Jung, chief technology officer at Mo-Sci. Throughout his career, Steve has been granted dozens of U.S. and international patents for healthcare innovations, including in bone grafting, wound care, tissue guides and scaffolds, load-bearing orthopedic implants, and dental implants.

> In today's episode, Steve will talk with us about the history of Mo-Sci and describe the science behind some of their well-known products. Plus, he'll share how a chance meeting with Delbert Day during his college years set him on the path to working with this innovative company."
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> (music)

SECTION 1

McDonald: "You've been working at Mo-Sci for quite a long time now, and it's a company that specializes in supplying specialty glasses for niche market applications, particularly in the medical industry. So, can you tell us a little bit about how the company got started and its role in the market landscape today?"

Jung: "Mo-Sci has been around for almost 40 years. And the original product that we actually still manufacture today was…or the reason why there's a company, it was based on an idea that Dr. Day and other collaborators at the University of Missouri had, which is

around this concept of making a glass microsphere for delivery into the tumor to release radiation internally instead of external. And so this product is now called TheraSphere, and it's distributed by Boston Scientific. And it's actually still growing. The product has been acquired a few different times throughout its life. And it's still helping people today, all around the world."

McDonald: "Are you able to talk a little bit, I guess, about the science of what you just said? That it's a glass sphere that delivers radiation into a tumor versus from the outside."

Jung: "Sure. So, glasses can be made of a wide variety of different compositions. And so in this particular one, the glass has an element called yttrium. Yttrium is an element that is able to be put into a nuclear reactor and made radioactive. The yttrium is a beta emitter. It releases energy over a relatively short period, maybe up to a centimeter from the individual microsphere. It releases a high dose of radiation, just kind of around where it's located. And you're able to deliver doses that are significantly higher than what you could do with external beam radiation. And the reason why this works is you put the bead at the place where you need the radiation. And you basically kill the cancer cells that are adjacent to the bead.

If you use external beam radiation, then the radiation has to travel through a whole lot of healthy tissue before it gets to the liver. And the liver is kind of centrally located in your body, so there's no great way to get at it from the outside. And so, by delivering this high dose of radiation, enough that it's going to actually kill those cancer cells, you cause a whole lot of damage to that patient. And so, like I said, there's just no great way to do it from the outside–in.

And so, this invention came along. The concept was, 'We're going to develop this great medical device. We're going to help these people.' And in theory that works. However, when you have this concept of delivering a radioactive component to a patient who is basically on their deathbed, things get a lot more complicated. And when the medical device itself also contains radiation, it's under a lot higher level of scrutiny. And so it took from an initial concept to FDA clearance about 15 years to gain clearance. And so in 2000 is when the FDA cleared it for use in the U.S.

So for about the last 23 years, it's been constantly growing in usage. It was used outside the U.S., I believe, prior to that, maybe in Europe. But the volumes were not very big at the time. The company that had the technology was quite small, and it was a pretty limited market space."

McDonald: "It's really great to hear that, you know, it's been available now the past two decades. Its use keeps growing so that future generations will have these treatment options for cancer that we didn't in the past, which should really hopefully, you know, extend life rates, make the success of this treatment better. So it's really great to hear about this research and know that it's starting to have an effect on the market today."

Jung: “Sure. Well, the exciting thing is the technology isn’t just focused on liver cancer. It can be applied to other cancers. And so there’s been a lot of research done at a variety of academic institutions where they’ve looked at different cancer types and been successful in killing those cancers. And so, hopefully, the commercial value is high enough that the large companies that have the resources to do the clinical trials and get these additional approvals will follow through and bring that forward for things like breast cancer, brain cancer, just a wide variety of other things that people deal with on a daily basis.”

McDonald: “I know one of the other products that came out of Mo-Sci research and development that has been in headlines is the MIRRAGEN, the world’s first bioactive glass-based wound care product. So could you tell us a little bit about how MIRRAGEN, that wound care product fits into the medical landscape?”

Jung: “Sure. So MIRRAGEN is very close to me. This was one of my inventions as part of my Ph.D. work. when I was at Missouri S&T. And the ability to…typically when you do inventions and things during your grad work, you kind of fill out the patent paperwork and you go off and get a job, and that’s the end of it. In this case, Mo-Sci actually licensed this technology when they hired me. And I’ve been in continuous development of this technology for 15 years. And so what started off as a research project at university, we very quickly found that we were able to do some experiments at a local hospital. We saw this material perform in ways that other products were not, and we got very excited. And so we built a company around this, and the company is called ETS now. Engineered Tissue Solutions. And we’re actively commercializing MIRRAGEN in the United States.”

McDonald: “What are some examples of the commercial applications of MIRRAGEN? Illnesses and diseases that it’s helping to treat?”

Jung: “Sure. So, MIRRAGEN can be used in both acute, so like surgical wounds, or chronic wounds, so like diabetic ulcers, okay? And there are literally millions of people in the United States walking around with these wounds that just will not heal. And so MIRRAGEN has been applied to a wide variety of these different types of wounds. And we’ve seen very good success with getting that wound to respond and actually start to heal and eventually close, which is very exciting.”

McDonald: “That is really exciting because, yes, it’s also, you know, diabetes is a big thing for not just the United State but worldwide right now. So, being able to find more effective ways to treat some of the symptoms is very encouraging.”

Jung: “Yeah. And aside from just nonhealing wounds, it can be used in surgery. It can be used in skin grafting applications. It can be used in just a lot of different places where you want your tissues to heal rapidly, where you don’t want to form a lot of scar tissue. So, when MIRRAGEN is applied to a wound, we tend to see this kind of reduction or minimal scar formation, which is great because that means the wound is much less likely to reopen. Scars are a lot weaker than native tissue. So that’s a very important thing. And bioactive glasses in general have been studied broadly to have antimicrobial properties. And so the ability to put a material on a wound and know that you’re going to have a positive effect

on controlling what kind of microbes can move into that environment is extremely important. There's a lot of talk now about antibiotic-resistant strains of different pathogens. And we've tested a variety of different bioactive glasses against these different pathogens, and also biofilms that the pathogens kind of form and live inside and has effectively kind of broken down that extra cellular matrix that they're living in and help to kill those different pathogens, which is great."

McDonald: "That's great. And just so fascinating. This entire field of bioactive glass I just find so fascinating. I didn't know much about it until I started working at The American Ceramic Society, and the more I learned, the more impressed I am.

So, for someone who's outside of the materials research field, they might be a bit surprised to learn that this is all based on glasses carrying, you know, the treatment inside the body. Because glass traditionally you see it around you. You see it in your windows, you see it maybe in your phone screens But you wouldn't think of it as something you would want to put inside of your body. That's usually a bad thing when you trip on broken glass. So how is this glass, this bioactive glass, different than maybe other glasses? And why is it good to put in your body in this case?"

Jung: "So that's a great question. So, look, everything is made of something, right? A medical device is either going to be made out of a metal, a polymer, a glass. You know, it's made of something. And usually it's, especially medical devices, they can be very complex and they contain all of these components, for a variety of reasons.

So, you're right. If you step on a shard of glass, it can hurt your foot. However, that glass was not developed to be put inside your foot. It was developed to be a beer bottle, or it was developed to be a windshield or something else. And so the glasses that we're talking about today are glasses that were specifically designed to be put inside the body. Whether it's a glass to deliver radiation, maybe it's a bioactive glass like you mentioned that we use regularly now in orthopedics, spine, dentistry, toothpaste, wound care. This material keeps expanding in its areas of use because it is so beneficial. We use glass materials and long-term catheters to kill bacteria. We use glass in just many different ways, either in medical devices as an active component, or it could be like a pass through in a pacemaker. So, it's a hermetic sealing material that would just basically not allow fluid transfer and also with like electrically ground metallic components. It's really a versatile material.

And so, it's exciting to be able to not just work in one area of health care but to see all this stuff, and then also we can make it."

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SECTION 2

McDonald: "So, as you mentioned in some of the previous responses, since we're working within the medical field, a lot of that needs FDA approval. It might be sometimes a bit more complicated to get products verified and out into market than maybe in some

industrial sectors because we need to keep in mind patient safety. So, what kind of is the product development process for Mo-Sci, creating these products that are meant to be used in humans?"

Jung: "Sure. So when a company comes to us, maybe they'll go to our online store and just buy samples of the normal bioactive glass materials that are out there, the 45S5s of the world. And they may do some internal development and not really talk to us much at all. Other times, they'll come to us and try to explain to us what they're really interested in doing. And this is where our design team can get in there and work with them and help them really meet their expectations. And so whether it's a certain porosity in a bioactive glass granule that they want to achieve. Or maybe there's a certain microstructure. Maybe they want it made out of fibers or microspheres or powder. As a material manufacturer, we have the capability to influence all these different things. And when you start to change the microstructure of the particles, or maybe even how they pack together, you then can change how tissue will interact and grow through that substrate, right? And so this allows you to really do very interesting things with, basically adding value to a material. So I could take just particulates of glass and have one outcome. And then I could have a porous scaffold with a lot of surface area and a completely different dissolution rate based on the surface area and get a completely different and usually better outcome because the material is dissolving faster just because of the shape as opposed to the material property itself. And so, we have the ability to kind of manipulate material properties, from a bulk to more of a surface area. And we've seen this do extremely well, especially in bone grafting but also wound care, where high surface area, there's a lot of surface area there for cells to kind of attach and start to reform tissues. The rate at which these things dissolve is also important. You don't want something to be there too long. And so having a material that is kind of matched with the tissue's growth rate is important so that it serves its function and then it gets out of the way. And so these are the things that we educate our customers about and help them to add technology to something that there's probably going to be kind of more of a 'me too' without it."

McDonald: "There's just so many factors to consider. You mentioned some of the main ones, but there's many more beyond that, too, that need to be thought about when working with biological systems."

Jung: "Of course."

McDonald: "What other applications does Mo-Sci help develop materials for outside of the healthcare setting? I know a lot of the bioactive glass is well known, but has Mo-Sci expanded into helping companies in other areas as well?"

Jung: "Absolutely. So we do a lot with glass-to-metal seals, and this could be in just a wide variety of different fields, where you're trying to have a high-temperature seal between a metal and a metal or a metal and a ceramic. We do things in the nuclear industry. So, we support some of the different nuclear projects in the United States with manufacturing for glasses for their melters, for nuclear waste vitrification. We do a lot with bond line spacing materials. And so this is where we would help a company with selecting the right size

glass bead for maybe an adhesive. If you want to glue two things together and guarantee that you have the right amount of glue, you'll add some small fraction of glass beads to that glue. When you press against that, the beads will make sure that all the glue doesn't squeeze out it. It seems simple, but it's used in tons of different applications now. We'll do stuff in electronics, aerospace, DOD, just anywhere people need a solution made of glass. This is really where we focus. And so, yes, we do a lot in healthcare, but we also do a lot in these other areas. So it's important that people understand that we're really a glass development house and not just a healthcare company."

McDonald: "That is a great point to make, is glass is useful everywhere, and you're experts in glass, you can help them there."

Jung: "Yes, exactly."

McDonald: "Do you have an example of maybe a glass fact that someone outside of the materials research field would be really excited to learn that glass can do? Or some property of glass?"

Jung: "I don't know about a property, but I would say this. I would be willing to bet anybody listening to this podcast probably owns glass that was manufactured at Mo-Sci. And it could be from the glass that's in the fillings in their teeth. It could be the glass microspheres that are in the spacers in their cell phones or their rearview and side view mirrors of their cars. It could be in the glass that's in the electronic metallic pastes that are in literally everything that has an electronic circuit in it. We touch so many different things. But it's always inside. You know, very few things are like, 'Oh, yeah, I recognize that. It's something that I saw at that factory one day.' But everybody that's listening to this most likely owns something that came from here, which is pretty incredible."

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BREAK

McDonald: "The American Ceramic Society's Bioceramics Division is dedicated to stimulating the growth and activity of the Society in the areas of the science, engineering, and manufacturing of bioceramics, biocomposites, and biomaterials. Learn more about this Division at www.ceramics.org/bioceramics."

SECTION 3

McDonald: "I'm very excited to be talking to you today because you have such extensive experience in glass. I know on the healthcare side, you've been granted dozens of patents for healthcare innovations, from wound care to tissue guides to bone grafting. So, how did you get interested in working with glass materials?"

Jung: "That's an interesting story. So, it actually started, I was on a hunting trip. I was maybe 16 or 17 years old. And one of my one of my dad's cousins was actually a ceramic engineer

from Rolla. And he's kind of telling me about it, I thought it was kind of interesting. And so I ended up going to Rolla for engineering school.

And I took a course. It was just a one-hour survey course about all the different types of ceramic fields that there are. And so during this class, Dr. Day gave just a single one-hour lecture about…he talked about TheraSphere, he talked about bioactive glass and some other things, and he talked about nuclear waste vitrification. Basically his research areas. And after that class, I went up and I asked him if I could work for him as an undergraduate. I was going to be in town for the summer, and I wanted to know if I could have a job. And he said, 'Have you ever worked, done anything with glass?' And I said no. He said, 'Okay. Well, do you have a resume?' And I said no. And so he told me to put together a resume and come to his office the next week.

And so I did that, and I went, and we had a talk. And I explained to him that I worked with my dad pretty extensively in terms of building houses and redoing rental properties that we had. And so I knew how to use my hands, I knew how to work. And so he hired me. And basically the summer between my freshman and sophomore years in college is when I started, I learned how to melt glass. And so I've been doing it ever since.

And I worked for him for nine years when I was in school. I started off as an undergraduate, I worked for him for four years that way. Then I went to grad school to do my master's, my Ph.D. And it was just an incredible experience."

McDonald: "It sounds like an absolutely fabulous experience, yes. After you got your Ph.D., did you transition at that point into working at Mo-Sci? So you went from kind of an academic setting to working in industry?"

Jung: "Yeah. I actually finished writing my dissertation here. So, the building that I was in on campus was being renovated, and I had to move my office somewhere, and this was about three months before I was supposed to be finished. So I moved into my office here, and I basically worked 10 or 12 hours a day writing my dissertation. I think I defended on a Thursday, and I started work on the following Monday. So, yeah, I transitioned pretty quickly from academia to the working world."

McDonald: "How has the transition from academia to the working world, especially into industry and chief technology officer at Mo-Sci, how has that shaped or expanded the type of research that you've been able to do?"

Jung: "So, I still do a lot of research in healthcare. And when I was at the university, I was obviously very focused on bioactive glass. I still do a lot of work in bioactive glass. Since I came to Mo-Sci, we've done some great innovative work in scaffolding technology and the commercialization of MIRRAGEN and other things. And there are probably, I think last time I counted, somewhere between 10 and 12 FDA clearances that have some piece of technology that I invented in it. So, it's something that I really enjoy doing.

But I'm also very focused now on a lot of other areas of the business. And so, in terms of expanding the business or kind of just rounding out different business segments, we'll focus research there. Customers will come to us and ask for xyz glass for whatever. And we support that. And so I work in all, many different areas of glass. You learn from every area, though, and they all apply back to one another. And I think that's really what makes us good here is that we're not so focused on just one thing. That when something that seems kind of weird comes to you, we've got a history with a lot of families of glass, and so quickly we can get to some sort of path to a solution.

And sometimes it's not just a compositional solution, but it's a form factor. So maybe it's a specialty powder or a microsphere or a fiber. And since we manufacture a lot of these specialty shapes as well, we have that in our bag of solutions."

McDonald: "Are there any specific opportunities or challenges that Mo-Sci is looking forward to tackling or pursuing in the future?"

Jung: "That's a great question. So, we're expanding our manufacturing capabilities on site. And we're doing that to support basically just specialty glass manufacturing worldwide. There's been a few companies in the last several years that have gone out of business. And the products that they made, while their businesses may not have been successful in the end, the products that they were supplying to their customers are absolutely critical. And so you put enough of those things together, and you can build a successful business. And that's really what we have here.

And so, yeah, I want to say, I would say that we want to continue on the cutting edge of just technology. You know, we don't want to just make stuff that is a 40-year project. Those are important to the value of your business, but we also want to stay on like the new stuff, right? And when you're out in front, you really kind of dictate or can help dictate where technology goes. And you kind of define what the capabilities are. And so, we really kind of pride ourselves on staying out in front. And we do that through internal work, we do work with universities on a wide variety of different projects. Maybe we'll partner with them or be a small subcontract. But we're involved with a lot of the stuff. We're involved with maybe the Department of Energy, the Department of Defense. And so, you take all your knowledge and you help to really push, push things forward."

McDonald: "Oh, definitely. And that's one of the reasons why The American Ceramic Society is so grateful to have Mo-Sci as a Corporate Partner. Mo-Sci really represents just the innovation and the creativity that companies can embrace and really be able to offer to their customers. And, as Mo-Sci is a Corporate Partner of ACerS, I know you've also been very actively involved with ACerS. You are one of our Fellows. You helped served as the founding chair of the Bioceramics Division. So, how has being an ACerS member or a Corporate Partner meant to you personally and also Mo-Sci as a larger business?"

Jung: "Sure. I'm a big believer in networking. And so, the Society for me is really, it's a resource of people. You can do Zoom calls, and you can do Teams calls, and you can have your one-hour sessions. And those are important for certain things. But it is still very important

to have that face-to-face discussion with people. You follow up. You have personal relationships. People are much more likely to pick up the phone and call you because they know you and say, 'Hey, I have this problem,' or 'Hey, can you make this for us?' And just having that network has been very important to us. I mean, we're still a relatively small business. We're fairly well known in the industry, though.

And you're right. I have served as, I was the founding chair of a Division. We don't have new Divisions very often in The American Ceramic Society. But biomaterials has been something that's been around for 60 years, and the need was there, commercially speaking, it's becoming much more important to organize this group. And so, the opportunity was in front of me, and we took it. And so we have a new Division now. It's growing. And we have a lot of academic people, but we also have commercial people that are in the Division. And it's a nice add to the Society."

McDonald: "It definitely is. And we greatly appreciate being able to have this new Division that really shines the spotlight on this growing field of glass and ceramics research, which is definitely going to make a big impact on healthcare and all other industries as we go forward."

Jung: "Definitely."

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CONCLUSION

McDonald: "Managing acute and chronic medical conditions is a stressful and often laborious process. But thanks to Mo-Sci's continuing innovations, glass is helping to improve treatments for a wide range of diagnoses, and applications for these products will only grow in the future."

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 Steve Jung and Mo-Sci. 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."