Chrome or Not Chrome?

Kunststoff Helmbrechts Gives an Overview of all Available Surface Treatment Technologies and their Advantages

Whether automobiles, shower bath fittings, or furniture handles: Surfaces with a metallic appearance are found everywhere. Mostly, the items are made of plastic that has been given the corresponding look – frequently by means of galvanizing, but also by means of modern chrome substitute procedures such as PVD, in-mold labelling or spray painting. For different component geometries, one or the other process is recommended.

Not all that shines is chromium. Which is fortunate, because real galvanization is currently under scrutiny by environmental authorities. The hexavalent chromium used for the purpose is toxic, is entirely subject to the European REACH directive (registration, evaluation, authorization, and restriction of chemicals), and is to be banned as possibly carcinogenic. Therefore, many companies, who wish to give their products metallic-sporting design, are searching for manufacturing alternatives. Functional considerations also play a role here. Capacitive operating concepts cannot be implemented with real galvanizing, but instead e. g. with film solutions. Also partial galvanizing and back-lighting effects are criteria for selecting the most suitable process. As a systems supplier, Kunststoff Helmbrechts AG (KH) applies different technologies for the production of articles. A closer look at the associated possibilities and limits can provide decision-making support for your own project.

The chrome effect on the panel surface is created by means of a PVD-coated film produced with the IML process (© Kunststoff Helmbrechts)

Real Galvanizing and Alternatives for "Partial Design"

Real galvanizing works best with ABS or ABS blends. The plastic surface is etched with chromium/sulfuric acid, which dissolves the butadiene fraction from the ABS. Hereby, microscopically small pores are created. Subsequently, the surface is inoculated with metal nuclei, which settle in the empty spaces and enter a firm bond with the plastic according to the press-stud principle. The first metal layer, usually copper, is then applied without an electric current, i. e. purely chemically. Depending on the aimed-for color shade and the required functionality, this is followed by the electrochemical application of metal coatings only a few µm thick, for example in the sequence copper/nickel/chromium.

The process creates extremely durable and wear-resistant surfaces with the typical "cool touch" and the high gloss of real metal (**Fig. 1**). However, the mechanical properties of ABS are not as good as e. g. that of PC or other plastics. Consequently, a multi-component part is sometimes necessary to give particularly stressed elements the required strength. This is also the classical method used for partial galvanizing. Only the parts that are to have a metallic shine later are made of ABS; the other parts are made of non-galvanizable plastic. However, the outlay for a 2-component mold and 2-component production is relatively high.

Therefore, with its "GalvanoLum", KH has adopted a different approach (**Fig. 2**). Here, the areas in which the required symbols are to appear later are printed with an etch resist lacquer. This permits extremely fine line widths of just a few tenths of a millimeter. In the following galvanizing bath, the metal layer cannot adhere to the treated areas, so that the raw material remains free and can be back-lighted. GalvanoLum is less complex in use than another conventional process, which interrupts the galvanizing process in order to remove the first metal layers in the required symbol shape via laser, so that the subsequent chrome plating cannot adhere. GalvanoLum is experiencing its first automotive series application in Opel's new Crossland X.

Regarding back-lighting, ABS always exhibits a slightly yellow color hue, which can disturb the intended design. This can be compensated with an ingenious lighting design – as for the Crossland X. Alternatively, the "FolioPlate" technology can be used. Hereby, an ABS film is back-molded with non-galvanizable material using the In-Mold Labelling (IML) process. Because the ABS layer is only 250 µm thick, the yellow tint is less noticeable than in an ABS component with 1 or 2 mm wall thickness.

The combination of FolioPlate and GalvanoLum leads to components for day/night design. In cooperation with the raw materials manufacturer Covestro and the surface specialist Bia Kunststoff- und Galvanotechnik, KH is presently testing a new process with a coextruded film consisting of a PC substrate coated with an ultra-thin ABS layer. As a result, the color temperature of the back-lighting is influenced even less.

Fig. 1. Optically difficult to distinguish: Chrome lacquer (top), galvanized coat (bottom) (© Kunststoff Helmbrechts)

Fig. 2. GalvanoLum – an efficient process for translucent symbols in a real chrome surface (© Kunststoff Helmbrechts)

Astounding Effects with PVD and Film Technology

With all processes that use real chromium, the operation of equipment with capacitive fields is not possible. But exactly this function is finding increasing demand, particularly for automotive interiors. A thin-layer technology that creates reflective surfaces the same as galvanizing, but without a screening effect, is physical vapor deposition (PVD) – and also here there are variants. In the original version, an injection molded component is coated with a primer in order to smooth the surface. The required metal is then applied in a vacuum coating chamber by means of physical reactions, whereby a nano or micron thick layer is deposited on the plastic article. Subsequently, the metal layer is protected with a clear varnish.

A more convenient alternative is back-molding of a PVD-coated film using the IML process. In its untreated state, the sandwich film with a central PVD layer is almost transparent, and is given its reflective appearance by printing the rear side black. Wherever the black color is left away, the film remains translucent. The result is an astounding effect when a light source (e.g. LED) is switched on and off – symbols suddenly appear and vanish from the glossy surface. Analogous to the "black panel" (disappearing effect on a black surface), one could call it the "chrome panel".

Not quite as reflective as the PVD-coated film, but still very close to the appearance of metal is the approach in which a PC film is printed with chrome color, and subsequently back-molded – as used for the decor rings of the shower fittings, which KH delivers to Hansgrohe. A useful side effect of the IML technology: The chrome-colored layer is always protected by the film. This protection can even be increased by applying an additional scratch-resistant UV-curing coating. Either a film with corresponding décor is used, or it is printed on the side of the film that will later form the component's surface.

Apart from the IML process, also the In-Mold Decoration (IMD) process creates appealing results: On a film that passes through the mold, elementary – i.e. non-critical – chromium is applied as a color package together with a clear lacquer as protection. Both ingredients are transferred to the component during injection molding. In this way, glossy and matt chrome as well as brushed metal looks can be created just as easily as different color versions.

The well-known hot stamping process, i.e. the transfer of chrome lacquer onto the component with a hot die, is most suitable if only small areas are to be given a metal appearance.

Fig. 3. The mirror effect only occurs if the applied chrome lacquer is max. 1 to 3 µm thick (© Kunststoff Helmbrechts)

Chrome Lacquers with Mirror Effect – and even with "Cool Touch"

If transparency is not required, and a full-surface chrome look is to be created, it is worthwhile considering classical spray painting. Compared with long-established metal-effect lacquers, the new chrome lacquers exhibit a greatly improved mirror effect. It is based on pigments of pulverized PVD layers that »

Fig. 4. Vanishing effects are possible by leaving out the black primer for the chrome lacquer (© Kunststoff Helmbrechts)

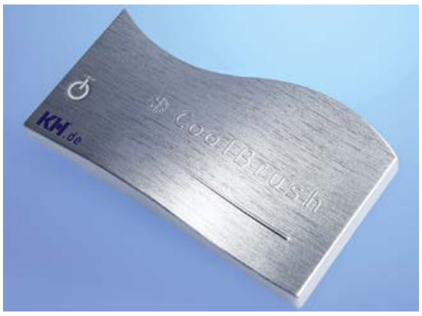

Fig. 5. The recipe for cool haptics with "CoolBrush": A laser-structured mold and thermally conducting plastic plus chrome lacquer (© Kunststoff Helmbrechts)

are embedded in the lacquer matrix. Processing these low-viscosity lacquers is highly demanding: The chromium lacquer is applied on an e.g. black primer coat some 15 µm thick, which conceals flow lines and weld seams, and must be extremely smooth. The thinner the lacquer layer is, the better, as the pigments can only align themselves without overlap in a layer thickness of 1 to 3 µm, thereby creating the mirror effect (**Fig. 3**).

The finishing coat is a matt or glossy clear lacquer layer about 20 µm thick. Only specialists are able to detect the difference to real chrome plating, and even vanishing effects can be obtained by leaving the black primer away as required (**Fig. 4**).

If PVD lacquers are combined with thermally conducting plastic and a laser-structured mold, the result is "CoolBrush", a process for which KH has filed a patent (**Fig. 5**). It creates components exhibiting the cool haptic of brushed metal in addition to the chrome look. A decisive advantage compared with galvanizing: The structure is less blurred, i.e. it remains more clearly visible. Moreover, the process is simpler and REACH-compliant.

Economically, it would be even more attractive to use chrome-look granulates for injection molding. But here, the appearance of the imitated metal surface is not entirely convincing. The material tends to form joint seams, and light reflection is not as good as with the previously described process. However, the method is a possible alternative for less demanding applications.

Conclusions

Today, there are numerous technical possibilities to create surfaces on plastic articles whose look comes close to that of real metals. Which process is most suitable for the respective application, depends on the component's geometry, the demands in terms of scratch and chemical resistance, and the required appearance (**Table 1**). A cost comparison of the technologies also reveals great differences. In order to find an optimum solution, we recommend cooperating with partners who can master the entire range of processes, and provide comprehensive consultation. ■

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Process feature	Galvanizing	GalvanoLum	FolioPlate	Injection molding	IMD	Hot stamping	IML	PVD	Lacquering	CoolBrush
Future REACH compliance	?	?	?	+	+	+	+	+	+	+
Metal haptic („cool touch")	++	++	++	0	0	0	0	0	0	+
Metal look	++	++	++	-	+	+	0	++	+	+
Quality gloss look	++	++	++	-	++	++	+	++	0	+
Quality matt look	++	++	++	0	++	++	+	+	++	++
Possible color options with metal look	-	-	-	0	++	++	+	++	++	++
Partial coating without masking	-	+	+	-	+	+	+	-	-	-
Possible laser etching of symbols	-	-	-	-	+	+	-	+	+	+
Transparent Symbols	-	+	0	-	+	-	+	+	+	-
Transparent surfaces	-	-	-	-	+	+	+	+	-	-
Possible complexity of component geometry	+	+	0	+	-	-	0	+	+	0
Surface hardness (scratch&abrasion resistance)	++	++	++	0	+	0	+	+	+	+
Integration of capacitive functions	-	-	-	+	+	+	++	+	+	+

Table 1. The correct chromium substitute process for every component: The matrix provides an overview (source: Kunststoff Helmbrechts)