Trey: Good morning, and thank you all for joining us. Today's webinar, "Chemical Resistance to Disinfectants," is brought to you by Eastman. Your presenters today are Kenneth Breeding, Dr. Yubiao Liu, and Cynthia Lewis. Cynthia Lewis is a market and insights strategy manager at Eastman Chemical Company in Kingsport, Tennessee. She assumed this role in May of 2013. Lewis is responsible for providing market insights and strategy for the medical portfolio in Eastman's specialty plastic business.

Joining Cynthia is Kenneth Breeding Junior. Kenneth is a sales specification associate for the specialty plastics business at Eastman Chemical Company also based in Kingsport, Tennessee. He is responsible for working with medical OEM, designers, and molders to drive innovation and new medical application sales development using Eastman's specialty medical-grade polymers.

Joining Kenneth is Dr. Yubiao Liu. Dr. Liu is a medical application development representative and medical technology platform leader. In 2012, Dr Liu joined Eastman Chemical Company as the medical application development representative specializing in Tritan copolyester applications in the medical device industry.

My name is Trey McDonald with UL, and I'll be moderating today's event. Please submit your questions by typing them in the question box located on your screen. Our panelists will answer them at the end of the presentation. We are recording today's event, and we'll send you a link by email when the slides have been posted to ulprospector.com. Now, I'd like to turn the presentation over to Cynthia. Cynthia?

Cynthia: Thank you very much. I'm really pleased to have all of you today with us. What we're gonna be talking about is chemical resistance in the world of medical devices. The life of medical devices is being shortened, and the performance is being compromised by a variety of external forces in today's healthcare environment. We'll look at the pressure that these forces exert on medical devices focusing on health care-associated infections, which we will call HAIs, and the resulting use of aggressive disinfectants in hospitals and other healthcare settings. We'll take a look at the need for chemical resistance in both clear and opaque devices and, finally, the results of testing to evaluate the impact of common medical disinfectants on leading engineering polymers. And, finally, at the end of this presentation, we will have an active question and answer session.

Today's medical devices must measure up to many standards with patient safety always being the ultimate goal. Medical devices do more for caregivers and patients with each innovation in medical and polymer science. They do more. They look better. They are lighter. They are easier to use. Devices are becoming more portable and come in contact with more people. And today's devices often are operated by patients as well as trained professionals. In addition to constant handling, devices must withstand frequent usage of aggressive disinfectants, disinfectant wipes, and sterilization as part of the increased emphasis on preventing HAIs.

So far, we've mentioned the forces that put pressure on the outside of devices. Many devices also must withstand attack from within, from powerful cancer and oncology drugs and their carrier solvents. And, of course, devices must stand up to this changing use environment cost-effectively for the greatest lifetime value of each device.

Before we talk more about HAIs, we want to define our terms. You'll see HAI used to refer to hospital-acquired infections, especially when talking about Medicare reimbursements implemented through the Center for Medicare and Medicaid Services or CMS, as we'll see in our next slide. This interpretation speaks specifically about patient infections that are not present or incubating at the time of admission to the hospital.

HAI is often used in a broader sense to stand for health care-associated infection especially by the U.S. Centers for Disease Control, the CDC, the World Health Organization, WHO, and other organizations who want to include settings beyond impatient acute care. This broader interpretation addresses healthcare workers as well as patients, and it includes outpatient settings such as ambulatory surgery centers and dialysis facilities. It includes long-term care settings such as nursing homes and rehabilitation centers. And it may even include home care usage.

Naturally, the health care industry's biggest concern is that HAIs put patients at risk. But HAIs contribute significantly to higher medical costs by extending hospital stays and readmissions. And now, HAIs cause reduced profitability to the hospitals who are currently operating at a one and a half percent profit margin.

In 2009, CMS began refusing to pay for some readmissions resulting from HAIs. Beginning in 2012, as part of the Affordable Care Act, CMS has a readmissions reduction program that lowers payments to hospitals with excessive readmissions, including HAIs. The links to this information is available in the notes section of this presentation, which you can download. As a result, U.S. hospitals are taking major steps to reduce and eliminate HAIs. More stringent disinfectant protocols have significantly reduced HAIs as reported by the CDC. But the long-term goals are yet to be achieved. As you can see the cost related to HAIs drive the cost of health care up in the U.S. $10 billion.

Collaborating with the CDC, Medicare has concluded that five types of HAIs are preventable when proper disinfection and aseptic clinical protocols are followed. These infections are associated with commonly performed procedures and often involve a device and patient interaction. Even Clostridium difficile, for example, which can work on a hard surface for five months or longer, requires an interaction between a patient and a hard surface. Usually, this patient is a weak patient who is critically ill. The hospital care...excuse me.

The health care industry is aggressively applying systematic disinfection and aseptic clinical protocols attacking infectious pathogens in two ways. These two ways are environmental cleaning and aseptic protocols. It's important for medical device makers to understand that hospitals have made significant changes in how they behave to proactively attack and prevent HAIs. It is also important to remember that both of these lines of attack involve the use of aggressive disinfectants, which can attack the appearance, performance, and life cycle of many classes of medical devices.

Let's look closer at each point of attack. Environmental disinfecting is especially important because organisms can live on dry surfaces from 2 hours to 46 months, depending on the pathogen. This table shows the survival rates of hospital pathogens, including the two most common superbugs on dry surfaces. Bleach does a great job of killing these microbes. Therefore, one of the major changes that hospitals have made in the past five years is widespread use of products containing bleach. All hard surfaces are wiped down with and, in some cases, soaked in bleach. Bleach leaves a residue, which patients perceive as dirty. So a second product is often used to remove this residue. The end result is a shortened life cycle of surfaces on equipment. Many device housings experience environmental stress cracking and can prematurely fail.

Because of clinical evidence, Chlorhexidine-isopropyl alcohol preparations now dominate the market. And wet IPA is pervasively wiped on the clinician's hands, on patient's skin, and on devices that touch patient's skin. Because of these practices, HAI rates for catheter-associated infections are falling significantly. However, today's medical devices, both disposable and reusable, are subject to higher levels of chemical attack from isopropyl alcohol, among many other agents. And we will address this list of active disinfecting agents later in this presentation.

Disposable catheter hubs, connectors, y-sites all visibly crack, causing clinicians to doubt their safety and quality. Devices designed 5 or 10 years ago are experiencing performance and functional issues. This can be after just a few minutes of active use for disposables or a few months in the case of a reusable monitor or portable imaging equipment. Because of this, device designers and manufacturers are looking for new materials that can perform better in this new use environment.

As consumers, we're all familiar with the hazing and crazing that result when molded plastic parts come in contact with even mild chemicals. Our sunglasses become cracked and brittle after repeated exposure to body oils and sunscreen, for example. Or our glassware becomes cloudy after a few times in the dishwasher. Excuse me. Our medical devices today must face even greater chemical attack from lipids, medical disinfectants, hospital cleansers, drugs and carrier solvents, the bonding agents that are used during fabrication, adhesives that are used during fabrication, and plasticizers that dwell in connecting flexible PVC parts. The device also must face the stress of constant use and handling.

Remember, when we talk about chemical resistance, we're talking about more than chemical compatibility. We're also talking about the stresses applied during fabrication and during everyday use. We'll look more closely at the fundamentals of chemical attack in the next section and will see that the ideal polymer for medical devices would have all of these attributes listed here in order to function well in today's challenging use environment.

I'll now turn to the technical details, and my colleague Ken Breeding will lead you through this section.

Kenneth: Thank you, Cynthia. Now, we're gonna transition over to, as she mentioned, a closer look at our information on what is chemical resistance, how is it measured, and what it looks like when you take some of these engineering resins that are currently used in the medical device market, how they compare on the same testing beside each other. So go on the next slide please.

So fundamentals of chemical resistance are in some cases known as chemical compatibility. We also know, we've heard already in this presentation, about environmental stress cracking. Environmental stress cracking is the one thing we know that we recognize in a device. When you spend a lot of money and resources on developing a device and get it launched into the market space, the last thing you wanna see is it fail due to environmental stress cracking. So a lot of times, engineers for medical device [inaudible 00:13:20] have to do their own protocol testing to measure and see if the product can meet the fitness for use for the application. But any kind of chemical attack that occurs, it has to have...not only just the material itself. You have to have stress applied, maybe through applied or residual, and you have to have the chemical itself. Next slide please.

Now, details of chemical resistance. Here's another slide we'll talk about chemical reactions between polymers and chemicals. There's a lot of things that go into play here. A lot of times, it's a lot more difficult to explain, but when you think of a solvent itself or a chemical in contact with a plastic, sometimes it has to be the solubility characteristics of the solvent as well as the plastic and the stress. You take away any one component of this, you do not have this environmental stress cracking. But in most cases, when you think of plastics and medical devices, whether it's residual or applied, there are stresses in the polymer itself. And you do know, as we just pointed out, there are more aggressive chemicals now in the market that are now aggressively attacking a number of the engineering polymers that have been in market for over 15 years. Next slide please.

Here are some examples. We have haze shown on the far left. We have spotting in the middle. And you have what we also have been talking about, stress cracking. Haze may be just a cloudy surface. Spotting may be where you might see some pits or pieces of the material that is dissolved. And then on stress cracking, you see where the cracks are occurring on the surface, and that's where you have a complete catastrophic failure. Next page.

There are factors that can affect chemical attack, temperature as you go up. And temperature, the reactions can be more aggressive. Stress concentration of the material or the notch sensitivity of the material can come into play. Fatigue, it can also come into play on the design of the part. And the concentration and the exposure time, which is also as the main primary catalysts for what causes environment stress crack resistance. Next page.

So what we've done at Eastman, we've been looking for a number of years at this issue as the market changed. And we've been focused on what can we do to measure our materials against other materials that are in this market and learn from this and what is the main drivers that's causing the chemical attack. Next slide please.

So predicting chemical resistance behavior. We have taken the current ASTM test, which is D543, which is for testing the chemical resistance. And what we've done, we've now recorded a lot of information on chemical compatibility or chemical resistance of air[SP] materials benchmarked against engineering polymers used in medical devices. There's an ANTEC paper that was presented last year in Orlando on chemical resistance, and there's one that goes back two, three years ago that was on residual stress. Both of these are related to some of the work that we've been doing internally at Eastman's technology labs to understand the chemical resistance behaviors and materials. Next slide please.

This is a busy slide, but I wanted to go into this a little bit so I can help you explain what's going on. We have four different materials, [inaudible 00:16:44] applied, of material. So upper left is the Tritan MX711. To the right is a lipid-resistant polycarbonate with a melt flow rate of about 6. To the lower right is a medical acrylic. It's widely used in the medical device market. In the lower left is a medical general purpose polycarbonate with a melt flow of about 15. Next slide please.

At this point, we're gonna launch the video to show you a time lapse photography of these parts all exposed to the same disinfectant, and they all have the same applied stress. You can see the acrylic is the first one to stress crack starting from the middle where the applied stress is. The general purpose polycarbonate is second. The upper right is the lipid-resistant polycarbonate. You can see the edge crazes that are occurring and cracking. And now you're starting to see cracks form from the center where the applied stress is. And the Tritan in the upper left hand corner is not showing any chemical attack. All these were again exposed to Virex Tb, a common disinfectant used in the hospitals. You can go back to the slides, if you'd like. And next slide.

So what we've been doing is understanding when we work directly with medical device OEMS and the hospitals, we're trying to understand what are the typical and disinfectants that they're currently using and why, and what is the active ingredients in each one of those common disinfectants. As you can see on this page here, a list on the far left, the active ingredients. We've already mentioned isopropyl alcohol, quarternary ammonium chlorides, phenolics, the iodine, alkaline, peroxides, hypochlorite, and chlorhexidine. These all are the different ones that we've run across in the last four to five years.

The ones that are more aggressive are the ones that have the isopropyl and the chlorhexidine gluconate and phenolics. Phenolics probably are the most aggressive on what we've been seeing on all plastics. The Sani-Cloths are the ones that we run into the most with most of the device companies we're working with, and they have the quarternary ammonium chloride along with isopropyl. So we're gonna move into some data that Eastman has generated as well as comparing with other materials as well as working with ASTM standards we talked about earlier. Next slide please.

So here's how we measure our chemical resistance or chemical compatibility. We take a strain gauge. We place molded plastic samples on there. We put a patch on there and soak the patch with the disinfectant. We allow it to sit for 24 hours at room temperature. And then we do the backside impact test to measure if it became ductile or brittle based on any kind of environmental stress cracking that may have occurred. Next slide.

So here are some data showing the Eastman Tritan copolyester. There's a standard flow of MX711, or standard grade. We have the high flow grade, MX731. The chemical compatibility or chemical resistance of those two materials against some of these common disinfectants is holding up very well. If you look at high flow polycarbonate or standard flow polycarbonate or even the lipid-resistant polycarbonate, you're seeing chemical attack based on some of the active ingredients in these disinfectants. The other one is the impact modified styrenic in the lower part, and it also shows chemical resistance [inaudible 00:20:27] against mostly isopropyl alcohol and iodine. Next slide please.

Continuing to look at chemical resistance with some of these common disinfectant cleaners, the ones that show the most aggressive attack is the phenolics. But, again, if you look at the ones that we were talking about earlier, the benzyl quat ammonias, the isopropyls, Tritan holds it very well. The polycarbonate, the materials at all three grades, the standard flow, the high flow, and the lipid-resistant, all are cracking and failing. When you say it's broke on a jig, that means, basically, under the stress that was applied and the solvent that it broke and was no sample left to do testing or measure any data afterwards. Next slide.

The other grade that we haven't talked yet is the MXF121. That's another family of Tritan products, but it's for the flame-retardant applications, typically, medical electronic devices. That material in itself is based on Tritan copolyester polymer. Incumbent materials that are typically in this market are PC/ABS. These other grades of polycarbonate with polyester alloys are also in this market. But what we're trying to demonstrate here is Tritan MXF121 has performance that is superior to incumbent materials PC/ABS that you'll find in these applications. These would be the skins or the outside enclosures of [inaudible 00:22:01] housings and drug delivery systems that have a catheter system hooked up to it. It could be a diagnostic system. There's a lot of different types of applications out there. So a number of these are now failing simply because the polycarbonate/ABS blend is not able to withstand the current chemical attack that's going on in the environment. Next slide please.

So chemical resistance summary, we recognize that residual stress is one of the drivers to causing chemical attack. Tritan copolyster has lower residual stress situated to the modulus and the glass [inaudible 00:22:37] temperature, excuse me, a longer cooling window. Polycarbonate always has a higher modulus and higher residual stress. And typically, most molders that run polycarbonate recognize you either have to slow down the process and use a hotter mold with the biggest recycle time or you have to do secondary annealing to help reduce some of that stress.

Toughness when you think of ductility or impact string, Tritan coploestyer is very tough, just like polycarbonate. Most of the other engineering polymers that are in the market, like acrylics and styrenics, are not necessarily what we consider tough.

When you look at chemical compatibility under stress, basically, our sample that does not [inaudible 00:23:24] stress crack or craze and therefore maintains its mechanical performance. You look at the copolyesters in general, they do a very good job in this market environment. Polycarbonate does have clear effect on chemical incompatibility. In other words, it will environmental stress crack very easily when exposed to common disinfectants in the hospital as well as the drug carrier solvents that are used in the oncology chemotherapy drugs. Same thing for the impact modified styrenics.

Overall chemical resistance or chemical compatibility, the copolyester has a very high, particularly Tritan. Polycarbonate would be considered medium at best. And the styrenics were considered very low. Next slide please.

Common secondary operations also can come into play on chemical resistance or chemical attack. Solvent bonding is one of those. When you think of bonding a rigid connector lure, like a male-female connection or stopcock, to flexible tubing, it could be PVC or your thing typically. You can typically use adhesives or solvent bonding. The solvent itself typically, one of the more common ones is called cyclohexanone, can be very aggressive towards some of these engineering plastics. In the case of the Tritan copolyester, there's not a chemical attack per se, but you do get really good high bond strings with the tubing and the rigid materials. So that typically means you have a much better device. You don't have to worry about the pull strength of the lure being pulled off the tube. You will get tubing failure before you get bond failure.

There's a lot of UV adhesives in the market space. We've been working closely with Henkel and Dymax are the main leaders in adhesives. And there's a lot of data that Eastman is generating today that we could share through our technology organization to support any program you might have. Same goes for ultrasonic welding. There's a lot of work that's been done on Eastman's durable side and the medical side looking at ultrasonic welding of resins and looking at how copolyesters weld compared to other materials. Again, the technology organization has a great resource for that information.

We've also done a lot of work on laser welding and laser marking. This is, again, a common area that we've been recognized in a number of medical devices, particular when it comes to laser marking, when you're putting coding on the device. This is something that we can share as well to your technology organization. And the second or last thing I wanna mention is the thermoplastic elastomer overmolding. A lot of these devices sometimes have soft touch or soft feel additives put on the surface of the rigid part. And that's to help them for patient comfort and safety. There's a number or TPEs that we've worked with out there in the market. Again, technology organization is a great resource at Eastman that we can share that information with you when you're looking at our materials in a medical device. Next slide please.

Sterilization, commonly gamma or E-beam is the common...some of the two major sterilization methods used in medical devices. One of the key things to point out here is a lot of materials have been used for a long time, and the medical device market has been living with what we recognize as a color shift. Basically, you mold a part or make a device. It may be a clear part, or it may be a slightly colored part. But if you do sterilization, you do see some shift in the natural color that you did as molded. In the case of the copolyester, in this case, the Tritan family, you see very minimal color shift after sterilization, and it recovers very quickly too close to the natural that you just molded. So that means you have a product now that you could control if you have a device that you need to have it in a transparent opaque color. It will now maintain that color after sterilization where before you're having to live with that shift in color. Next slide please.

So in summary, there are several test that Eastman [inaudible 00:27:24] perform chemical resistance. We have this information that we keep to share with our customers. And we share it typically in a way that it helps them make good choice or sound decisions about material selection when you are looking with medical devices and you're trying to look at the downstream environment that the device would be exposed to within the time of its life. We have looked at the polymers and the chemicals. We've looked at the stress and the time and temperature that these are all exposed. We've been trying to look at actual fitness for use requirements in these applications and trying to correlate what we're doing with...and an accelerated version of what could actually happen in that environment. And our Tritan copolyester has been shown and has got the best combination of chemical compatibility, physical properties to be used in medical applications. So at this time, I think this is the last slide. Is it? We could probably start working into the opening up of the question section.

Cynthia: Thanks, Ken. All right, some of you have published your questions. And let's see. Let's start off with in which applications are you seeing this polymer being used?

Ken: You want me to answer that?

Cynthia: Yes, Ken.

Ken: There are a number of applications, anything from blood applications to chemotherapy drug delivery systems to syringes to opaque housings on diagnostic equipment, ultrasound equipment. There's a lot of different applications. But the only thing I can say that we're not in is long-term implantables. So things that are typically 28 days or less, you can think of a device from a stopcock to the manifold to male/female connectors. We're basically in all those.

[00:29:32]
[silence]
[00:29:46]

Cynthia: A question from one of our attendees, was STERRAD and STERIS usage evaluated?

Dr. Liu: The answer is yes. We tested other low-temperature hydrogen peroxide to plasma sterilization with all the materials, including Tritan copolyestyers. Eastman copolsters have very good physical property tension in terms of [inaudible 00:30:16], optical clarity, and also the chemical compatibility.

Cynthia: Have you tested this resin for reusable sterilization like autoclave, hydrogen peroxide sterilization? We just answered that question. Okay, the autoclave...

Dr. Liu: No, Eastman copolyesters, those material has [inaudible 00:30:43], you know, not suitable for autoclave. So we never tested our material, you know, after steam sterilization.

Ken: I mean, to help also expand on that is [inaudible 00:31:00] if you're using a single-use disposable device and you do not want the hospital to reuse it, this [inaudible 00:31:07] Tritan materials or our copolyesters will not be able to pass an autoclave test. So you'll get deformation. Next question.

Cynthia: The next question is is the FR [inaudible 00:31:32] referenced halogenated or non-halogenated? Ken, I think you can take that one.

Ken: Yeah, I'll take that one. It's non-halogenated. We were working with a company that was going to be launching a product in North America and in Europe. And in the European market, they wanted to be non-halogenated. Over in the North American side, it didn't seem to matter. But it is non-halogenated.

Cynthia: Does Eastman have a notification of change policy?

Dr. Liu: Yes, we do. All the Eastman copolyesters, the medical grade, ISO [inaudible 00:32:17] certified, and we offer the notice of change notification to the customer.

Ken: The answer to the question is yes.

Cynthia: We have a question regarding...well, they point out that most of this data was based on Tritan. And they'd like to know more about how the Tenite family performs in comparison. We'll have to take that question offline. Make sure that you put your email address into the form, and we can get back to you specifically on this.

Dr. Liu: I can have a comment on this. We do test it, you know, the Tenites, with the same testing, you know, protocol. So, overall, Tenite has pretty good, you know, chemical resistance in terms of the disinfectant oncology carrier solvent and also oncology drug. And we can collect more information, you know, if you give us their contact.

Cynthia: [inaudible 00:33:31] questions are pouring in. This customer is asking what the rough cost estimate is comparing the Tritan family to PC/ABS. Ken?

Ken: From a cost perspective, it's very similar. I mean, typically, in these applications, it depends on, you know, basically the volume. And the one way I wanna point this out is the applications at Eastman is currently running [inaudible 00:34:13] Tritan MXF121 where originally [inaudible 00:34:17], the molds were built for PC/ABS, and they were gonna launch in PC/ABS. But they went to the Tritan MXF121 for the reasons that they needed to go there. So combination of chemical resistance or compatibility was one of those. So cost differences are not that different. I mean, I think at this stage, I can't comment much on price, because [inaudible 00:34:41] have to know more about the opportunity, then I can talk about then. So if there's anyone that's interested in learning more about the PC/ABS alternatives, just send us an email and let us know who you are, and we can definitely work out and talk with you about that.

Cynthia: Okay. Is the FR-grade also tested to ISO 10993?

Dr. Liu: The answer is yes.

Cynthia: Yes. Okay, and what biocompatibility testing has being carried out? Definitely, the ISO 10993. Anything else?

Ken: We've been testing, minimal testing, typically for class one device. So we've done skin sensitizations and things like that, but we didn't do full implantables.

Dr. Liu: Yeah. This is for the MXF, you know, 121. But for the regular Tritan, Tritan family of 711, 731, we have a full, you know, biocompatibility test, like, you know, skin sensitization, a [inaudible 00:35:44] test, maximization test. Yeah, we have the full test.

Ken: Correct.

Cynthia: Are these resins readily available in China? The answer to that is yes.

Ken: Yes.

Cynthia: What is the melt flow the MX711?

Dr. Liu: The melt flow of 711 is around, like, 9, you know, comparing it to...we have a high flow version, MX731, which is [inaudible 00:36:18] 16 to 18, depends on the temperature and pressure.

Ken: Yeah, they're very comparable to lipid-resistant polycarbonate and a high flow polycarbonate, pretty close on viscosity.

Cynthia: Do PETG or PET have similar environmental stress cracking resilience as Tritan?

Dr. Liu: So, overall, you know, Tritan is [inaudible 00:36:48] performance the chemical compatibility, you know, comparing to other material like PETG and PET. PETG, overall, you know, also has a better compatibility comparing to polycarbonate. So the key issue here is those material, you know, they have a inherently lower molding stress in the parts comparing to polycarbonate or polycarbonate/ABS alloy. So, overall, PETG has a better, you know, [inaudible 00:37:24] comparing to polycarbonate.

Ken: Yeah, like as you point out, Tritan is still superior over PETG.

Cynthia: Okay is the material FDA-approved to be used in medical applications?

Dr. Liu: The answer is yes.

Cynthia: And do you have ISO 103485?

Dr. Liu: For this one, I'm not that familiar with this ISO 1034. So, yeah, send us more information. You know, we may follow up with this.

Cynthia: What about the stress cracking resistance to fuels and hydrocarbons?

Dr. Liu: Overall, you know, it really depends on the application. But we do, you know, had some in-house testing, you know, using the immersion test. We submerged copolyester, the sample, in the hydrocarbon, such as [inaudible 00:38:31], heptene, hexene. You know, those type of, you know, short-chain hydrocarbon. We do we do not see distinctive, I mean, the volume change or weight change or color appearance chance. So, overall, you know, for the short period of time, we should have a [inaudible 00:38:56] very good, you know, chemical compatibility. But in the long run, you know, it's not recommended for the long-term storage or contact with those kind of chemicals.

Cynthia: Do vapor environments rather than liquid solutions present longer term risks? How can these be addressed?

Dr. Liu: This a good question. We do have some kind of, you know, customer asking us about some chemical compatibility in terms of the gas, you know? For example, like the static in drugs, you know, those are all like hydrofluorocarbon. And as you see, the today's presentation, you know, all our testing, it's based on their liquid, you know, chemicals has direct contact. And we do not have, like, validated, you know, testing protocol for the gas. But, overall, you know, when you are evaluating your material, the product performance, basically, you can set up, you know, [inaudible 00:40:04] based on each application, set up your own acceptance criteria, such as, like, the optical clarity change. Or maybe, you know, before and after the exposure at the sudden temperature and pressure, and you measure, you know, the physical property, the change before and after, and you can set up your own testing, you know, like acceptance criteria. We answer this kind of question to our customer, so basically gave the recommendation. So hopefully, they can borrow the principle of our existing testing protocol to apply to their own, you know, testing method.

Cynthia: We have another question that is about processing. One of the participants said that they've been working with Tritan TX1501HF, and they found that it's been a little difficult to process. They would prefer not to use mold release agents. And so they'd like to know more about the performance of these materials in that environment. Ken, would you like to address that?

Ken: Well, I mean, again, it would be something that we have technical resources, strictly, field tech service reps that are good about understanding the mold process, the mold conditions, the tool design to better understand what's going on in your application with TX1501. We do have [inaudible 00:41:40] of any kind, injection molding applications. We typically recommend running with a mold release additive. But there are some cases where they're not. And, again, it goes back to the mold designs. So that's where we have expertise, and we have people that are willing to openly share that information, if you would like to work with us on this opportunity or project. So if you do show interest in our MX grades, which are medical grades, and you wanna meet with us, please let us know through contacting us, and we'll definitely set up a face to face meeting with you and have this discussion further.

Cynthia: What is the transparency percentage for display applications?

Dr. Liu: As you know, Tritan copolyester has an excelelnt optical clarity. It has very low haze and a very high transmittance. You know, in the visible range, it's over 90%.

Cynthia: What is the mechanism by which environmental stress cracking occurs? And what happens on the molecular level?

Dr. Liu: This is a good one. So as you see from the slide, it also mentions, you know, the take home message for environment stress cracking. So, basically, for the chemical to have contact with the materials, you know, it takes energy to break down their polymers, you know? So, basically, there's no chemical reaction happens between chemicals and the molecules. So the mechanism for [inaudible 00:43:23] cracking, it's more like visco-elastic behavior for the material, the polymer chain, they have, like, entanglement to each other during the injection molding process with the chemical and stress applied to the material. So polymer chains, it's more like a going through this entanglement process.

So when this polymer chain under the stress, with the help of the chemical exposure, and then the polymer chain will slide against each other, they will generate some kind of, you know, the void between the polymer chain. And then with time goes on, with the help of the chemicals and stress, the [inaudible 00:44:10] becomes craze. And craze [inaudible 00:44:13] grows bigger to form the crack. So that's pretty much, you know, how the parts goes through the environment stress cracking, you know, in the molecular level like this.

Cynthia: Is the shrinkage of Tritan comparable to polycarbonate? And can Tritan be molded in the existing PC mold?

Ken: The answer to the question is the shrink rates are basically the same. And the answer to the question about molding in existing polycarbonate molds, that can be a yes/no question. In most cases, the process can be adjusted, and it will probably run in the existing mold. It may not work at the same cycle time. It may be based on the features of the design. There might be some tweaks in the mold that may be required to make it more process-friendly for the Tritan material. But, actually, in more cases, it does work just fine in existing polycarbonate molds. And, again, it's a case-by-case basis.

Cynthia: What about the operating temperatures? Is the dimensional stability of your product guaranteed at a temperature range of about minus-20 Celsius to about plus-50 Celsius?

Ken: You wanna answer that, Yubiao, or do you want me to?

Cynthia: That's centigrade, sorry.

Ken: Yeah, I figured it's centigrade, yeah. It's got good impact strength at below zero. There's been some testing that we've done with some packaging applications that shows good toughness at low temperature. And it certainly has good toughness at 50 C. You wanna comment anymore about that, Yubiao?

Dr. Liu: Yeah. Actually, you know, the Tritan copolyesters has over excellent, you know, low-temperature toughness property. You know, we got customer, they use material, you know, even down to their liquid nitrogen temperature, still keeps the good toughness without showing the [inaudible 00:46:23] failure. So, definitely, Tritan, for low temperature, it's very suitable for that kind of application.

Ken: Yes.

Cynthia: What precautions need to be taken during ultrasonic welding to avoid environmental stress cracking?

Dr. Liu: You see the Tritan copolyester is suitable for ultrasonic welding. And, definitely, when you are selecting pick up the suitable parameter for the welding process, using, you know, the appropriate pressure and welding time, the force, speed, trying to minimize the welding stress in the parts, you know, if you do it, like, you know, more aggressive way to introduce, like, residual stress into the welding joint parts, it's always the weakest link for the parts. And then when they are exposed to the chemicals, you may have some problem in the future. So, definitely, be aware of that, trying to minimize the welding stress.

Cynthia: Can annealing disfigure your parts?

Dr. Liu: It depends on your annealing.

Ken: [inaudible 00:47:46]. Typically, your annealing temperature is below the glass transition temperature of the polymer.

Dr. Liu: Yeah. And, overall, as we said, a polycarbonate has a higher molding high stress, they need annealing after the product is made. For Tritan, for Eastman copolyester, the family, we have our low, you know, molding stress in it. So, overall, we don't need annealing, you know, for the secondary, I mean, process.

Ken: Yeah, you don't get any benefits by annealing Tritan like you would in polycarbonate. So it's not really something that we [inaudible 00:48:20] that often.

Cynthia: And there are 94V-0 upgrades available?

Dr. Liu: [inaudible 00:48:29].

Cynthia: Not at the moment. What cautions need to be taken during laser marking to avoid environmental stress cracking?

Dr. Liu: As we say, Tritan copolyestar, can be laser marking without any additive in it. Not like many other technique or other material, they need additional laser absorber, you know, to give the good contrast. We have some, you know, success story, you know, using Tritan with laser marking. But in terms of environmental stress cracking, we have limited knowledge at this point. But, overall, I would say the chemical compatibility, you know, for laser marking parts, you know, if they are only made it on the surface of the parts, we will not see any distinctive differences. I would say maybe the chemical compatibility should be still the same.

Cynthia: Does the range of disinfectants currently represent the global marketplace or just the U.S.?

Dr. Liu: This is a more, like, you know, the overall study. You know, we go through the CDC report. I think this is more, like, related to the global market. And maybe in different region, some of the medical disinfectant or chemicals is not available in that area. So the customer, they have to be cautious about what kinds of chemical has potential contact with the products and then be actively looking for the type of ingredient, you know, to be aware the potential risk of the material selection when they're exposed to those chemicals.

Cynthia: Is there a possibility of in-mould labeling?

Dr. Liu: Yes, the answer is yes.

Ken: It's already being done.

Cynthia: [inaudible 00:50:42] slides. Yes? I'm sorry, Ken, I interrupted you.

Ken: I was just gonna say it's already being done commercially. So that's just kind of [inaudible 00:50:49] people know that.

Cynthia: Can tracking be coded with...

Dr. Liu: [inaudible 00:50:57].

Cynthia: [inaudible 00:50:58] hard coding? Any feel for adhesion of coding to Tritan?

Dr. Liu: Yes, the answer is yes. We do have, you know, several success story about Tritan coded with a different type of hard coding. Overall, you know, the Tritan has similar, like, hotness comparing to polycarbonate. But they are not as good as acrylic. So we do have customers that are looking for improved scratch resistance. So we test it in several type of hard coding. It works very well, you know, without sacrificing the toughness and also keep the same optical clarity and also, definitely, I mean, improve the hardness of the surfaces.

[00:51:46]
[silence]
[00:52:00]

Ken: Any other questions?

Cynthia: Have you performed any environmental creep testing as opposed to constant strain testing? Reverse impact testing published? Is this data available?

Dr. Liu: [inaudible 00:52:20] creep testing. This is a good one. You know, actually, as we said, we presented that there was an impact testing results. There's a ongoing project right now doing the creep testing [inaudible 00:52:40] at a given temperature and humidity. And as you know, this takes much longer time for us to get the reports. We can follow up with that.

Ken: Yeah, that's the only thing we have announced. Under ASTM, the creep module is done at different loadings.

Cynthia: And there are several people who need to contact us to follow up with the presenters on potential applications. Yeah, we do have your contact information as you signed up today. And we will follow up on any questions we could not answer or need to discuss further.

Cynthia: Yeah, I think we're out of time. There's been so many questions pouring in here. But we will get back to each of the respondents. We do have your contact information. And in closing, you will be able to download this presentation. Several people have asked that question. And if you need more information, just reach out especially to Ken. And we really appreciate the time that you took to spend this time with us today.

Trey: Perfect, Cynthia. And a big thank you to our other two presenters, Dr. Liu and Kenneth, a big thank you to everybody at Eastman for a really great, informative presentation. As Cynthia did say, we will be sending you guys a copy of these slides and a download link for those as well as the recorded copy of the webinars. You can also share those with others at your company and then watch that again on your leisure. So, again, a big thank you for everybody for attending, and have a great rest of the day.