Trey: Hello, everyone, and thank you all for joining us. Today's webinar, "Trendwatch: Materials Matter for Advanced Mobility" is presented by PolyOne. Your presenters today are Brad Trembath and Kelly Wessner.

Brad is the national sales manager for PolyOne's Specialty Engineered Materials transportation business focused on the automotive and on/off highway vehicle market space. He manages the team of sales professionals strategically spread throughout North America that works in the traditional thermoplastic market space as well as new technologies aligned with automotive driver assistance systems and electrification. Brad's education includes a Bachelor of Science in Mechanical Engineering and an MBA, both from Michigan State University.

Joining Brad is Kelly Wessner. Kelly is the global transportation marketing director for PolyOne's Specialty Engineered Materials business. Prior to joining PolyOne, she worked for GE Plastics, SABIC, serving as OEM director for General Motors. Previous positions at GE Plastics included account manager, global application development leader, and application development engineer. Kelly holds a Bachelor of Science degree in Mechanical Engineering from Purdue University.

My name is Trey McDonald with UL, and I'll be moderating today's event. You can send us questions by typing them in the question box located on your screen, and then a panelist will answer them at the end of the presentation. We are recording today's event, and we'll send you a link via email when the slides and video have been posted to the UL Prospector Knowledge Center. With that, I'd like to turn the presentation over to Brad. Brad?

Brad: Thanks for the introduction, Trey, and hello everyone. Thank you for joining me and Kelly today for what we hope will be an informative and enlightening discussion of materials that are shaping the future of personal transportation.

Before we get started, we wanted to let you know that you'll be receiving the slides from the webinar from UL Prospector in a follow-up email. So it should come as no surprise to anyone that advanced mobility technologies are moving faster than ever before. We might not have a flying car in every garage, but we're definitely getting closer to the "Jetson" era. And what's behind all this exciting change? Consumers and their evolving needs, wants, and behaviors are a big factor.

Safety is another major reason. There is an increased attention to keeping all of us safer on the road these days as more and more cars hit the highway. It helps to remember that society was mobile way before smart phones. We basically invented the wheel and charged ahead from there.

In reality, the factors driving mobility advances are as varied as the ideas in materials that are needed to address them. And the pace of change is unprecedented. For example, the trend towards reurbanization is drawing younger and older consumers back into cities like never before. This mass migration is affecting everything from infrastructure and building projects to transportation modes, both public and private. It's affecting what it means to get around town.

So who's really behind the wheel? Car sharing or collaborative consumption is giving the term carpool a whole new meaning. It's also giving OEMs new ideas. Consumers are empowered today thanks largely to the internet and social media, which provides more immediate and direct feedback channels. Consumers are talking, and manufacturers are really listening. Even crowd-funding sites combined with more accessible, affordable tools, such as 3D printing and rapid prototyping are having an impact.

Kelly: Today, we'll look at four trends that we see shaping the future of advanced mobility. For each trend, we'll also take a look at the design directions resulting from it, as well as the material requirements and solutions.

Trend number one is automotive connectivity. It has been part of the landscape for some time now. We're all familiar with hands-free Bluetooth and voice control for systems such as entertainment, climate, and navigation. This is really just the beginning. Automakers have shifted. They used to be hardware providers who moved us from point A to point B.

Now, they're software, hardware, and experience providers who are "changing the way the world moves." That's a direct quote from Ford's CEO, Mark Fields. And he's not just talking about change. Ford's SYNC Connect technology, as well as similar technologies from other OEMs, allows you to remotely start the

vehicle, unlock your doors, track the fuel, and much, much more, all from your smartphone. From voice-activated infotainment centers that keep us in the groove without losing our grip to sophisticated smartphone apps that allow us to remotely manage performance and maintenance from anywhere, our cars are helping us do more and be safer.

Creating vehicles that connect on a personal level is no small feat. To do it, manufacturers are blending hands-free and hands-on technology to create more personalized driving experiences. And as we continue to expect more from our car interactions, yet, expectations for the material that enhance them are growing, too.

Design thinking for automotive connectivity of the future is centered on a few things. Personalization, including the ability to design your own interior colors and finishes. Communications, component housings that have conflicting requirements, unfortunately. Creature comforts that still have to maintain safety while performing well.

What are some of the materials that can meet the challenge of these design directions? For thermal management, conductive polymers take the heat and dissipate it in heat-sensitive systems, such as infotainment systems and automotive LED lighting. For functional aesthetics, TPEs bring a soft touch in wide range of colors, while certain polymer additives can provide color harmonization across multiple polymer types. For vibration management, TPEs can also be customized to dissipate vibration as small amounts of heat, which can improve comfort in seats, and also stabilize sensitive electronics. TPEs are no longer just for look and feel. They've become very functional.

Finally, there's a huge need for shielding. There's more risk of crosstalk than ever before in vehicle interiors, and that's a real safety concern. Specific EMI/RFI shielding and conductive formulations are the solution to this challenge.

Brad: Trend number two is the rise of advanced driver assist systems, also known as ADAS. These are the eyes, ears, and bodyguards of our modern vehicles. From backup cameras and blind spot monitoring radar, to sensors that keep tabs on environmental conditions and enhance performance, these systems are making travel safer and more enjoyable than ever before. They're both interesting and useful, and they improve the ways our cars interact with us and protect the people we care about. They seem to be growing by the day.

They also place some unique requirements on the materials needed to produce them. As the technology that drives ADAS systems races forward, the materials that support it need to keep up. Each new innovation brings new challenges. This means that engineers need to approach materials selection with a fresh set of eyes.

Designers are creating new systems with an eye toward three challenges. Miniaturization. More tech must be densely packed into smaller spaces. Sensitive electronics are being placed in more demanding conditions, including exposure to heat and/or chemicals. Some component housings, interior and exterior, must complement vehicle design aesthetics.

These challenges can be translated to material needs for high dimensional stability. Devices must perform in all conditions without changing shape, and this requires customized engineering thermoplastic compounds. Vibration management. Thermoplastic elastomers can help maintain a steady environment to protect component performance.

Thermal management. Conductive polymers can keep ADAS tech cool and comfortable and can also prevent EMI/RFI interference between components. Functional aesthetics. Thermoplastic elastomers and custom compounds can offer the special effects and surface finish options that align form and function. Durable color. Some ADAS housings require vibrant, stable color that rests UV, and master batches are the answer here.

Kelly: Trend number three is electrification. Today, the great all-electric vehicle race for market superiority is humming along at breakneck speed. At one time, electric cars were primarily regarded as a gimmicky choice of well-to-do tech and entertainment barons. Let's be honest with ourselves. But now, electric cars are becoming more viable for general consumers by the day.

Just look at the Chevrolet Volt, 238 miles per charge with an MSRP of $37,000, and that's before any tax incentives. Why is this? There are two reasons, increasing regulations and market preferences. These are causing manufacturers to invest more resources into the technology. Companies including GM, Tesla, Volkswagen, BMW, and many others are working hard to develop better batteries and lighter components that will help reduce consumer worries about range while reducing cost.

The number of fully electric vehicles entering the market just from 2019 to 2021 is incredible. The goal is to position this new breed of vehicle as a practical answer to growing concerns for efficiency, sustainability, and affordability. It goes without saying, but electric vehicles require vastly different components than gas-powered ones. With the added challenge of affordability and increased miles per charge goals, material requirements to support evolving designs and parts are getting tougher all the time.

Designers are focused on all-electric vehicle design innovations that require sensitive electronics and critical components, maximizing miles per charge by removing weight to offset larger, heavier batteries, which are now in the 400-pound range and above, maintaining design aesthetics and devices that must be compatible with frequent design updates.

Materials that can bring these ideas to life include conductive plastics which promote thermal regulation for batteries that see a really wide range of temperatures. Vinyl with its inherent flame-resistance as well as compounded engineering thermoplastic can provide the flame resistance, burn rates, and low fume production needed for ULs and other compliance. A variety of thermoplastic compounds can achieve the chemical resistance that housings and trays need to handle the potential corrosiveness of supercharged batteries.

TPEs can help reduce noise and vibration. Materials must now help mask ambient road noises no longer concealed by internal combustion engine noise. And finally, structural composites can address the final two material requirements by increasing durability of underbody systems such as strut and springs while removing weight to extend range.

Brad: Our final trend today is mobility on demand. The rise of urbanization and the sharing economy have forever altered our relationships to our vehicles. It's even possible that the paradigm of the two-car family will soon be a relic. That's why startups, governments, and vehicle manufacturers alike are looking at ways to capitalize on car-sharing and ride-sharing models of transportation. These interested parties envision a society in which we simply push a button and reserve time in a car we don't own.

Vehicles designed specifically for the car and ride-sharing economy require material surfaces that can withstand the wear and tear of exponentially more passengers while being stain resistant and easy to clean. This uptick in usage calls for both superior durability and innovations in surface cleanliness to make riders safer and more comfortable. Design considerations include the following, durability and wear resistance, focuses on passenger-centric design, which include entertainment, food storage, and creature comforts. Surfaces need to be easy to clean and, preferably, antimicrobial.

So let's look at the material requirements and the materials that can meet these needs. Anti-static additives can keep dust and allergens to a minimum. Durability. Thermoplastic elastomers and additives are the answer to handling a greater volume of passengers without showing signs of wear. Cleanliness. Various thermoplastic formulations can help keep cars clean, safe, and pleasant for passengers, and low-maintenance for owners.

Anti-microbial additives can reduce micro growth for a healthier ride. Scratch and mar resistance. Additives can help vehicles resist wear and tear. Durable color. Colorant and additive master batches prevent fading, flaking, UV damage, and normal wear and tear.

So if you're not familiar with PolyOne, we are based in Avon Lake, Ohio, just west of Cleveland. So, go Cavaliers! With facilities around the world, we provide manufacturers and processors across nearly every industry with specialty polymers, colorants and additives, polymer sheet, and services such as polymer distribution and design. So with that, let's open the floor up for questions now.

Kelly: Looks like we have a question coming in here. Our first question is, "Do you think the ADAS suppliers are ready to incorporate more plastic into their high-tech systems?" That's an interesting question. I am assuming that this is alluding to the plasticky feel compared to super high-tech systems. So yes, ADAS

suppliers absolutely have to be ready to incorporate plastics into their systems.

Let's look at this from a big picture. As we move closer and closer to autonomy, electronics for B to X will increase. So that's vehicle to vehicle, vehicle to infrastructure, vehicle to cloud. These are absolutely essential to a fully autonomous vehicle. It's the ability of a vehicle to communicate with its surroundings and take that data, process it, and make a decision based on that data and then act, right? So it's basically artificial intelligence here.

So the software complexity of this is completely mind-boggling. And the hardware both inside and outside the vehicle, is really gonna have to change accordingly. So for example, outside the vehicle, of course, street signs, stop lights, crosswalks, they're all going to have to have different equipment to communicate with vehicles, etc. But on the vehicle, the use of sensors and cameras is gonna continue to increase. And this means that the data processing units are gonna have to increase, too. The sheer number of ECUs is gonna be incredible.

So that, of course, is going create a package space issue for us all. Shrinking part size, consolidating parts, that's going to be necessary, and this is where thermoplastics really offer a ton of value. For example, the heat generated from processing units could be managed with thermally conductive thermoplastics instead of really bulky metal heat sinks. This design possibility is very important and gives a leg up to thermoplastics.

And honestly, while tech companies are focused on their tech, it's really the role of us in the materials world to play that role and provide guidance and insights to those companies. Let them focus on developing their high-value tech. We can be there, side by side with them, to help them put the right materials in the right place.

Brad: You know, to expand upon that, Kelly, as we see a more digital vehicle, the demands on the systems are ever increasing. This is generating more heat in the systems, and this heat is not only in the processing units but it's also being transferred to the actual devices that are providing input for ADAS technologies such as camera systems, radar technology. These small tightly-packaged products such as the radar sensors, the camera systems are getting higher and higher in thermal energy, which in that thermal energy has to go somewhere. So thermally plastic conductive materials are a great fit and answer here where packaging constraints and design freedom are a large challenge.

Kelly: Good. Thanks, Brad. All right, we've got another question here. This is another interesting one. "So how will car sharing affect the overall number of cars? And will that decrease plastic business in the automotive sector?" So that's an interesting one because the answer, I think...I don't think, it was...the answer was different about two to three years ago than it is now. A couple of years ago, consultants and, you know, the powers that be were saying, "Oh, no. This could be really bad news for the automotive industry."

But the more this is being assessed...the consensus is now that actually vehicle build will benefit from this. And the reason is that you're providing mobility to more people. More people will have access to vehicles. So the result will be a greater number of miles per vehicle or miles traveled overall.

And so with car sharing then, what we're gonna see is right now, a personal vehicle sits in a garage or a parking lot 90% of the day, and it's used about 10% of the day. Well, with car sharing, that's gonna flip. So with multiple users, it'll be 90% of the day where that vehicle is being used. And so you can imagine what that's going to do to the wear and tear on a vehicle. All right, you're gonna hit 100,000 miles on a vehicle much faster in a shared mobility world than we will now.

So we touched a little bit earlier on the durability requirement, a lot more people using a vehicle, getting in and out. They may or not have the same respect for that vehicle that they would for their own if they paid for their own vehicle. In terms of build, it's expected, actually, to have a positive impact in just how rapidly cars will turn over, will increase. So you may have, you know, four years. You need to do some massive...either you need to turn a vehicle over completely, or you need to at least do some refurbishment and things like that. It's going to be a very different model.

Brad: So I've got another question here from Felipe. "What about recycling possibilities considering all the additives and other elements added to the finished new materials?" That's a great question. A lot of our materials that are filled with these additives, they're based on a general resin that you might be familiar with,

such as polypropylene, nylon, PVT, and the list goes on and on. And the majority of the material content in these solutions is the base resin. So from our side of things, recycling will not be a large issue. Yes, there is gonna be some concerns around some highly, highly filled product, but on an overall basis, recycling will still continue.

Kelly: Good. Thanks, Brad. We've got one here regarding structural composites. "So what are some cost effective ways we can leverage structural composite technology? Will this really become commonplace?" We didn't do a whole lot on structural composites in this, but it is a really important part of extending range or maximizing range through lightweighting solutions.

So it's a good question because it's a reality. We all know that, right now, structural composites can be very expensive. But the reality is that not everybody needs the composites found in a Boeing Dreamliner, right? And in the automotive industry, there's actually a real spectrum of performance needs throughout the vehicle. And we're all being forced to think much more creatively about composites and where you apply the right material for the right application.

For example, we can use structural composites to selectively reinforce certain areas of a part rather than making the entire part out of a very costly structural composite. So localized reinforcement is a way to skin that cat or a way to approach that cost concern. And, in general, one of the things that we're certainly seeing is that the use of thermoplastic composites is growing. A lot of the initial growth in composites was with thermosets. But as many of you know, I'm sure, the cycle time for thermosets can be a challenge, and there's not quite as much design flexibility with thermosets.

So thermoplastics are growing. And the industry has done a great job of lightweighting parts to injection molding. But now, if you think about this, if you can incorporate like a continuous fiber reinforced thermoplastic with the benefits of injection molding, you can come up with some very creative solutions to how you make a cost effective part. Brad, anything to add on that?

Brad: No, I'm good, but there is another question from DJ out there. "What do you mean by customized engineered material?" And that's a great question, and I think we should kind of back up in what that means. A customized engineered material, specifically in the plastics world...PolyOne, we compound a solution to solve a customer's challenge. And so from our standpoint, we can choose any resin. We can add various fillers whether it be carbon fiber, fiberglass, glass B technology, add UV packages to these products, maybe do something...adding conductive materials to the process. And then compound that solution into pellet form that can be sold to any injection molder. So that's what a customized resin is, and we pride ourselves on tailoring our solution to solve a customer's need. So I hope that answers your question, DJ.

Kelly: And, you know, this is how that applies to the space of advanced mobility. All of these various technologies are going to ultimately enable autonomy and a shared mobility environment. The requirements of those applications are changing day to day, right? These technologies are being developed at a very rapid pace. So we don't know right now what all the requirements and materials will even be two to three years from now.

So material science companies have to be able to adapt on the fly and enable their customers or those who are developing these applications. We have to be in a position to enable whatever those changing requirements are. If we stay stagnant, we're doing ourselves no favor. We can help advance this even faster by creatively thinking about new material technologies to enable those evolving technology or application requirements.

If there are any more questions, you can feel free to submit those online here. Oh, you know what, sorry, one more in here about shared-use vehicles in urban settings. So we talked about shared use in terms of vehicle build and what that means in terms of durability of the interior of the vehicle. But another thing to highlight here is that shared used vehicles in urban settings...vehicles will be designed or some will be designed for urban settings exclusively, so for last mile commuting, etc., and will likely be rated for low-speed travel, so, for example, 35 miles per hour and below.

So this is something...and I'm glad that this question came up because this is something that we're really keeping our eyes on, because what does this mean for crash worthiness requirements? Will there be greater flexibility, perhaps, for structural design if crash requirements are decreased in certain environments? If you have a 35-mile-an-hour max speed, do you really need to have the same crash worthiness as a vehicle that

can go 70 on highways? If so, you know, that can really open up the door for new opportunities for metal replacement in areas where, traditionally, that's been considered just absolutely off limits for thermoplastics and thermosets.

Brad: So there's a couple questions around 3D printing materials and how that's affecting the design and development of materials. So that's a great question, and, absolutely, 3D printing is changing the way we design and engineer materials for solutions. One of the things that's challenging with these highly-filled products is being able to 3D print those items. So, for instance, we wanted to take a backup camera and 3D print a housing for that system. With the amount of fillers that are in these thermally conductive plastics or electrically conductive plastics, it's a challenge. And PolyOne is certainly working on solving those problems. So absolutely, 3D printing is having an impact on design and development of these specialty components, but we have to catch up with the ability to 3D print these highly-filled products.

Kelly: And a related question is around whether there are 3D printed materials being used in automotive components now. The place where they're being used is in very low volumes, very low volumes. The manufacturing speed is just too slow right now. So yes, being used in some specialty vehicles. We're seeing things that are on both specialty as well as like race vehicles that are extremely low volume applications. But when we look at as a typical automotive platform now as being, you know, 120,000 vehicles or more, we've got ways to go here, we really do.

But a place where this is being looked at extensively is in both aftermarket, so where you can do some customization or, say, interior components, etc., or also in the service area. So how can 3D printed parts be utilized for repair of a given application, not necessarily just thinking about the upfront OEM manufacturing process?

Brad: For instance, Ford has partnered with Carbon3D printing, and they're developing the technologies around making that possible in the future. So yes, 3D printing is absolutely important, and it's in its development phase with these more highly engineered materials.

We've got another question here, and I wanted to talk about this a little bit. "Will future automotives come on solid polymer binders and propellants?" I'm struggling with this one a little bit. I know that in the battery world...and technology is being developed right now for, instead of a liquid-type battery application, more of a solid-state battery. And that's in development at numerous OEMs focusing on those efforts. So I think that's the next step in battery technology, which you could consider a propellant to move the vehicle forward. But I'm struggling a little bit with that question.

Kelly: Did we hit them all here? Great. So unless there are any additional questions that pop up here, we wanted to say thank you so much for participating today. And if you have any additional questions please feel free to contact us. You can see the number here at the bottom of the screen, 440-930-1321. Or visit our website, polyone.com.

Brad: Thank you, everyone, for your time and attendance today, greatly appreciated.

Trey: Awesome. Thank you, Brad and Kelly, for that really great and informative presentation, a lot of great questions, too. We do encourage you guys to check some of the other PolyOne webinars on the UL Prospector Knowledge Center and also encourage you...We will be sending a copy of the slides and the recorded presentation to you via email. So do be checking your email for that in the coming days. But again, a big thank you to everybody for attending and have a great rest of the day.