Covestro materials take auto interior design in a bold new direction

The automotive industry continues to evolve, facing unprecedented challenges and opportunities, from enhanced connectivity to the development of alternate fuels and evolving regulations related to VOC emissions and sustainability. These megatrends are redefining the role and function of auto interiors.

Empowering performance: Our waterborne PU technology INSQIN® enables flexible, adaptable and durable materials with a premium look and feel. The product features empower performance even in the thinnest layer and create inspiration for material applications. INSQIN® offers consistent qualities sought by automakers and drivers: durability with a premium look and feel. In fact, our INSQIN® waterborne polyurethane technology produces synthetics that deliver a look, feel and performance that is similar, if not better, than genuine leather. The technology is also light weight, enabling it to be incorporated into innovative interior designs and integrated with the latest technical equipment.

Waterborne polyurethane synthetics: a great alternative:INSQIN® is produced at state-of-the-art facilities that do not use solvents, for a lower VOC impact on the environment. Because of this, waterborne polyurethane synthetics produced using INSQIN® offers a lower carbon footprint than traditional wet-processed materials. This makes it possible to save up to 95 percent of water and 50 percent of energy compared to a non-waterborne polyurethane production. The environmental benefits are also backed up by a third-party Life Cycle Assessment that shows water-based technology reduces global warming potential by 45 percent.Drivers today increasingly want an intelligent, enjoyable and healthy in-car experience. This is creating greater clamor for

smart, functional and attractive interior design. Harnessing INSQIN® waterborne polyurethane technology, Covestro is fully equipped for these changes and evolving demands. Our high-tech polymers combine amenities with functionality, allowing materials to be used for diverse applications in seats, door panels and headliners.Proven for their excellent material properties and functionality, Covestro's polyurethane synthetics are preferred by many industries such as auto,furniture and sports footwear and apparel.INSQIN® technology combines excellent durability with a premium look and feel.INSQIN® technology gives OEM partners and consumers a more sustainable choice.Waterborne polyurethane synthetics made with INSQIN® technology offer a look, feel and performance that is similar, if not better, than genuine leather.

Resin solutions designed for stain and smell blocking interior paint

Increasingly, consumers and painters look for stain and smell blocking interior paints that are high in performance and low in emissions. Covestro designed NeoCryl® HP-4200 and NeoPac™ HP-5081 to meet these needs. As well as stain isolation – and smell blocking for NeoPac™ HP-5081 – both resins offer scrub resistance and formulation without coalescents.

The need for more functional stain- and smell-blocking coatings: When painting their interior walls, today's decorative paint consumers increasingly look for solutions that can resist and isolate stains or smell.Stain- or smell-blocking interior paint allows these consumers to cover stains or smells efficiently when painting, without the application of multiple layers to the wall surface.These stain- or smell-isolating paints can be applied as a wall primer, locking in the stain or smell to prevent bleed-through. After this, the primer only needs to be covered with one extra coat for a stain -free paint finish.At the same time, consumers also seek decorative coatings with

high-performance functional properties, such as good adhesion, chemical resistance, and high gloss. They also look for coatings with more natural ingredients, such as low-VOC paints.To create these interior paints and primers, coatings manufacturers need resins that can isolate stains and smell well.

NeoCryl® HP-4200 and NeoPac™ HP-5081: Low-VOC, stain and stain & smell -blocking resins from Covestro: To address this need, Covestro created NeoCryl® HP-4200 and NeoPac™ HP-5081. We developed these decorative primer resins to meet the need for stain isolation, more natural ingredients, and strong functional performance in paints and coatings for interior walls.With their ability to isolate a wide range of stains effectively, NeoCryl® HP-4200 and NeoPac™ HP-5081 make painting over pre-existing stains easier – whether the stains are from grease, oil, water, smoke, or nicotine. The resins can act as a stain blocker in interior paints, primers, or topcoats on a wide range of interior wall surfaces.In addition, NeoPac™ HP-5081 can isolate smells, such as from tobacco, in pre-existing finishes.NeoCryl® HP-4200 and NeoPac™ HP-5081 can also help you improve functional performance in your coatings. Both solutions offer good mechanical and chemical resistance properties, and can be formulated to achieve scrub class 1. They're also stable with colorants, enabling you to create a full range of color paints. NeoCryl® HP-4200 and NeoPac™ HP-5081 can also both be made with a formulation that doesn't use coalescents, enabling interior paints, primers, and topcoats that are very low in VOCs and odor. This also supports compliance with regulatory or labeling requirements.NeoCryl® HP-4200 and NeoPac™ HP-5081 enable Covestro's coatings customers to create primer, paint, or topcoat solutions that offer stain or smell blocking, along with an improved emissions profile and high-performance properties. In turn, this makes painting over stains or smells – on a wide range of substrates and surfaces – much easier for end-users.To demonstrate how well our resins can isolate stains, Covestro performed several lab tests using NeoCryl® HP-4200, aiming to ensure that they closely reflected real-world applications.We started by painting large segments of plasterboard material to represent interior walls. We then covered each of these 'walls' with a coat of a different common stain-causing substance: felt-tip pen, highlighter, coffee, crayon, and nicotine.After application and allowing each stain to soak into the paint, we applied a primer and a top coat of paint with a roller and allowed it to dry. We did this with benchmark paints, primers, and top

coats, and those made with Covestro’s NeoCryl® HP-4200 resin.To assess how well the coatings could isolate the stain, we measured the color change between the final paint finish and an unstained area using colorimetry measurements.The results showed that coatings formulated with Covestro’s NeoCryl® HP-4200 resin could isolate stains similarly to, or better than, other benchmark stain-isolating coatings. NeoCryl® HP-4200 could isolate marker-pen stains particularly well.

Stain- and smell-isolating resin solutions for tomorrow’s interior wall coatings: By combining stain blocking with lower-emission ingredients, and high-performance properties, Covestro’s NeoCryl® HP-4200 and NeoPac™ HP-5081 stain-blocker resins help meet multiple painting consumers’ needs. In this way, the resins can improve the possibilities for stain- and smell-blocking paints, primers, and coatings for interior walls.

Part of Covestro’s advanced coating resin technology toolbox: NeoCryl® HP-4200 and NeoPac™ HP-5081 are just two of many coatings solutions available in Covestro’s architectural resin technology toolbox. This toolbox includes waterborne acrylics, acrylic copolymers, acrylic emulsions, hybrids, tribrids, alkyds, urethanes, and partly plant-based resins.Together, these solutions can enable high-performance coatings such as varnishes, aqueous paints, UV-curable paint, isolating paint, sealers, low-cure powder coatings, and more. These coatings can be used across multiple substrates in a range of interior environments, including high-moisture areas.Key Benefits of NeoCryl® HP-4200 resin: Stain-blocking: Both NeoCryl® HP-4200 and NeoPac™ HP-5081 offer broad stain isolation.Smell-blocking: Alongside stain isolation, NeoPac™ HP-5081 also offers smell blocking.Labeling-compliant: With low VOC content, both resins can help you meet labeling requirements.Scrub-resistant: NeoCryl® HP-4200 and NeoPac™ HP-5081 have a scrub class of 1.Pigment-tolerant: Both resins have a high pigment tolerance, enabling color excellence.

More sustainable building with climate neutral Makrolon® RE resins

As the construction industry strives for greater sustainability, our Makrolon® RE resins reduce the carbon embedded in the polycarbonate used for translucent roofing, skylights, light domes and facades. This ready-to-use solution makes more sustainable construction an option for builders today.More sustainable buildings: a challenge for the entire value chain.Everyone’s talking about the building environment – the spaces we live and work in and how sustainable they can be constructed. So the construction industry faces multiple sustainability and climate change challenges. Up to now, the key priority for owners has been the operating life of a building, giving energy management, insulation and cost efficiency the primary focus. But climate-aware, more sustainable building practices now demand taking a wider, more circular view of a building’s full life cycle. This means measuring the carbon footprint of the actual construction process as well as the carbon emissions from extracting and producing the materials is crucial. This shift to circular practices will require a collaborative approach across the value chain. As a major chemical producer, we are developing climate-neutral solutions for the construction sector that are already available today.

Polycarbonate: a transparent, energy-saving building material.Transparent sheets made of polycarbonate (PCS) are an interesting material for a sector looking for cost-effective solutions. PCS sheets are inherently lightweight, transparent and extremely tough. Crucially, they can be tuned for a wide range of colors and degrees of transparency. This makes them optimal for applications that require some degree of light transmission or scattering, such as roofing and facades, light panels, skylights and greenhouses.Letting daylight flood into a building through panels or skylights creates a more livable and workable environment, while the need for artificial lighting is reduced or eliminated, saving electricity and operating costs .Color, form and degree of translucency can also be engineered with additional functions such as heat insulation. Polycarbonate sheets made with Makrolon® are an asset for architects, designers and construction companies who want to unite design freedom in shape and form with excellent weathering and durability properties. Makrolon® RE resins: more sustainable climate neutral* polycarbonates, available today.To meet the growing demand for more sustainable building materials in the construction sector, we have developed a new

portfolio of Makrolon® RE resins that can reduce emissions to levels as low as zero.Makrolon® RE is a more sustainable, climate neutral* grade of PC resin with performance identical to fossil-derived, conventional polycarbonates. With Makrolon® RE, construction companies, architects and designers can replace fossil raw materials with climate neutral ones at the beginning of the value chain.How do we achieve climate neutrality? First, we integrate alternative raw materials – circular feedstock inputs like plant residues and used cooking oils - into our chemical feedstock using an ISCC Plus certified mass balance approach. This chain-of-custody accounting method allows fossil and alternative raw materials to be mixed into large-scale chemical plant production but to be tracked and allocated separately. This mass balance approach enables renewable materials and circular feedstocks to be attributed to specific end products in a verifiable way. Second, we use renewable energy to power the chlorine electrolysis process and other key steps in the polycarbonate production. The result is a drop-in solution with zero technical risk and no needs to change processes for our customers. The share of attributed sustainable material can reach as high as 89%, with a carbon neutral manufacturing footprint. And Makrolon® RE resins deliver exactly the same technical performance as fossil-based polycarbonates. Our carbon neutral Makrolon® RE portfolio is an optimal choice for customers looking for alternative raw materials with a lower carbon footprint that meets their sustainability targets today.

Key Benefits of Makrolon® RE are Zero emissions: Makrolon® RE is produced using renewable electricity with no CO_2 emissions.High performance: More sustainable Makrolon® RE meet the quality of fossil-based polycarbonates.Fast implementation: Makrolon® RE is a drop-in solution with no need to change production processes.High-performance: Makrolon® RE offers high transparency, very good weathering and high stiffness.Energy-saving: More daylight in a building means lights can be turned off, saving energy. We support our industry partners in the construction industry in meeting their sustainability targets. With our climate neutral Makrolon® RE portfolio, our customers enjoy exactly the same quality and performance as fossil-based products without the need to change existing production processes.

Promoting circular design strategies:

Design is a critical driver in the shift from a linear economy to a circular economy. Key is to consider the end of product life during the initial design phase. By utilizing circular design strategies, electrical and electronics disposal can be more effectively recycled and reused. Subsequently, material efficiency will be enhanced and carbon emissions reduced.Covestro created the first Circular Design Guidebook geared specifically for the electrical and electronics industry. This Guidebook is designed to help designers, developers, and other players in the value chain to consider the Circular Economy at the outset of product design, as well as providing guidelines on how to select materials.In addition, Covestro's Color & Design team offers CMF (Color, Material, Finish) guides to integrate aesthetic CMF design into Covestro's more sustainable polycarbonate material portfolio and promote a design approach that brings aesthetics together with circular design.

Collaborating with value chain partners :Collaborative effort is required from all stakeholders to achieve a circular economy. Covestro collaborates with our partners to build up the recycling value chain. For example, we have partnered with Chinese beverage provider Nongfu Spring and recycler Ausell to build a recycling value chain to meet the growing demand for high-quality, traceable, recyclable plastic pellet as raw material. Moving forward, Covestro is eager to work with ever more partners across the value chain to achieve our fully circular ambition. Key Benefits:Comprehensive solutions: Offer a full range of more sustainable engineering plastics solutions for the electrical and electronics industry.Brand value: Realize the sustainable commitments of electrical and electronics brands to elevate their brand value across the globe.Smaller footprint: Reduce the carbon footprint of end products in traceable ways.Eco label: Enable electrical and electronic brands to obtain eco labels, such as EPEAT

Covestro in Consumer Electronics:

Covestro has launched a whole set of material solutions exclusively for laptops. Materials in these solutions possess a variety of excellent properties: high rigidity, high strength, Thinwall flame-retardantcy &, colour flexibility and low carbon. Covestro not only ensures the functions of the computers, but also aesthetics and sustainable development.Lighter, thinner and stronger.As one of the crucial tools for white collar

workers, commercial laptops are expected to be easy to carry and as such, need to be high-performance and portable.Covestro’s carbon fiber reinforced Polycarbonate and thinwall flame-retardantcy solutions are the best choices for commercial laptops models which can achieve much more light weight comparing to aluminum meanwhile still maintain the excellent mechanical performance and meet the safety requirements.
When materials meet with aesthetics:More and more young customers are willing to buy netbooks. Besides the lightness and portablility, the most obvious feature is their fashionable and colourful appearance, attracting numerous students, designers and other professionals. As a Porlycarbonate material supplier of consumer electronic devices, Covestro has built up its professional capabilities in the field of CMF (colour, material and finishing) to meet the growing design needs of electronics customers. The global colour and design department of Covestro's polycarbonate business unit can provide polycarbonate colour matching services with global unified quality. They also released the CMF trend colour palette in 2020 dedicately for Consumer Electronics & Home Appliances on the basis of polycarbonate materials.Through professional colour matching services and rich material experiences, Covestro is able to combine design aesthetics with functions, materializing innovative personalized designs. A bland laptop can be turned into a stylish electronic device through this process. This transition has brought computer designers and end consumers a new CMF experience.Covestro’s PCR (post-consumer recycling) product portfolio-Bayblend®, Makron® and Makroblend® use upgraded recycling technology to provide 20%-75% PCR polycarbonate materials for laptop shells. Covestro's PCR recyclable materials feature traceability and high quality. Covestro is committed to working with all parties in the industrial chain to regenerate waste plastics and apply them to the production of laptops to reduce the impact of plastics on the environment.

Additionally, Covestro has cooperated with upstream suppliers Neste and Borealis. They have produced a renewable phenol-rPhenol, which is certified by ISCC Plus via mass-balance. Then Covestro further processed r-Phenol into polycarbonate materialsor laptops. Covestro can help customers to reduce carbon footprint from the source of materials, supporting to improve carbon footprint to achieve carbon neutrality.

Demonstrate new designs that support 5G technology

5G will seamlessly enable a fully mobile and connected society. This technology will also play a key role in the digital transformation and will be used for high-capacity and high-performance broadband access in dense urban areas. To implement 5G, the demand for base stations and other equipment will increase drastically. Covestro teamed up in a pilot project with Umeå Institute of Design and Deutsche Telekom to implement these solutions into urban environments.We can help our customers explore design possibilities for 5G network infrastructure while ensuring excellent signal performance up to mm waves. For this, we offer state-of-the-art testing facilities in a wide signal range of up to 50 GHz at our Asia-Pacific innovation center in Shanghai.Materials for the networked world.In a pilot project alongside Deutsche Telekom and Umeå Institute of Design, we developed appealing and functional 5G small cell casings based on Makrolon® polycarbonate. With color, material and surface finish in mind, this infrastructure can either blend into or stand out of the environment. The developed designs, like the Bird or the 24h5G, show novel routes for better integration into urban environments while encouraging people to trust new technologies.

Why Makrolon® polycarbonate is the right solution for 5G applications:Signal transparency: Makrolon® polycarbonate features excellent signal transparency, even at mm wave lengths.Highly impact-resistant: Makrolon® polycarbonate offers high impact resistance for durable 5G network infrastructure.

Dell Technologies and Covestro work to move the closed loop forward

Identify a supply of high-purity materials and ensure the preservation of engineering properties during closed loop recycling:As the teams began their work, they identified two major areas of question. First, when attempting to re-use plastic after it has been used in an application, there is a limited supply of high-purity material available. Polycarbonate manufacturers, like Covestro, typically seek high volumes of transparent plastic which can be ground-up after its first life, and re-incorporated into new plastics—thus bypassing raw materials made from petroleum.A possible solution to this challenge is to first identify plastic which is used in a specific, high volume application, then recover a sufficient quantity after its “first life”, and finally re-grind and re-incorporate it into plastic, which is then used to make the same application. This is called a closed loop. The plastic obtained from such a closed loop will already contain the additives required to meet the application specifications and, when in high volumes, the plastic produced will serve as a reliable feedstock to re-use in the same application. With several million notebooks manufactured every year, only a very small fraction are currently recycled – meaning there is great opportunity here.

Challenge:

Maintaining engineering properties in closed loop:

With a steady supply of high-purity material identified, the challenge remained: Are engineering properties, such as tensile, impact and flame retardance retained when these plastic components (both painted and un-painted) complete the closed loop?.The study, conducted jointly with Dell Technologies, used Covestro Bayblend® PC/ABS plastic, which contains a mineral filler, is flame-retarded and also contains 30% post-consumer recyclate (PCR). This material is formulated to meet the demanding engineering specifications of Dell Technologies for use in notebook parts.

The molded notebook parts were ground-up, following which, 20% re-grind was added in each subsequent loop, thus gradually increasing the recycled content in the plastic after each loop:

- The starting material contained 30% recycled content
- The plastic created after the 1st loop contained 44% recycled content
- The plastic created after the 2nd loop contained 58% recycled content
- The plastic created after the 3rd loop contained 72% recycled content

Solution

A well-defined source helps maintain engineering properties after multiple loops

It was discovered that when a well-defined source was used to create the re-grind, the engineering properties of the new plastic material created did not deteriorate markedly and were similar to the starting plastic, even after three recycling loops. Interestingly, there was also little effect observed when the recycled parts which were ground-up had been painted.Since the average lifetime of a notebook is 3 to 8 years, going through three of these closed loops would keep plastic notebook components in circulation from 12 to 32 years, while retaining the demanding engineering properties which Dell Technologies specifies. The results were shared at ANTEC® in 2023.The results of the closed loop recycling study may potentially be replicated in other consumer and business segments, where high volumes of parts are made, by using well-defined plastic materials. Examples include network devices, servers, home automation devices, smart speakers and other mobile devices.

Let’s talk to find out how Covestro can assist in the development of a closed loop for your application.

About Dell Technologies

Dell Technologies (NYSE: DELL) helps organizations and individuals build their digital future and transform how they work, live and play. The company provides customers with the industry’s broadest and most innovative technology and services portfolio for the data era.

Key Benefits:Flame retardant Meets strict flammability standards and thermal requirements.Impact resistant Strong yet lightweight.Aesthetics Offers design flexibility that is a designer’s dream

Innovative E&E solutions inspire fruitful collaboration

Covestro has long been a reliable polycarbonate supplier for Vimar, an innovative player on the low-voltage E&E scene. At a recent tech-day, we presented our latest material innovations, including Makrolon® TC. Vimar’s R&D team immediately recognized its enormous potential in solving a key challenge.

Heat management for fast-charging USB switches and sockets

For fast-charging mobile phones, USB sockets and switches are the state of the art. Today, many switches and sockets have integrated USB Type-C outputs, optimized to charge one device up to 3A (e.g. tablets and smartphones).The new products deliver a power up to 30W in different combination of voltage and current manage by devices and USB sockets (power delivery standard).In these applications, it is crucial that design meets the very latest technology. Conventional polymers have insufficient thermal conductivity to meet these requirements.

Reducing temperature in a key part of the electronic board

Fast charging generates heat, which brings standard polycarbonates to their performance limits. Temperatures of 118°C have been measured closed to the transformer. Therefore, a great need for improved heat management was identified. Vimar asked if significant temperature reduction could only be achieved by changing the polycarbonate grade. In response, Covestro proposed thermal conductive Makrolon® TC – which can be processed with the same tool as standard polycarbonate. After putting Makrolon® TC to test, Vimar was extremely impressed by the results.Thermal performance is one of the most important parameters to consider when designing USB sockets. By using standard PCS, high temperatures were measured around the transformer on the electronics board. With Makrolon® TC, we found a solution that lowers the temperature and meets the requirements of the EC/EN 62368-1 safety standard for IT and audio/visual.Heat management is essential for countless electrical and electronics applications. We are very pleased that our thermally conductive Makrolon® TC proved to be an effective solution to Vimar's challenge. It’s a great

example of how we support customers and create value with our portfolio and application know-how.

Using Makrolon® TC 210 in place of standard polycarbonate lowered the measured temperature to 106°C, a total reduction of 12°C reduction. This thermal conductive solution not only brings a substantial heat reduction improvement, but also can be used with the same equipment as standard polycarbonate – meaning no additional expenditure for Vimar.

Key Benefit:Thermal conductivity: Combining good flowability and mechanical properties.Heat reduction More than 10°C temperature decrease in this application.Easy processing: Easy to process using the same tool as conventional polycarbonate

Electric car components made with safe, tough, and light materials

The electric vehicle (EV) will demand high-performance, fast-charging batteries, crash-safe structures, effective battery cooling, and stable powertrain components. Our materials and coating technology will help manufacturers build better electric cars.

Apec®:Heat-resistant thermoplastic for automotive, lighting, and medical technologies

Bayblend®:Versatile toughness via blends of PC+ABS; PC+ASA; ABS+PC and PC+SAN

Baydur®:Baydur® – the versatile polyurethane that meets the needs of a variety of applications

Makroblend®:Smart combinations of polycarbonate and polyester in ultra-tough materials

Makrolon®:High-performance polycarbonate for applications in diverse industries.

Key Benefits:Lightweight: Stiff, light composite materials reduce electric vehicle battery and component weight.Safe: Our EV battery packaging is impact-resistant and can be tailored to any cooling system.Cost-effective: Durable electric powertrain parts use mass production technology.Easy to manufacture: Materials are formable, strong and well-suited to EV components with modular design.

We offer a range of innovative polycarbonate and polyurethane materials that help EV component producers address the pain points associated with electric cars, and to accelerate the transition to a circular economy.

EV battery packaging: high-performing, robust, flame-retardant materials for electric cars

Packing many fast-charging cells into an electric car battery means having components that are flame-retardant, impact-resistant and robust at both low and high temperatures. Our lightweight Bayblend® FR polycarbonate and ABS blend are an excellent solution for cell holders and other EV battery modules, remaining stable even at 80° Celsius, ensuring optimal operating efficiency. It also meets the UL94 V-0 rating for flame retardancy. Our Makroblend® resin has the durability needed for the protective housing, and has been proven to withstand vibration and impact, including abuse testing conditions.

Polyurethane pultrusion for EV battery case: cost-efficient manufacturing of robust composite parts

As electric car battery technology evolves, lightweight modular, extendable frames and battery housings enable manufacturers to meet future performance demands easily. Pultrusion is a proven, cost efficient manufacturing process for creating these composite parts from polyurethane resin and glass or carbon fibers. A battery pack from our Baydur® PUL material significantly outperformed a benchmark battery pack in crash testing that measured energy absorption, deformation, shock and vibration.

Powertrain electronics: materials for electric car components with less warpage, less density and less electro corrosion

Electric cars are triggering a shift away from semi-crystalline components under the hood towards amorphous materials. From high-voltage plugs to sensors, converters, inverters and bus bars, all-electric powertrain parts demand increased dimensional stability, limited warpage, less humidity absorption, and no electronic corrosion. Our Apec® FR, Bayblend® FR, Makroblend® FR, and Makrolon® TC give makers of EV powertrain components a wide selection of materials that meet these criteria, including isotropic shrinkage and phosphorus based flame-retardancy without electro corrosion.

Thermal management: electric car battery packaging to support liquid, air or phase change cooling

High-speed charging can quickly overheat electric car batteries, which should be operating under 40°C for peak efficiency and longer life. We match the battery packaging to its thermal management. Bayblend® FR4065 EV was developed to keep

its strength in contact with water/glycol battery coolants. Flame-retardant Bayblend® FR3042 and FR3080 EV are suitable for air-cooled systems. Flame-retardant Bayblend® FR 3040 is geared for air-cooled systems. Specific Makrolon®, Bayblend® and Makroblend® grades have chemical resistance to phase change materials. Heat-dissipating Makrolon® TC grades offer increased thermal conductivity while keeping good levels of flow and ductility.

Aesthetic toolkits: Stay ahead of emerging industrial design trends

When it comes to industrial design, the use of textures, colors, and tactile materials turns functional applications into irresistible aesthetics. To help customers find the right material solution, our color, material, and finish (CMF) team has developed three industry-specific toolkits, responding to upcoming trends in electronics and electrics (EE), automotive, and healthcare.With our CMF aesthetic toolkits, we help translate the freshest design trends from concept to material, so you can bring your vision to life.

The Covestro CMF team collaborated with academic and industry partners to research key trends in the main engineering plastics industries, to inspire CMF experts and industrial designers. Together with Tongji and Shanghai Jiao Tong universities and Good Matter Design Studio, we identified the most important emerging and long-lasting megatrends for EE, automotive, and healthcare. Each industry has its own target audience with specific functional, sustainability, and aesthetic material requirements and preferred colors and textures – so, we've created three inspirational toolkits, each giving a taste of what's possible with our powerful CMF insights.Thanks to the visual, tactile, and mechanical properties of polycarbonates, there's a world of innovative CMF design

to explore. Industrial designers need to develop products that stand out in the market, fulfil increased circularity requirements, and align with a company portfolio, all while tapping into upcoming consumer trends. From eye-catching colorways to appealing finishes, every element plays a role in evoking an emotional response in consumers – creating an aesthetic and functional design that truly elevates your product and brand.Guided by our CMF approach – focusing on functionality, aesthetics, and circularity – our aesthetic toolkits enable industrial designers to explore four trends in each of our key industries. For example, the EE industry is more interested than ever in how devices coexist with people and the environment, making life easier through smart homes, IoT, and 5G connectivity. Automotive developments are moving from purely industrial to design led, enabling precise interaction between user and vehicle, with a primary focus on interior applications. And in healthcare, inclusive design considerations for an increasingly diverse population meet a growing desire for more individuality and empowering patient treatments that enable better mental and physical well-being. Our toolkits in the edition 2022/2023 inspire industrial designers to translate industry-specific trends into material solutions and enable a better understanding of the properties of polycarbonates. By capturing the structural and visual effects of different material combinations, they effectively and efficiently bring more sustainable designs to life.Discover how these trends can be reflected in circular, aesthetic, and functional design.

Covestro is far more than a materials manufacturer: we’re an inspirational and collaborative partner for designers and CMF experts, helping them realize their vision with our high-quality polycarbonates – on an industrial scale. By enabling functional, aesthetic, and circular design, we add value for customers, consumers, and the environment.

The Covestro 2022/2023 CMF aesthetics toolkits edition won a German Design Award from the German Design Council in the category ‘Excellent Product Design – Material

and Surfaces’. The toolkits inspire designers to explore the many aesthetic and functional possibilities of polycarbonates in the CMF field.

Developed in collaboration with renowned designer Chris Lefteri, the toolkits pave the way for inspiring dialogue and creative collaboration between the Covestro CMF team, industrial designers, and brands’ CMF experts.

Key Benefits:Consumer focused: Colors, textures, and patterns evoke an emotional response and elevate brand perception.

Targeted: Industry-specific toolkits for designers and CMF experts in EE, automotive, and healthcare.

Inspirational: Research, toolkits, and chip samples spark creativity and innovation.

Global: Universal megatrends are reflected in solutions for today’s globalized industries.

Award winning: Aesthetic toolkits won the German Design Award 2022, offering inspiration to designers.

Surgical: Specialized materials for critical medical applications

Medical device manufacturers rely on our portfolio of medical-grade polycarbonates, blends and specialty films for a wide variety of surgical applications. These materials are often necessary to produce instruments and equipment surgeons can depend on during even the most complex operations.

Medical-grade polycarbonates and blends for surgical devices

Our specialized medical-grade polycarbonates and blends meet properties required for surgical devices, including mechanical strength, dimensional stability, chemical resistance, heat resistance, and glass-like transparency while also supporting sterilization methods commonly used in the industry.

For devices that demand superior and lasting strength, Glass filled medical Makrolon polycarbonate offers the required balance of strength, stiffness and biocompatibility for surgical instruments, making it an alternative to metal. Device components can be made smaller and thinner to improve the ease of use of handheld devices and portable equipment.

For reliable surgical devices, Biocompatible makrolon polycarbonate offers toughness, glass-like transparency, dimensional stability, and the ability to be sterilized across a spectrum of techniques. These attributes make it well suited to applications including trocars, robotic components, blood oxygenators and reservoirs.

For high heat medical devices, shortening patient wait times by speeding up the process needed to disinfect instruments after each treatment can improve efficiency in clinical and hospital environments. Tristel solutions set out to achieve exactly this with its new Stella System, enabled by Apec 1745 high-heat polycarbonate.

Convestro developed a new portfolio of low friction polycarbonates for medical applications with sliding components. Biocompatible low friction Makrolon also has the ability to be sterlized across a broad spectrum of techniques including gamma sterlization.

Maintained sterility in the operation theatre with Thermoplastic Films

Maintaining sterility while using medical devices and high-tech equipment in the operating room is critical. Platilon® and Dureflex® TPU films are used in multiple applications during surgery, thanks to their versatility and biocompatibility.

Dureflex and Makrofol TPU films for surgical applications offer customized propoerties such as innate soft touch, good visual clarity,tensile strength and good puncture and temperature resistance.Protective sleeves and covers for articulated OR equipments such as surgical robots made with TPU films,offers elevated performance and good tear and high heat resistance and protect patient and staff from contamination.Low gloss TPU film grades used for incision drapes as its thin but strong and elastic,hence provides clear surgical site visuals without glare.TPU for drapes in slush machines and fluid warming equipment provide a sterile barrier.

Biocompatible Makrolon® houses new surgical device

Previously, surgeons had to subjectively determine how much pressure to apply to a knee implant during surgery. Now there's a specialized device that provides real-time data, so they can adjust pressure exactly: the OrthoSensor™ Knee Balancer - with biocompatible Makrolon® Rx1851 polycarbonate housing.

Our biocompatible Makrolon® Rx1851 medical grade resin provided the flow, lubricity, easy release and strength our customer was looking for. The material is compliant with FDA-modified 10993, Part 1 standards and, importantly, also allows custom color formulations. In this case it was four translucent colors – brown, green, blue and yellow – each indicating a specific surgical size. During development, we worked closely with OrthoSensor's molder to ensure the highest standards were met.

Why Makrolon® Rx1851 was the right solution for the OrthoSensor™ Knee Balancer

Biocompatible: Satisfies major bio-compatibility requirements, including ISO 10993-1.

Light & strong: Makrolon® Rx1851 is exceptionally tough and durable with high impact strength.

Chemical resistant: Stands up to harsh disinfectants.

Customizable color: Different color options available according to product requirements.

Ease of use: Good flow and lubricity allow for fine product detail and easy mold release.

Bayfol HX used to create Sony 360° display concept for floating holographic augmented reality images

The R&D Team of Sony Corporation in Tokyo is looking into new concept displays to contribute to Sony’s strong innovation pipeline and create the next-gen image experience for consumers. One of the ideas they wanted to realize was a new display that can project floating images within a 360-degree direction while at the same time being transparent. Sony chose Covestro’s photopolymer film Bayfol® HX to overcome challenges on the trade-off between image brightness and transparency in order to realize a breakthrough augmented reality (AR) display device.

Why Bayfol® HX was the right solution for Sony

High transparency Volume holograms recorded into Bayfol® HX respond to, and redirect only, the light coming from the projector whilst being completely transparent

High Δn High Δn allows high diffraction efficiency for the redirected light from the projector, thereby enabling high image brightness.

Easy processing No chemical pre-treatment or post-processing necessary for the recoding process

Laminate recorded film on a cylindrical surface While enabling simple recording in a plane configuration, the flexible plastic substrate and the inherent stickiness of the functional layer of Bayfol® HX allow easy lamination on cylindrical curved surfaces, enabling a 360° field of view

Makrofol® LM 914 enables lensless design for hybrid instrument clusters

Whether conventional, hybrid or electric vehicle, advancing digitalization requires new approaches in automotive construction and design. Forward-looking technologies and materials are crucial to ensure a smooth transition to digital applications. Makrofol® LM914 light management film is the solution of choice for hybrid instrument clusters.

LM914 is just the latest in a long line of innovative polycarbonate materials: With the transition away from traditional gauge and pointer instruments towards next-generation digital displays, the market needed an engineering grade optical film with excellent light management, anti-glare surfaces, and with a reliable global source.

This polycarbonate (PC) light management film offers black panel technology for hybrid clusters. Makrofol® LM film enables the seamless integration of displays and backlit graphics, fade effects and precisely controlled light functions.Makrofol® LM914 allows for a lensless design which enables more sophisticated cockpit solutions, consoles and displays that in future will play a key role – not only in the automotive industry, but also

in the electronics and consumer markets.Covestro’s Makrofol® LM914 combines layers of polycarbonate and acrylic (PMMA) into one film. By adding a scratch-resistant surface to the tinted polycarbonate layer, the cover lens formerly used to protect the analog or hybrid cluster becomes obsolete. This lensless design makes the cluster more compact, so it takes up less space in the automobile and allows more freedom for designers.Not only does this eliminate superfluous components in vehicles and the energy required to manufacture them, but also allows OEMs greater design freedom for brand differentiation. The tinted film is printable and delivers precise light transmission, high mechanical strength, scratch resistance and reduced reflections.

Key Benefits:

Simplified construction: Assembly is simplified as many conventional components are no longer required

Seamless: Readily implementable; no need to alter formulations, equipment and processes

Multilayer capability: Ability to combine different materials or functional layers into one film

Design freedom: Enables homogeneous aesthetically pleasing surfaces with sleek lighting appearance

Customizable: Available in various thicknesses; thicknesses, light transmissions, and gloss levels

Robust and biocompatible: high-performance TPU in wearables

Straps are an important component of wearable devices and watches. They must be robust, withstand the elements and also be comfortable, even if they are in contact with the skin for prolonged periods. That is why Xiaomi chose Desmopan® as the preferred material for their smart watch straps.

Covestro's high-performance TPU grade developed by its material experts immediately made Desmopan® the ideal choice for Xiaomi's wearable devices and smart watches. Covestro's thermoplastic polyurethane Desmopan® offers high wear resistance, flexibility across a wide range of temperatures, and high elasticity over the entire hardness range. It also possesses excellent resistance to oils, greases and solvents as well as good resistance to weathering and UV radiation.

The selected Desmopan® TPU grade for Xiaomi smart watches fulfills the biocompatibility and cytotoxicity requirements for long-term skin contact. Moreover, the material is molded such that it possesses a pleasant surface texture to ensure wear comfort over a long period.

It therefore comes as no surprise that Desmopan®'s robustness, outstanding physical properties, processability, versatility and skin-contact biocompatibility make it a top-choice material for smart watches and numerous other industrial applications involving wearable devices.

Desmopan® TPU is a durable elastomer which is resistant to many challenges that smart watch wristbands are exposed to, for instance UV radiation, chemicals present in soaps, disinfectants and sunscreens, fatty acids in sweat, saline water and chlorinated water in swimming pools, to name but a few.

Desmopan® TPU also has a great feel and soft texture. Most importantly, it is biocompatible and comfortable in wearable components that are in close contact with the skin over a prolonged period.

Without compromising on quality or performance, Desmopan® TPU products offer numerous benefits such as a high degree of elasticity over the entire hardness range in addition to wear resistance and flexibility across a wide range of temperatures.

Apart from its excellent oil, grease and solvent resiliency, and its resistance to abrasions, weathering and high-energy radiation, the Desmopan® range allows product experts and developers from across various industries tremendous scope in terms of versatility and design freedom.

The selected Desmopan® TPU grade for Xiaomi offers precisely these solutions – durability, design freedom, style and biocompatibility for Xiaomi smart watch straps and wristbands.

Key Benefits

Durable: Resistant to chemicals and weathering, excellent durability against cracking.

Any place, any time: Night or day, dry or wet, hot or cold – Desmopan® is up for it.

UV-resistant: Colorfast and UV-resistant – Desmopan® is ideal for wearables.

Stylish and smart: Excellent esthetics and colorability allow us to put the smart in a smart watch.

Comfortable: Desmopan® is molded with a soft, pleasant surface texture for wear comfort.

Biocompatible: No discomfort, no skin irritation, even when worn for long periods.

Materials that Make the world a brighter place

Our materials enrich our daily lives and make the world a brighter place. They contribute to efficiency, safety and sustainability, and have demonstrated their performance in countless projects and collaborations with our partners and customers.

Adhesives

Our broad selection of high-performance polyurethane raw materials for superior adhesives can improve the sustainability of your products and optimize your production processes thanks to faster curing times.

Flame retardancy meets reliable electrical performance

Flame retardancy is widely requested and specified by battery pack designers. Underwriters Laboratories (UL) 94 V-0 rating at nominal thickness is a commonly used metric. Electrical safety is also satisfied by electrical properties measured in volume resistivity and dielectric strength.

Covestro’s Bayblend® FR series enable packaging solutions with the right flame retardancy and electrical resistance properties. With UL 94 V-0 listings all the way down to 0.75 mm thickness and a surface resistivity of 1016 Ω, this family of materials helps to meet the safety demands from battery manufactures.Thin-wall flame retardant Bayblend® inspires novel designs

As battery packs are trending towards larger size and higher energy density, components are expected to be thinner, more integrated, and lighter. And the demand for materials able to fulfill these needs is increasing accordingly.

The new Bayblend® FR3080 EV is exhibiting more industrial acceptance. This advanced PC+ABS alloy combines a UL 94 V-0 listing at 0.8 mm in all colors, high flow, excellent impact resistance and colorability. Compared with Bayblend® FR3010, Bayblend® FR3080 EV offers ~20% higher impact resistance (at 23°C), and thinner UL 94 V-0 certification. These material improvements enable new design possibilities.

In the automotive industry, customers demand battery systems be guaranteed for no less than ten years. This includes not only the cells, but also packaging components. As a result, designers should choose engineering plastics with a continuous use temperature or RTI (Relative Temperature Index) that matches the temperatures a battery may see during its lifetime. Based on safety tests for lithium-ion battery systems such as thermal cycling, humidity and temperature aging an RTI of 80˚C in all three categories should be considered.

Heat and humidity play a role in evaluating long-term physical durability. Components are often evaluated in severe environments, such as the commonly used 85°C/85% RH aging for 500 to 1,000 hours. Covestro Bayblend® FR4065 EV combines resistance to high temperatures and humidity. This product enables the integrated design of busbars while withstanding high temperatures (up to 110°C) caused by rapid discharge. Thermal stability over a wide temperature range helps meet the demands of long-term durability and part-to-part consistency from battery manufacturers, OEMs and consumers.

Polycarbonate solutions support the electrification trend in mobility

The automotive industry is facing significant disruption as the shift towards electrification opens up new options for plastics in Li-ion batteries and electric powertrains. The boundaries between the electrical industry and automotive will move and therefore cause a paradigm shift. Electric powertrains come with new challenges and polycarbonates could be an unexpected solution to help OEMs stay ahead of the curve in a changing automotive industry.

Fast-charging batteries form the lifeblood of electric vehicles and many of our everyday devices. A quick charge or discharge makes battery temperatures rise steeply, which can compromise battery life, safety and efficiency . With Makrolon® and Bayblend® polycarbonates we can provide versatile battery packaging solutions to help safely manage these thermal conditions.

From electric vehicles (EVs) and buses to e-bikes and even planes, energy storage systems (ESS) will play a vital role in future mobility. As the share of renewable electricity generation grows, so does the need to compensate for its intermittent nature using battery storage.

The high-speed charging and discharging that we demand, particularly in cars, triggers a chemical reaction in batteries that can push their temperature to dangerous levels. Battery cooling systems are designed to maintain maximum operating temperatures of 40°C or less, and they should never exceed 60° C for an extended period. At 150° C and above, cell breakdown in batteries can turn into a self-feeding cycle called thermal runaway, putting the car’s occupants at serious risk. This makes battery thermal management and cooling systems crucial to ensuring high safety standards.

In parallel, in colder climates, batteries also need to be housed warmly enough to keep them working smoothly when outside temperatures plunge far below freezing.

How do batteries stay cool?Heat generation can be offset by forcibly cooling down the battery, or by slowing down the charging process. A slow recharge is not what customers want on a road trip, so thermal reduction is usually required. Cooling can be done actively using liquid coolants or passively using air, though air cooling is generally not well-suited for fast-charging batteries.

In contrast, liquids such as a water/ ethylene glycol mix or dielectric fluids perform the cooling job well, achieving an even temperature around the entire battery surface. Water-based coolants must be kept separated from electronic components to avoid short-circuiting the battery. In some systems, a dielectric fluid cools the battery cells through direct contact.

What role can phase change materials (PCM) play?A hybrid approach to battery thermal management is offered by phase change materials (PCM). These are materials designed to absorb heat and energy by melting at a specific temperature that is tuned with the application. This takes up less space than traditional liquid cooling, making it highly interesting for applications such as electric motorcycles.

Which Covestro polycarbonates are suited to which cooling approach? No matter which battery thermal management systems approach a manufacturer chooses, we offer a range of reliable, safe polycarbonate-based materials for battery packaging. These resins provide excellent dimensional stability and durability over a wide range of temperatures.
For air-cooled systems, we offer Bayblend® FR3040 EV, a blend of flame-retardant polycarbonate and acrylonitrile butadiene styrene (ABS). Used as a cell holder, it allows rapid UV-cure adhesion of cells to achieve consistent cell-to-cell spacing allowing

uniform airflow.

Makrolon® TC110 FR is a thermally conductive, electrically resistant, flame retardant material ideally suited for air-cooled systems acting as heat sinks, cell holders and frames.

For liquid-cooling, Bayblend® FR 4065EV is a great solution for battery housing because when tested, it retains more than 90% of its original impact strength after being immersed in water/glycol coolants. This is higher than other competitive polycarbonate blends and in the same range as other thermoplastics such as Polyamide 66.

Where manufacturers choose the phase change materials route for cooling, Makrolon®, Bayblend® and Makroblend® grades' chemical resistance has been tested against commercially available materials where the consistency can change depending on the battery temperature.

How can manufacturers benefit from our battery thermal management systems expertise?We have been working with Tongji University in Shanghai and Toronto University to develop innovative material solutions for cool and safe battery packaging. Customers benefit from our engineering expertise in battery thermal management systems, our data and simulation tools, and our network of field service representatives. We help manufacturers take full advantage of the properties inherent in our materials.

By working with you to understand your design objectives, and recommending and testing the ideal material mix, we can help bring your energy storage and battery-driven applications to life.

Durability is our most important criterion. EV charging stations need to be able to withstand harsh outdoor conditions for years, in settings that range from deserts with high temperatures, UV intensity and sand exposure, to coastal Arctic locations with subzero temperatures and prolonged saltwater exposure. Retaining key properties such

as impact strength, color fastness and surface quality throughout this wide range of extreme conditions is vital.Aesthetic flexibility is another major consideration. The materials we use should accommodate a variety of colors, shapes and finishes suited to different use cases, ranging from public to private installations of EV charging stations.

Why does EVBox choose Covestro for material solutions in electric car charging stations?

Ten years ago, our founder Bram van de Leur called Covestro with a great idea: his new company EVBox needed to develop a housing for an EV charging station. He had already worked with Covestro in the CD industry, and knew the company could produce plastics that meet durability requirements while also offering color options, transparent parts, and design flexibility. That’s how the first steps were taken.

Today, Covestro Makrolon® makes up the majority of materials used for housing parts in EVBox electric car charging stations. With Makrolon® we can combine hardware protection with aesthetics and design flexibility. Covestro’s expertise in polymers also shows in their support with our technical feasibility studies on long term durability. This helps minimize our risk during the development stage. We also value the injection molding support that Covestro provides during the A, B and C sample phases we go through in product development.

In recent years, our partnership has intensified as EVBox has scaled up to meet the high volumes and quality standards of the automotive industry. In multiple large-scale and complex industrialization projects, Covestro is a trustworthy partner providing material solutions, testing and validation support. Their dedicated team is reliable and truly understands what we need to achieve to be successful.

Why Makrolon® offer the right material solutions for an EV-ready future:Weatherproof: Makrolon® housing parts resist moisture, rust, UV, and wide temperature changes.Safe and robust: Casings are electrically insulated, tough, impact safe and flame retardant.Flexible design: EV charging brands can express their identity with forms, colors and textures.Cost-effective: Durable Makrolon® components can be mass-produced easily.Reliable partnership: Covestro supports you from material validation through full-scale production.

Coatings, paints and inks – High-performance protection

Our innovative and more sustainable solutions help coatings manufacturers advance their formulations. We develop, manufacture and market a high-quality range of raw materials for coating formulations. Discover our products!

Composites: Explore our selection of high-performance composites with superior properties such as flexible tapes or sheets that look and sound like metal. Our versatile solutions are cost-effective and ready to scale.

Elastomers: We provide a wide range of high-performance raw materials for superior cast polyurethane elastomers – along with professional, customized support based on our innovative material systems and proven machine technologies.

Films: Explore our broad range of high-performance polycarbonate films, polycarbonate blend films and TPU films – with properties tailored to meet your specific needs.

Foams:Our extensive range of high-performance polyurethane raw materials offer solutions for flexible, rigid and integral skin foams – with properties tailored to meet your specific needs.

Makrolon® TC thermal conductive plastics: next-generation heat management

Heat-reducing materials for electronic devices act as an enabler for the digital revolution. Our Makrolon® TC thermally conductive plastics combine heat management with the properties next-generation materials demand: functional integration, reduced weight, and reduced RF interference for wireless connectivity.

Materials with thermal conductivity will enable the electronic devices of tomorrow to operate smoothly. Already, 5G network infrastructure, Wi-Fi routers, electric vehicle batteries and LED lighting require more than just heat management. Thermally conductive materials should provide interference-free wireless connectivity, longer battery life, impact safety and less weight.

Lightweight Makrolon® TC thermally conductive plastics are easy to process and give design flexibility to product engineers. Polymer grades for injection molding, extrusion, 2K molding and 3D printing can be tailored for electrical conductivity or insulation. We support customers in material selection, using computer-aided simulations to achieve the best performance and heat management for your application.

Our team of experts continuously work on improving our tools and applications, so we did with the Heatsink Screener Tool using Makrolon® TC. Are you interested in comparing polycarbonate Makrolon® TC with aluminum for heatsinks in a quick, easy and precise way?
The Heatsink Screener is a web-based tool to quickly compare (screen) Makrolon® TC versus cast aluminum for heatsinks. It also highlights the weight savings potential of Makrolon® TC over aluminum, while maintaining similar heat management performance.

From security cameras and logistical trackers to video projectors, the internet of things (IoT) relies on a steady 5G signal and uninterrupted in-house Wi-Fi. Makrolon® TC products combine good thermal conductivity with stable radio frequency (RF) transmission. Since they are not made of metal, they avoid signal shielding, making it easier to integrate an antenna into any router, wireless device or household appliance. Housings made of Makrolon® TC seal and protect valuable electronics from dust and moisture. Makrolon® TC provide strong flame-retardant properties to ensure a safe and reliable operation.

Battery applications: thermal conductivity meets impact resistance

High temperature reduces a battery’s power output and extends its charging time. Cell holders for lithium-ion batteries designed with electrical insulating Makrolon® TC dissipate heat effectively, enhancing the device performance and extending its useful lifetime. In addition, Makrolon® TC110 and TC110 FR grades pass the impact tests required for many battery-powered portable devices.

LED heat sinks: lighter than aluminum and more flexible in design.Today, energy-efficient LEDs are the norm when it comes to lighting applications. However, the design and shape of industrial luminaires still do not enable players to fully exploit the potential of LED technology. Makrolon® TC polycarbonate performs effectively as a LED heat sink, yet is lighter and offers far more design opportunities than aluminum. Injection molding reduces complexity and assembly cost, and enables designers to create non-traditional shapes, use in-mold processes and optimize joining techniques.

Mobility: A proven solution to reduce weight and complexity:Makrolon® TC polycarbonate in automotive applications opens the door to new possibilities, such as

more flexible heat sink designs, integrated electronics, and the use of housings for thermal management.

Decreasing component weight is an effective way to boost vehicle fuel efficiency and performance. Makrolon® TC is a proven solution in the automotive industry to do just that. It reduces the weight and complexity of components compared to ones made of die-cast aluminum, while keeping the thermal management performance stable. Using computer-aided simulation to redesign components can even lead to an outperformance of die-cast aluminum in terms of thermal management. For Electric vehicle (EV) batteries thermally conductive polycarbonates allow the design of innovative cooling cell holders. Also for various other E-Mobility applications Makrolon® TC offers even more benefits beside efficient thermal management. As an example, the good dimensional stability of parts made with Makrolon® TC may enable automation in battery assembly for electric vehicles, thus reducing costs in EV manufacturing.

3D printing: design freedom, resource efficiency and thermal management for personalized and small series production.Depending on the selected grade, Makrolon® TC polycarbonates can be processed by injection molding, extrusion and even 3D printing; a resource efficient technology that enables personalized and small series production. Our application development team can help you design complex structures while using computer-aided component simulations to improve your heat management performance.Sustainability: mono-material polycarbonate solution for simpler recycling and less energy consumption

Thermally conductive polycarbonates can be recycled together with conventional polycarbonate grades, which simplifies material management and reduces the complexity of sorting and storage during recycling. Compared to standard aluminum

heat sinks, Makrolon® TC polycarbonate compounds consume 60% fewer resources during production and require 75% less energy to recycle.

Rethinking LED heat sinks with thermally conductive Makrolon® TC

LEDs consume way less energy than conventional lighting and emit less heat too. This opens up new opportunities for designers in terms of materials they can use as heat sinks for replacement lamps or next-generation luminaires. We developed Makrolon® TC as the optimal LED heat sink.

The LED market is growing rapidly as consumers switch from incandescent bulbs to more energy-efficient LEDs. We set ourselves the objective of anticipating lighting designers' and manufacturers' needs by ensuring that we have the ideal heat sink materials readily available for LED lighting development and production.

Challenge: Offer a heat sink to increase LED performance and lifespan

When a LED reaches a high temperature, its color attributes change, the lumen output decreases and its lifetime shortens. This makes an effective and durable heat sink critical to the performance of a LED. We set ourselves the goal of providing a superior solution to aluminum, which is heavier than the materials we have at our disposal.

Solution: Offer all the advantages of aluminum with added benefits.

Collaboration with lighting industry partners led to the development of Makrolon® TC, a thermally conductive polycarbonate especially for LED heat sinks. The material has sufficient thermal performance with the added benefits of being lighter and more durable than aluminium. It also reduces production costs by eliminating assembly steps.

Because the material is injection molded, it also gives designers the freedom to create non-traditional shapes, use in-mold processes and optimize joining techniques.

Why Makrolon® TC was the right solution for LED heat sinks

Flame retardant: Has an Underwriters Laboratories 94 flame class rating of V-0.

Thermally conductive: Material acts as a channel for heat to pass through.

Ultra-durable: The material is corrosion, abrasion and heat resistant.

Light weight: Helps to reduce the overall weight of the LED lamp.

Design freedom: Allows shapes and features not possible with aluminum.

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Laminate recorded film on a cylindrical surface While enabling simple recording in a plane configuration, the flexible plastic substrate and the inherent stickiness of the functional layer of Bayfol® HX allow easy lamination on cylindrical curved surfaces, enabling a 360° field of view

Holographic films such as Bayfol® HX photopolymer film from Covestro has the potential to push the boundaries of what's possible with automotive lighting over the next decade.

The use of film technology for automotive lighting offers several benefits. Holographic films provide automotive designers and engineers with design freedom while using light as a design element. Besides allowing a vehicle to stand out from the pack, Bayfol® HX does not require a lot of space for installation and can make a big impact in a small space. It also has the potential to be used in a modular system, allowing for easy and adaptable holograms and designs.

Holographic lighting also adds an additional safety element by enabling the vehicle to be seen and allowing for displays that communicate safety messages, such as "stop." Once limited to fighter jets and luxury vehicles, head-up displays (HUDs) show important information, such as speed or navigation directions, directly in the driver's line of sight. Now, HUDs are more widespread and offer safety benefits over standard car cockpit displays by helping the driver keep their eyes on the road.

Conventional HUDs project the information only with the help of the bare windshield's reflectivity into the driver's eyes. The given reflectivity of the windshield however limits the brightness of the image and in addition the size of the image at a given space for the projection unit in the dashboard.

Now, automakers are exploring new designs for HUDs that feature augmented reality (AR) technology to overcome these downsides. With breakthrough optical films technology, Bayfol® HX photopolymer film enables new designs for HUDs. An AR HUD featuring a holographic film in the windshield allows light to be redirected efficiently from the projector towards a viewer, keeping energy consumption low. It's also possible to

realize larger images while only taking up minimal space for the projector in the dashboard with an AR HUD.

Why Bayfol??
Customizable, allowing for design freedom

Thin and lightweight

Fully transparent with glass-like transparency

Simple and efficient processing

Compatible with common production processes such as film injection molding

Bayfol®:Engineering thermoplastic and specialized photopolymer films

Makrofol®:Thermoplastic polycarbonate films

Makrolon®:High-performance polycarbonate for applications in diverse industries.

Key benefits

Design freedom: Integrate new interior space design visions for unseen styles, aesthetics and curves.

Tough: Create screens and displays that are scratch, head impact and chemical resistant.

Lightweight: Enjoy functionality and efficiency while saving weight, space and process complexity.

Flexibility: Integrate screens and displays with a wide range of technical possibilities.

Clarity: Achieve glass-like optic transparency with trace-free surface usage and vibrancy-enhanced clarity.

Customizable: Adapt our holographic films and polycarbonate materials together with our application development team.

Easy production: Reduce process complexity by focusing solely on the polycarbonate material.

Augmented reality / holographic films for head-mounted displays

New display concepts and augmented reality (AR) glasses require lightweight screen materials that meet the stringent optics and technology standards set by the industry. Bayfol® HX holographic film satisfies these requirements. Our development team works with you to customize the film to your specific screen view or display application.

When manufacturing holographic optical elements (HOE), Bayfol® HX film can be adapted to a wide range of solutions, including paper-thin, transparent, and even cylindrical 360-degree displays, light-guiding or laser beam filtering lenses and wearable devices.

Polycarbonate films and resins for functional overhead consoles and infotainment displays

Fully functional smart surfaces integrate touch controls, display screens and lighting. Thanks to modern and advanced molding technology, electronics can be placed in slim, lightweight panels providing complex 3D shapes and content to the user’s eye.

With the use of Makrofol® films and Makrolon® polycarbonate materials, a single

structure is created that enables seamless function integration while offering design freedom for our customers

Polycarbonates from Covestro allow designers to create unique forms for screens and interactive displays. Seamless 3D displays, combined with exceptional thinness, high optical quality and robustness, turn interiors into a multimedia stage.

Our Makrofol® films and Makrolon® polycarbonate materials give designers the freedom to create versatile, multifunctional and high-impact surfaces for all types of interiors.

With our materials, unseen curvature radiuses and complex geometrics allow for endless designs, while functionality and reduced process complexity enable heightened efficiency.