

Metal Effect Design in the Injection Molding Process

Finishing within the Mold Meets the Highest Demands for Surface Design

An innovative evolution of the ColorForm process from KraussMaffei is on its way: one-step injection molding of sophisticated design parts flow-coated directly in the mold with a fast-reacting polyurea coating. While the process already established in the market creates high-gloss, matte or textured full-tone color surfaces, the enhanced process creates new freedom in design in the area of high-quality metal effect surfaces that are also more durable.

New cars, cellphones and flatscreen TVs produced by various brand manufacturers often have a similar high technical and functional level. In this case, the design takes center stage in purchasing decisions, in addition to the option of letting customers individually design their new product. This trend puts high demands on the production of plastic visible parts. The palette of equipment colors, design elements and functional surfaces continues to increase in size. New processing techniques must ensure that the target marks of a "classy product look-and-feel" and "cost-effective manufacturing" do not drift apart.

Looking at trendy vehicle interiors shows that the design of door and interior panels, trim elements, radio bezels and center consoles is becoming more and more complex. Similarly, the importance of product and packaging design has also increased outside the automotive market. The one-step ColorForm process (provider: KraussMaffei Technologies GmbH, Munich, Germany), which in the future can also be used to manufacture components with metal effect surfaces, is geared towards designers of the above-mentioned product areas. Injection molded parts with an almost mirror finish or a »



The component surfaces have mirror finish immediately after opening the coating cavity.

The surface can also be entirely or partly matte and even textured. Even backlit lighting effects are possible

Process Innovation

The ColorForm process is currently taking root on the market for automotive parts. In this process, a thermoplastic article, which has been injection molded with a rotary table, swivel or index plate mold, is flow-coated in a second cavity with a polyurea reaction coating. A mixing head located as close to the mold as possible is used for the flow-coating process. With this technology, articles can be coated with a cycle time of less than a minute and in almost any color, including high-gloss piano black and clear.

A new option is the use of a 3-component (KraussMaffei) mixing head instead of the 2-component mixing head used to date. This allows a polyamine paste previously enriched with metal pigments to be added to the two reacting agents of the polyurea coating, polyamine and polyisocyanate as a hardener. This method creates resistant and non-fading coating layers with a metallic finish. This type of 2-component reaction coating with the addition of a third color component has been newly developed by polyurea coating system manufacturer Panadur.

If the coating cavity is textured in accordance with the surface texture of aluminum or stainless steel, the result creates the visual impression of metal parts. What is particularly appealing is that the surfaces follow every shape and the coating with its metallic effect even covers tight radii and the edges of punched holes in the component. Unlike real metal surfaces, surfaces with ColorForm metal effects are largely scratch-resistant and pleasantly thermoneutral. The surfaces are also easy to clean.

Unlike plastic parts with metal inserts, the new process makes it possible to create articles with a metal finish in one shot – including in large-scale series production with multi-cavity injection molds where applicable. In general, it is also possible to add metallic pigments in an optimized pigment form during the enhanced ColorForm process, making it possible to achieve typical metallic glitter effects.

brushed aluminum or stainless steel look – with the option of having the corresponding surface textures – have a high-quality appearance and can be produced at considerably less expense than design components made in multi-step production processes.

Visible Parts with Metal Effects from a One-Step Process

While metallic paints use pigments of different shapes, the design of metal effects requires the addition of very fine spherical pigments. This creates a uniform “metal surface” in the injection mold during the finishing process. Depending on the design of the mold, these kind of metal effect surfaces can either have a mirror finish or resemble brushed metal made of stainless steel or aluminum.

The surface textures in the desired design are incorporated into the negative of the mold surface. During the flow-coating process of the plastic base body, these textures are transferred onto the coating surface of the component. Even reddish or greenish copper effects have been achieved during initial principle studies; even patterns, text and emblems could be integrated in the components with elegance. Thanks to the high mechanical resistance and the resistance to UV light of the polyurea coating, the new process can also be used to manufacture exterior components, such as parts of spoilers, exterior columns and sill trims.

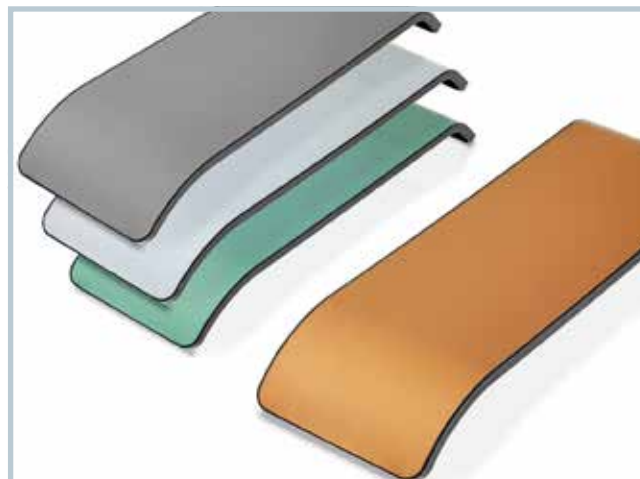
Integration of Lighting Effects

Even multicolored components can be created. Fine beadings can reveal the col-

ored or clear thermoplastic base material and they can be surrounded by high-gloss, matte or textured surfaces in any color – even those with metal or depth effects. Compact design edges are also possible, even in combination with light effects if LED elements and fiber optics are integrated into the translucent thermoplastic base bodies. As always with the ColorForm process, even tight radii and punched holes with surrounding edges can be coated with a uniform layer thickness even in the case of metal effect variants.

Whatever the designer chooses, the component remains in one mold forced into shape throughout the entire process. This results in a high dimensional accuracy, since the component is not exposed to free shrinkage. As a result, the ColorForm process is always one-step. If a multi-component injection molding machine is used, the components can also be fitted with other material such as soft components. The cost-efficiency of these processes obviously depends heavily on the cycle time. The cycle time has very recently been reduced to less than a minute through new recipes, without loss of surface quality.

This increases design freedom even more since joint lines on the thermoplastic base body are being completely covered. As a result, the visual design does not need to factor in component structures from the construction design. Meanwhile, process engineers focus more on the advantages of the one-step production process, which happens completely free of release agents and solvents, as well as of the short color change times.



The ColorForm process now also allows the manufacturing of interior and exterior components with surfaces with a metallic effect. The injection molded parts look virtually like real metal and are protected from mechanical stress by a polyurea coating

(figures: KraussMaffei)



Almost ready-to-install parts can be withdrawn from the mold after flow-coating the injection-molded base body with a polyurea coating. The parts can even be multi-colored and can contain intricate logotypes, emblems or decorations

The Three Components of a Two-Component Finish

This may sound like a contradiction, but it has a simple explanation. The two-component polyurea coating consists of the reacting agents polyamine and isocyanate as a hardener. As the third component, the spherical metal pigments, which the coating manufacturer mixed into parts of the polyamine beforehand, are added in the 3-component mixing head immediately prior to injection. Since the polyamine and isocyanate are the decisive factors for the reaction process, the coating is referred to as a two-component coating, despite the addition of the metal pigments. The polyurea coating is completely solvent-free and, thus, meets the requirements of the Directive 1999/13/EC of the Council of the European Union from March 11, 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents.

This technology expanded to include metal pigmentation is also the subject of a joint project of Panadur GmbH in Halberstadt and the Kunststoff-Zentrum in Leipzig, both Germany. The project has received funding from the Federal Ministry for Economic Affairs and Energy. The objective of the project is the "development of a UV-resistant, scratch-resistant system with a metallic effect based on aliphatic polyurea for coating plastic parts

in a continuous IMC process." The experiments at the facilities of the coating manufacturer Panadur as well as at the Kunststoff-Zentrum in Leipzig were carried out on systems from KraussMaffei and aptly demonstrated that the ambitious goals were achieved.

Processing without Release Agents

Short color change times become more important as the color palette of the polyurea coating becomes broader. To accommodate this requirement, KraussMaffei has developed various system concepts, which can be used to process multiple colors. With an optimal system design, a color change requires less than 15 minutes and allows for a user-friendly switchover in a few simple steps. The reduction in downtime compared to previous color change concepts benefits the productivity of the entire ColorForm process. Instead of volatile organic compounds, alkylsulfonic phenyl ester is used for the flushing operations, so that the entire production process runs free of any VOCs.

The newly developed polyurea coating systems from the coating manufacturer Panadur for the in-mold metal effect coating process without release agents can be applied to articles from very diverse thermoplastic classes such as ABS, PC/ABS, PC/PBT or ASA. The coating has excellent adhesion to these plastics; it is UV-resistant »

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Archive

Two trade press articles relating to the ColorForm process, which were the basis for the developments described in this publication, were published last year. They are available free-of-charge in the archive of *Kunststoffe international*:

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The combination of injection molding technology with the reaction engineering coating opens up new opportunities for driving sales in vehicle manufacturing, consumer electronics as well as communication and packaging production technologies



and temperature-resistant; and it can be highly elastic as well as abrasion-resistant.

Even though the manufacturing process with the low-viscosity coating system is complex, it is easy to manage in practice. First, the basic structure is injection molded using a rotary table, reversing plate or index plate mold. Next, the component, which has not been demolded, is moved to the second cavity and

flow-coated with the polyurea coating. After a reaction time of less than one minute, the coating has cured to such an extent that a handling unit can remove the almost ready-to-install component from the mold. During the curing time, the next substrate is already injection molded at the first cavity.

To prevent the flow marks of the metallic pigments from becoming visible

during flow-coating, the coating manufacturer adds plasticizers to its coating formulation. The consistency of the coating mixture as well as the reproducibility of colors and metal effects has been marked as very good. Thanks to sophisticated mold concepts, even multi-cavity molds for the production of large-scale components can be used with the corresponding component geometry.

Outlook

Even without details from further research and testing, achieving series production with the ColorForm injection molding process has put additional configuration options in reach. This includes manufacturing components with a metallic coating (glitter effects), the application of pearlescent surfaces in the injection mold and the simultaneous flow-coating of multiple partial areas with coatings of different colors and with various effects. Moreover, components with surfaces exhibiting an antimicrobial effect can be produced through the addition of silver or copper particles. ■