Trey: Hello everyone, and thank you all for joining us today. Today's webinar, Special Effects: Unique Ideas for Plastics, is brought to you by RTP Company. Your presenter today is Shawn Bergsrud. Shawn is the North American color manager and has been with RTP Company for 27 years.

Shawn started his career as a color development matcher and has held various titles and responsibilities over the years, and most recently, he was head of color development. Shawn is based in Winona, Minnesota's RTP facility and is a key member of RTP's color group.

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 that's located on your screen, and our panelists will answer them at the end of the presentation. We are recording today's event and will send you a link by email when the slides and video have been posted to the UL prospector Knowledge Center. With that, I'd like to send the presentation over to Shawn. Shawn?

Shawn: Good morning, everyone. Thanks for joining us today. As Trey said, my name is Shawn Bergsrud, and I am the North American Color Lab manager here at RTP Company. Today we will be discussing special effects available for thermoplastics. These effects are both aesthetic and functional and give your product the edge and differentiate it.

On the agenda today, we will begin a quick introduction of RTP Company and our color division before jumping straight into our special effects. We will end with a few case studies, as well as the color design support RTP Company can offer you. If you have any questions during the presentation, you can type them into the chat box at any time.

Many people know RTP Company as a global compounder of custom-engineered thermoplastics, with more than 1500 employees and over 500 million in sales. Unlike some of our other competitors, we are an independent, privately held company. This is important. Being independent allows us full design and material flexibility. Rather than making short-term decisions to meet short-term goals, we are able to take longer-range views when making these decisions. We are committed to serving our customers all over the world, well in the future. We process all types of thermoplastic resins, down to commodity resins such as polyethylene, through engineered resins like ABS, PBT, all the way up to high-temperature resins like PEEKs.

With 18 production plants, and even more sales offices located around the world, we're well equipped to serve you with consistent thermoplastic materials, wherever your facility or facilities may be located. As a matter of fact, we have more than two million square feet of production space around the globe. And on top of that, we have eight color labs located between the U.S., Mexico, France, Singapore, and China.

We have a number of product families that provide different attributes for your specific thermoplastic compound. As you know, I'm in the color group, but as you look at all the other technologies that we offer - conductive, flame retardant, specified, you can send in your color target and this can be done… You can develop your color locally and produce globally since we have our global facilities. And we can transfer these formulas readily. And for this reason we have a global color palette.

So there are three different coloring options, and the first one we have here is a masterbatch. And what a master batch is it's a concentrated formula of colorants and other additives dispersed in a color matrix. And you can think of this as your cake mix where you buy a cake mix and you just need to need add water. So you're just letting it down or add a defined ratio or percentage to color your material. Masterbatches are widely used in commodity resins where you buy a material in bulk but you wanna color it multiple different colors.

The next option is pre-color. This is where the colorants has been added to the compound and [inaudible 00:04:13] at RTP. So this is an as is, ready-to-use solution. There is no dilution. It's used as 100%. And the cube blend, this is a master…or a combination of the masterbatch where it's blended with the resin. And you can see down here in the bottom right-hand corner, that's a replication of a cube blend wherein0 the masterbatch has been blended with the neat resin. Most the time you'll see this used in our long fiber application because we're unable to critically color inline. So blending that masterbatch with the long fiber pellets still aids...allows you to get that custom color with those materials.

So the color group is just one of the many product families within RTP Company. What we do best is work together and collaborate. So I work with these product groups listed here, the flame retarding group, conductive group, structural, where what the color group does is enhance the other properties that those other groups have provided. So with a structural product, maybe we're working on a black nylon but the customer also wants it to be laser-markable. So that's another kind of functional aspect to the color group.

That's my very brief introduction to the color division. And now we're gonna dive into the color fundamentals of this presentation. There's three sciences which make up color and those are biology, physics, and chemistry. In the upcoming slides, you'll learn on how they play a vital role in how we see color. So the three elements shown on the slide, we're able to see color. All three must be present, and what you can see here is that this light source radiates energy or light, and then the light is reflected from an object to the observer. So what we see are the wavelengths which are reflected.

Our eyes are the observer in this scenario, and they have two types of photoreceptors within. And these are also known as the "detectors." These are rods and cones. Rods are what allow us to see at low level of light, and cones are what are sensitive to the three different colors are. So you can see that the cones are sensitive to red, green, and blue, and the combination of these three colors produce the array of colors that we see.

For example, the mixture of blue and red produce the violet color. So what these cones do is they send the signal to the brain to get the decoded. Next here I have shown is the electromagnetic spectrum and you can see that visible light is a very, very small portion of the electromagnetic spectrum. The wavelengths of visible light are between about 400 and 700 nanometers. And you can see that we're falling between ultraviolet and infrared. The wavelength of visible light correspond to different colors. So you can see over the 400 to 700 nanometers that the color changes. The shorter wavelengths of light correspond to violet while the larger wavelengths or longer wavelengths of light correspond to red color.

There are times where I hear that color matching material is an art. And that is simple balancing act between mixing different ratios and colorants. Well, there is a little truth to that, but really we take science into serious consideration. The colors that we see are the wavelengths of light that are reflected back to our eyes and light behaves like a wave. And upon interacting with an object, it can either be absorbed, reflected or transmitted. So you can see here that this is the true arts and color.

So as I mentioned before, that white light is made up of visible light. It can be separated into the individual colors when passed through a glass prism. You can also see this when the rain is clearing away, we're lucky enough to sometimes see a rainbow. So I have pictured here is white light divided into its individual wavelengths. You can see that when it hits a blue object, only blue wavelength of light are reflected. In the case for a black material, all wavelengths of light are absorbed. And then with the white object, the opposite response occurs, reflecting all the light back to the eye.

So taking this one step further, there is a method to measure the specific reflectance of a color and that is using a spectrophotometer. The spectrophotometer produces a spectro-reflecting curve which shows the percent transmission or reflection of a material versus the individual wavelengths' color. Each color produces a unique special curve, so each one you can say has its own unique fingerprint. Let's just take a moment to review the curves that I have shown here up on the slide. I have three different ones showing blue, green and red. You can see that the blue color reflects wavelengths corresponding to blue, the green color corresponding to the green wavelengths of light and similar in the red. We're having high reflection corresponding to red wavelengths of light. This is important when we go to reverse engineer a color or match a color target that you send in. We can measure the spectral reflectance curve and this helps us chose the correct colorant and ratio to match your color.

The last science which involves color is chemistry. Chemistry involves the colorants which we use in thermo plastic, and the two types are pigments and dyes. The difference between the pigments and dyes are that pigments are non-pliable and pigments will suspend in a thermoplastic, where dyes are soluble. And what I mean by soluble, if you just think of sugar and hot water were it dissolves, and where, if you were to put a pigment in a resin, it would just be suspended. The difference in the behaviors of the pigment and the dye is desirable in different situations, and I'll explain a couple of those coming up.

There are two different categories of pigments, and this is based on their molecular structures. This includes inorganic and organic pigments. Inorganic pigments come from various metal oxides and other substances in nature such as oxides and sulfides. Organic pigments are synthetically made and they are carbon-based. Dyes are also synthetically made, but the difference between the pigment and the dye is that they are soluble.

On this slide, I will quickly go over, compare and contrast between the organic and the inorganic pigments. Organic pigments typically have a smaller particle size and for this reason, it makes them harder to disperse due to their large surface area. Since they are organic, they have limited heat stability and most of the time the max is 300 Celsius, but this varies depending on the pigment. The good thing about organic pigments is they have higher color strength which means a little goes a long way. They also typically can produce more vibrant colors. The light fastness or UV stability is generally not as good as the inorganic. If you think about this, that we are organic and if we go out in the sun for too long, and we forget our sunscreen, that we can get burned. There's been some sort of UV degradation. When UV degradation occurs in the pigment, that results in the color shift. So that's something that is evaluated with an outdoor application.

In contrast, the inorganic pigments have larger particle sizes which makes them easier to disperse, and since they are from nature, most of them that they have higher heat stability and some cases higher than the thermoplastic itself. They are weaker in color strength but have the advantage of improved at light fastness. And finally we have dyes, and like I said, these are soluble. The good news here is that they have high color strength and they can be used in transparent resins to tint the material without adding opacity. They are commonly used in styrenics and engineering resins, but there are concerns for migration but when used in a compatible resin system, this concern can be eliminated. You can see here that dyes are also used to create the special effect edge glow. On the bottom right here, you can see that we're having a transparent material with the edge glow effect.

Color is evaluated two ways. This is done through a visual check and instrumental evaluation. And this is because neither visual nor instrumentation does a comprehensive job on their own. Both methods are applied to ensure that we have adequate color control.

The first way we evaluate color is visually. A person with confirmed color vision use the standard and compare it to the [inaudible 00:15:01] under a specified light source. It's a plaque to visually [inaudible 00:15:06]. The plaques are then measured against one another on a spectrophotometer. The spectrophotometer quantifies the special reflectance or transmission of the color throughout the wavelengths of visible light. If a spectral curve overlays. it's considered a good match. And also the spectrophotometer can produce color space values which can quantify color. You can see here that here is a two special reflectance curve. They're similar but they don't overlap. So possibly we have a yellow spectral reflectance curve. They're both green but the green one is a little lighter in color. As the spectral reflectance curve shift upward, you get a lighter color, and as it shifts downward, a darker color.

One interesting phenomenon that happens in color is called metamerism. This is where two objects will match under one light source, but not another. When metamerism is not present, no matter what the light source, the objects will match. When a material presents metamerism, it will match under one light source, but not another. So we can determine if there is metamerism issue by looking at the spectral reflectance curve. If the curve overlay, we know that we used the proper colorants and ratio to produce this color, and because, like I said, each unique color...each color has a unique spectral curve. And also, you can see when metamerism is present that the spectral reflectance curve cross over multiple times, meaning that they will match under one light source, but not all.

And this is important to note that if you have matting parts for instance in a different resin systems, we wanna know your primary and secondary light sources so we can get them to match as close as possible. In the interior of a car, you have, say, you have a tan interior. Well, it's not all made out of one resin system and probably not all the same colorant package. So it's important that they at least match likely under daylight since it's an automobile.

Environmental factors to keep in mind when dealing color as they influence the way the observer sees color is, first of all, the observer, each person, sees color uniquely. This can depend on their emotion, their gender, and their age, and many other factors. The light source produces different spectral distributions. In our light box in the lab, we have…we can produce…we can simulate different light sources. A couple here are D65 which is daylight, cool white fluorescence and incandescence. For those of you who are unfamiliar with those, cool white fluorescence is more of a blue white light, and incandescent is a warmer, rather [SP] light. So just keep in mind that the different light source will make the color look different.

The background can also influence the color. If you have two plaques of the same color on a black piece of paper and a white piece of paper, the colors can appear different. And finally, I have the viewing angle. The most common viewing angle is 45 degrees but depending on the material and the special effect, you may want to view it at multiple different angles. But when viewing a color visually, keep in mind, just to keep these as constant as possible.

Next, I have specification and tolerancing of color. This can be done using numeric color modeling. Numeric color modeling provides a unit of measure for color just as if we were to measure the distance between two objects, if distance between two objects can be measured in several different units, whether that is feet, inches, or meters. You can see there are several different units there and the same goes with color. There are several different methods that we can quantify color.

Color space helps us to specify, identify, and compare colors. And what is great about color space is that it helps…it puts numeric values in color which helps remove some of the bias factor from viewer to viewer. The color spaces I will talk about are going to be CIE 1931, Yxy, CIE L star, A star, B star, CIE L*C*h, and then also a tolerancing system CMC l:c.

Before I move on to those color spaces that I just referenced, I'm quickly going to define some common color terms. The first one here is the hue and this is the actual color perceived. So this is your ROYGBIV. Chroma or saturation is the vividness of the color. So you can see that I have chroma listed in this circle here on the right upper hand corner. Chroma increases as we move towards the edge. So we have a higher chroma value at the edge.

Lightness, this is a measure of brightness of the color. So how light or dark the material is and think about this on a gray scale. And the terms “tint” and “shade” are property of the hue. Tint is where the hue has been lightened and shade is when the hue has been darkened. Two examples of this is pink is a tint of red, and maroon is a shade of red. In the color lab, when we do pigment evaluations and some quality assurance on masterbatches, we'll do a tint strength test to ensure the color strength of the material.

The first color space is CIE 1931 Yxy. This color space uses the numeric values Yxy. The capital Y represents the luminance value while the xy coordinates are the chromaticity values. The xy values are also known as the color coordinates. You can see on the graph on the left here, we have an xy plane. The coordinates will determine where you are in color space. For example, if I have the coordinates 0.2, 0.2, I fell down in the blue region. Where if I had the coordinates 0.2, 0.5, I'd be a green hue.

To further explain the color space, you can see that the hue or the color changes as we move around the color gamut while the chroma or the saturation of the colors increase as we move away from the center. Something to note about this color space is that you can see that the wavelength, the distance between them, are non-uniform. And this is important when we go to…when a put a tolerance on a color in the color space. Just as an example here, again, I'm gonna use that blue example. So we are down here in the blue and I have a color shift of 0.01, 0.01. That would be a large visual change in the blue. If I was up in that green hue, the same distance, the same change in color would likely not be visible to the human eye. So depending on where you are, what hue you are in this color space, you may need to open or broaden or tighten your tolerances.

The next color space is CIE L star, A star, B star. This color space was developed in 1976, and unlike the previous color space, it is uniform. It also is the most widely utilized color space in the thermoplastic industry. This color space identifies the color values L star, A star and B star. The L star value is the lightness value so this is how light or dark the color is. The A star and the B star are the chromaticity values. The A star is the red to the green value, and the B star is the yellow to the blue value.

You can see on this picture on the left that the color space utilizes traditional xyz coordinate system. The L value is the vertical axis where the color coordinates are on the A and the B. The origin is very neutral, and as we move up and down, the color gets light and dark. If we move outwards on the A and B, we have an increase in chroma or saturation in color, and as we move around, we have a color or a hue change.

To find the total color shift between two colors, you can use the equation shown here on the bottom left. This is called the delta E value. This value tells us how far a color has shifted. You can see that I've also noted that this is a dimensionless number. Therefore, it doesn't tell us what direction our color is on. For instance, if we have a delta E of one, I do not know if my color is too yellow, too red or light or dark. We need to look at the individual delta values to determine this difference. So the delta A, delta B, and delta...delta L, delta A, and delta B values.

When tolerancing in this system, you must choose the difference limits between the delta A, delta B and delta L values. And what this does is it creates a coloring spots around your standard. So if I have my standard, it would be in the center of the box. And anything within the area of that box would be considered within color spec.

The next color space is L*C*h, and what this... Excuse me. This color space is very similar to the one we just talked about. The only difference is that the coordinate system has moved from Cartesian to cylindrical coordinates. As we can see the same pattern, a vertical shift in color space would move our color lighter and darker. Also, as we move from the origin outward, we increase in chroma and the hue changes as we move around.

So down here, I've shown you how we can easily convert between the two. You can see that the L value is the same as before. This is the lightness value. C is the chroma value or how saturated it is. You can see just looking at the chromaticity plane that the chroma value is how far it is out from the origin or the radius. The hue angle is an angle or measurement starting from the positive A axis [SP] moving counterclockwise. So you can see here it's the distance from the A value to our chroma value. You can see here, if I had a hue angle of 0 degrees, I would be a red color and if I had a hue angle of 90 degrees, I would be a yellow color.

And the last color space, CMC l:c is used for tolerancing. And this is based off the previous color space we talked about, the CIE L*C*h. What this tolerancing system does is it provides a better visual agreement or better agreement between the visual and instrumental assessment. CMC produces an ellipsoid around the standard whereas the before I talked about the CIE LAB producing a tolerance box. This ellipsoid is typically twice as tall as it is wide. You can see that we have this l:c value, and this is our lightness to chromaticity value which are set at the typical standard of two to one, meaning that our eyes are more forgiving to a color shift that is lighter or darker than an actual chroma or hue change.

This ratio can be changed depending on your application. It can be increased or decreased if you need a change on tolerance. You can see here, the ellipsoid on the right has a smaller lightness value. So it's a one and a half to one. So we're keeping the same chromaticity specification. So how does this compare to the tolerancing system in the CIE LAB? Well, if we have that box versus this ellipsoid, the edges of that box, the corners, can visually look out of spec but still read within spec on the spectrophotometer. So this color space, the CMC, provides a…when we're using the ellipsoid, provides a better agreement between the visual and instrumental assessment so that when we go to QC the color, that it visually looks good and it reads [inaudible 00:29:44] specification on the spectrophotometer.

Color tolerances are developed around raw material processing and customer goal for visual appearance. Keep in mind that not all materials can meet a critical color tolerance. An example is that RTP works with probably 60 different resin systems and alloys plus the... You can modify them with all sorts of fillers. An unfilled resin is easier to control, or a filled resin. So for working with an unfilled polyolefin, typically the color tolerances can be much tighter than, say, we are working with a high temp carbon fiber-filled material.

Another thing to keep in mind is that asymmetrical tolerances are perfectly acceptable to use. We see this often in medical industry. Common color for them is white. So for customer orders of bright white, they're only willing to take it on the blue side of the standard and that is because we saw on these color space that blue and yellow were opposite of each other. So they're willing to take it on the blue side. Yellow can be thought of by the consumer as dirty or degraded and they don't want that in a hospital setting.

Another important aspect of color is the color communication. That is because, individually, looking at a color where it can be subjective and trying to convey that information can be difficult if we don't use effective color communication. On this slide, I have a picture of a sun setting over a lake. I don't have it shown yet. I just want you to think up to yourself about a sun setting over a lake. Can you picture the color of the sunset? How would you describe those colors to someone else?

Here's the photo. It has several different colors. We have pink, yellows, oranges, and even some reds, and blue. But how do we define those exact colors for a color match? And this can be done a few different ways and I'm gonna present some options on how we can properly give definitive target so that when we do a color match, our target is not moving. So some preferred targets are, you can see here, physical color target. This means that you have a current part and you want to replicate that color. You can send that in for a custom color match or you're walking through the hardware store and you like a color of another product or maybe marketing is providing that part of the specification. Send that in for a color match.

The next definitive...or next target, preferred target, would be a color reference such as a pantone reference. The thing with pantone is that the pantone books are printed at different times and use different inks. So with age, those colors can shift. If we are going to match your pantone, we prefer to match your exact pantone, not use the pantone book that we have. So if you send that in, we can return that when we do the color match. And the last way to specify a color is through color space values. And that being any of the ones we talked about plus multiple others that we didn't discussed today.

Other application requirements that are looked into when we're doing a color match is first of all and foremost, the resin and the compound needs to be specified. If you already know what resin you're gonna work with you can... That's easy. You just send...tell us what the resin system is and then we do our match. Say you're working on a new application and you need a custom compound. That's when our product development team helps product families come into play, where you need glass-filled flame retardant, nylon. You would work in collaboration with the structural group and the flame retardant group in addition to the color group to get all those properties you need.

When we're developing the application, we respect your regulatory restrictions, and also we will ask you your processing method and secondary operation…processing method. Dispersion quality of a masterbatch must be much better when we are doing a film versus an injection moment part. That's why we're asking these questions. And secondary operations, example here is if you're doing some sort of bonding with a material. To optimize formulations, we can use different dispersion aids which can interfere with adhesion or bonding of parts. So we're not trying to ask too many questions, but we wanna get all the information upfront so that we can get the development done right the first time.

RTP uses color nomenclature in addition to the resin and the compound nomenclature. This is a five to - six digit colored number followed by a letter. This nomenclature identifies the regulatory and formulation commitment of the material. For quality control of products, we also have lots of traceabilities. Each nomenclature, so each color number, has manufacturing and quality control specifications set up in development and follow through scale and into production for the continuous improvement. Color products must not only need a color requirement but many other physical property specifications, and this what contributes to consistency with RTPs products.

So in summary, RTP Company supplies innovative and functional colors in multiple different formats to fit your needs. Color is perceived and influenced by biology, physics, and chemistry. There are several different color spaces available. What is best for your application may not work, may not be the correct or suitable choice for another. Effective color communication is crucial to color matching and in tolerancing. When we use those definitive targets, it makes it much easier for us to hit the target the first time, and it also speeds up development which is what everyone wants. So at this time, I hope you have enjoyed this introduction to color. I will to turn it over to Trey for just a few minutes while I get prepares for the Q&A session.

Trey: Perfect, Anna. Thank you so much for a really great and informative presentation. Just wanna go over a few things. We received a couple of questions about where can I get a copy of the slides, where can I see a copy of the recorded presentation. We're going to be sending you guys a link via email on Monday. So guys do check your email for that. It will contain a copy of the recorded presentation and a copy of the slides so you can watch that again at your leisure. [Inaudible 00:37:47].

So this time we are going to move in to our question and answer sessions. We do have a great technical expert in Anna on the line. So please do send us your questions or type them in the question box located on your screen. We got a lot of great questions coming in so far. So we encourage you to continue to do that. Let's see, we have a lot of questions so far. So I'm gonna go ahead and turn it [inaudible 00:38:08] to Anna. We can get that kicked off.

Anna: Thank you. So I have pooled up the questions. The first one I have here is, “When would you use Yxy color space over L star, A star, B star?” In my experience here, the Yxy is typically used when you're working with transparent or translucent materials. So maybe a light-diffused material where the LAB or L star, A star, B star provides a very good reflectance colors. The Yxy is more for transparent and translucent colors. This is… The Yxy scale is widely used in the automotive industry for those interior button applications and also in the lighting industry. But the Yxy, those XY coordinates with the, excuse me, the color of the white light, that is where they’re using those Yxy color.

So my next question here is, “Why would masterbatch be used over a pre-colored compound?” Well, masterbatch, like I said, is a concentrate and it can be let down into [inaudible 00:39:46] different resin systems. A masterbatch is designed to be let down into... So the carrier resin determines what resins we can let it down into. So as my example in the presentation, we have someone that buys commodity resins such as the polyethylene by the rail carton and they wanna color it six different colors. Well, it's much cheaper for them to purchase six masterbatches over six pre-colored compounds. It's just economics.

I have another question here and it's, “What is the practical difference between Hunter color lab space and CIE LAB 1976?” In these two are almost identical. And it says, “What is the acceptable, visuable color difference for white, yellow, red, and so on, in comparison to these measurement of values?” And I'm gonna kind of interpret this question a little bit, and the fact that they're asking what is the standard tolerance, and that is depending on the application. A matting part wouldn't need a much more tighter tolerance. So maybe a delta E of under one. Whereas if you're using it as a commercial match or maybe you just need to identify small, medium, large, your tolerance can be much more broad.

Another question I have here is, “Do colorants suspect physical properties of the compound?” That is an excellent question, and yes they do. And our other product families give the color lab a little bit of a hard time because of this effect. But when you're designing your product and you know that color is going to be involved, we know right away to almost over engineer the natural materials so that when we match the color, that we're producing the correct physical specification for you.

My next question is, “Is there any specification like distance or quantity of light being applied to check the product color output?” Depending on the color space that you use, for example, that Yxy would be a great one to look at here. The capital Y is that luminance value. So that's your mono-transmission. Otherwise, there are other color spaces and ASTM values which can define the percent transmission of light through a transparent or translucent color.

Another question I have here is, “When I'm coloring [inaudible 00:43:24], what would the viscosity of the colorant and carrier compared to the resin which I'm molding part to ensure good cosmetics?” So when we design a masterbatch, we typically design them with higher flow so that we can get good dispersion and uniform color mixing within the [inaudible 00:43:46] because there is very limited time to get the mixing whereas in the pre-colored compound, it's already mixed for you so you just need to re-melt the thermo plastic and injection mold your shot.

Here is another question. “What would the LAB of a clear...LAB value of a clear transparent part be?” Well, on a spectrophotometer, it would depend if you're gonna…you would need to be reading in direct transmission or total transmission depending on the translucency of that part. And it would still give you the light and dark factors according to the color.

Another question here, it says, "I have heard that it's impossible to obtain an aqua/teal color ABS material. Is this true? And also can you explain why it is so difficult?” Well, I think I have good news for this person. But before I say 100% that an aqua or teal can be produced, that we likely can hit your color target. And if you would like me to review that one individually, I would love to take a look at your part and determine if the aqua and teal color can be produced in that ABS compound.

I have another question here and it says that I mentioned that “neither the visual and instrumental assessment does a complete job individually, and they're best when used in conjunction. What's the risk of relying on instrumentation only?” Well, the risk there is a couple of things. If your machine is not calibrated correctly, it could be giving you false results. And also, that I don't know if you've ever done this but you've taken apart and you've read it in different locations, [inaudible 00:46:08] on different location for that part that you can actually get a pretty wide range of color just by moving it around in the spectrophotometer. So that's why we say it's best when… That’s to control the color both visually and through instrumentation.

I have another question. “We use L star, A star, B star to measure yellowness index on a clear or translucent part. Should you put a white backer behind the sample when taking the yellowness index measurement?” I believe there is a call out in when you…in ASTM, either C1925 or E13, which will run you through the procedure on how to correctly measure that. Offhand, I do now know about the white backer but I'm guessing if you're changing the white backer, that would skew your results...would skew your results.

The next question I have here is, “Do we offer colors with better UV resistance than others? Well, there are UV absorbers and UV [inaudible 00:47:46], and what those do is they stabilize the resin system. The pigment or colorant choices are really what dictate the color shift. So by using both inorganic pigments, we have better light [inaudible 00:48:03]. So there's no additive, UV additive to help stabilize the actual pigments themselves. What I'd like to say is that we're only as good as our weakest link in the material. Say we use a highly chromatic yellow, while this yellow is very susceptible to UV and the yellow starts fading so the entire color starts to shift.

I have a question here that says, "What kind of carrier is typically used for concentrates that would be used in nylon 66?" The answer here would be nylon 6 or nylon 66 would be the most common. There are a couple other options available but those would mitigate the effects due to the carrier.

Another question I have here is, "Are there alternatives to the 2000 QUV test?" And to answer that person's question, there are several different weathering specifications out there. The automotive industry uses two different Xenon-Arc method. There's an interior and exterior. There's the weathering method where you send them to the Arizona and Florida and they do actual outdoor accelerated weathering.

Another question here is, "Do you have masterbatches for rubber field? What kind of carriers?" And that, if it's going to be TPE material, we do have different options but, again, that's going to depend on if it's a thermoplastic polyurethane or polyester. Knowing those, we will pick the proper carrier so that we're not interfering with the hardness of your material.

Here's another question about matte and gloss and how they affect color measurement. Not [inaudible 00:50:41]. So if you think about the surface of a material, and it's matte and glossy, so it's very smooth, the light reflects almost directly back at you, now think about if you have a textured part. When the light hits the material, the light scatters in all different directions. So this is why if you're looking...if your part is half glossy, half texture, the textured part almost looks a few units lighter in color than the glossy part.

So here I have, "What are the typical concentration for pigments, inorganic and organic and dyes?" And that is a very bright question, and that depends on what your color [inaudible 00:51:30] will be, if you're using a colorless, transparent resin such as polycarbonate. Polycarbonate, if you're not familiar with that resin, is what is used in the lenses of your glasses. That, just to tint the material, would take fractions of a percent. Whereas if we're trying to make a highly opaque polysulfone, which is for amber yellow color and we're going for a white target, that's gonna take a lot more pigment to cover up.

I apologize. My questions got mixed up here. We have a question. "Can you do a color match using RGB numbers?" And the answer is yes. RGB numbers can easily be converted into some of the other common color spaces that I've talked about earlier. There are several color converters right online if you were to type that in. So we are able to match RGB numbers on the spectrophotometers or we can shift into something that we're more familiar with like the LAB.

Another question here was that I... It states that I said that, "Organic pigments come from metal particles. Would that make them have higher or better heat stability?" Well, when we talk about organic, we think of carbon-based. And carbon have a specific heat stability so that the metal won't be the link… The weak link would be the carbon-based structure.

Here is another question. "Why does the chromaticity diagram contain a linear and non-linear quarter?" That's a good question. This color space was developed many years ago in 1931. It was one of the first color space developed, and I believe they've only... These color spaces have only evolved to make them more uniform. The fact that it is a non-uniform color space is why they are...why it is not linear.

Another question here is, "How do I coordinate between colors, structure, and FR for a specific application?" First of all, you would get in contact with your sales representative, your sales engineer, and they would direct it through the system. We kind of have a hierarchy system of what group works on it first, in this case, but we'd still all would collaborate on it. So the sales engineer would likely involve a flame retardant engineer along with the structural and color group all at one so what we can all put our design input, make sure that we met that specification.

Let's see, another question I have here is, "How is transmitted color developed when filtering to a desired color using a transparent or translucent resin?" Well, we didn't get into this too much because it goes a little bit more in depth in that we can… In a spectrophotometer, it can also read through a transparent or translucent chip to give us those spectral curves. And we can use maybe Yxy as a good color space for color matching that system.

Trey: Thanks, Kelly. It looks like we have time for one more question.

Anna: One more, okay. I'll try to pick a good one, and for those of you who I didn't get to your questions, you will be provided a copy of this presentation which has my email at the end. And I would love to discuss your questions further.

All right, one more. So, "How do we quantify special effects colors?" And that's a good question because special effects, maybe it's a metallic, maybe it's a... RTP offers floral [SP] colors. Well, let's just talk about metallic. Metallic, when viewed at different angles, appear different. So what we do is we'd use visual quality check for an inspection but it would be backed up with a spectrophotometer but knowing that those numbers can change, vary quickly depending on the reflectance of those metallic type particles. If it was a swirled colored material, I don't know if any of you have heard of that special effect, we had actually…ensure the quality of the individual colors of the material so that they are on specification. And then it's just a matter of blending those on the right ratio. All right, that was my one question.

I appreciate everyone's time. I know it is very limited for everyone.

Trey: Right, Anna. Thank you so much. Appreciate everybody for attending. We also do encourage you to check out some of the other RTP webinars that we do have on the Prospector Knowledge Center. Really great, really informative. Again, we'll be sending a copy of the recorded presentation and the slides to your email. So do be checking for that. We'll be sending that out on Monday. Again, a big thank you for a really great video. Have a great rest of the day.