Optically and Haptically Effective Chrome Surfaces

Laser Treatment for Defined Brushed Chrome Structures

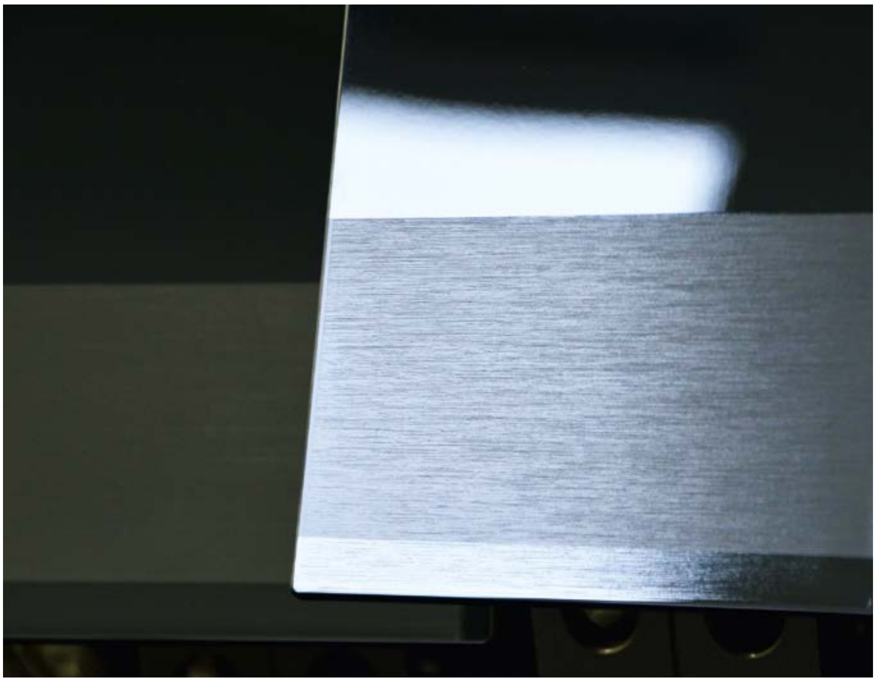
Combining attractive optics with the effect of metal haptics gives plastics surfaces an upgrade. However, finely brushed structures often disappear when the parts are subsequently electroplated or damage their surface. This can be avoided by mold and laser structuring of the blank and its chromium layer.

The automobile industry has in recent years invested more and more in high-value surfaces and an exclusive ambience in automobile interiors. Besides wood applications and lacquered parts, these design elements include electroplated plastics which in particular look and feel good to the touch. The combination of real metal surfaces, free forming by injection molding, and low-weight plastic has great application potential. In addition to the familiar matt and bright surfaces, brushed surfaces are increasingly in demand. A new process patented recently by BIA Kunststoff- und Galvanotechnik GmbH & Co. KG of Solingen, Germany, now combines brushed optics with the advantages of electroplated plastic. Such novel optical and haptic interplay creates interesting design elements by combining the structured surface of the component with subsequent optical treatment of the electroplated surface.

Electroplated Plastics as Décor Elements

When décor parts are produced, electroplated plastics combine optical, haptic, and economic factors. The design freedom in the production of injection molded parts realizes complex geometries and enables the production of highly detailed free-form surfaces. To increase the attractiveness and value of the automobile's equipment, a layered metal structure is deposited on the surface by electroplating [1]. This not only creates the optical effect of a metal surface, its layer thickness also creates the haptic impression of a metal part. Besides applications in the car exterior that are generally performed in bright chrome, matt surfaces in particular have been in focus in recent years for a wide range of applications in the car interior (**Fig. 1**). These décor details range, for example, from chrome frames on displays to switches, grips, and other operating parts [2, 3].

Where matt surfaces are involved, the car manufacturers distinguish themselves by different degrees of gloss and brilliance. During electroplating, "flaws" can be created in the layer structure by special additives that matt the surface due to light refraction. Depending on the arrangement and quantity of these flaws, large differences can be created in the surface appearance. In the past, BIA Kunststoff- und Galvanotechnik has already helped shape the definition and develop specific surfaces according to OEM specifications. They include such surfaces as 3Q7 (VW Group), SilverShadow (Daimler AG), and even pearl gloss chrome (BMW Group). »



A chromium plated surface with and without brushed, fine haptic structuring, built with the new décor process of BIA (© BIA)

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Fig. 1. Various chrome surfaces in comparison: classic gloss chrome (left), modern matt chrome surface (top right) and "Texture Chrome", a special BIA development (bottom right) (© BIA)

Surface Structures of Refined Components

Negatively structured cavities are state-of-the-art for creating décor surfaces directly in the mold. Depending on the detailing and complexity of the structures required, interesting design elements can be created via mold configuration and tempering [4]. If these parts are further refined by subsequent lacquering or other layering methods, this also affects the structures molded into the blank part. Lacquering and deposited layers level out structures and alter the optical effect. The haptics remain in tact, of course, but the detailed mold structure no longer has a decorative function.

This also applies to parts with molded structures when they are electroplated. To retain the brushed structure in spite of the fact, these surfaces are sometimes brushed mechanically. This approach is very elaborate and must be regarded critically with respect to part quality for adhesion and corrosion tests, because mechanical brushing removes part of the chromium layer. Particularly in exposed areas this can lead to total abrasion of the chromium layer, faster corrosion, and nickel release.

Another method for producing brushed structures involves reworking the nickel layer. This approach is also rather complex, since it interrupts the layering process. Further, intricate activation of the nickel layers has to be secured prior to final chrome plating. Moreover, the nickel dust generated by the brushing process is problematical in the production surroundings. That is why this processes have not yet been successful in industrial production.

As an alternative, film parts are currently used. They are built up from a back-injected film that imitates an aluminum brushed surface. However, this effect is purely optical and lacks any haptic structure or a true metal surface. On the other hand, a film can illustrate very flexible décors.

A New Process for Brushed Structures

BIA Kunststoff- & Galvanotechnik has developed and patented a process that simplifies the production of defined brushed structures on electroplated plastic parts. On the one hand, this process creates the optical impression of a brushed surface which, on the other hand, is supported by haptic structures, thereby giving an overall impression of high value (**Fig. 2**).

To create this effect, a brushed structure created in the mold is combined with subsequent treatment to the electroplated surface. In the mold, the area of the part that is intended to represent the brushed structure as décor is structured correspondingly. Appropriate temperature and process control transfer this structure to the blank in the injection molding process. For this process, all common ABS polymers or electroplatable ABS blends can be used.

Following injection molding, the parts undergo an electro plating process to produce a layer structure defined by automotive standards and consisting of copper, nickel, and chrome. For interior applications, this results in a layer thickness of approx. 40 µm for the entire system. The leveling effect of the copper deposit in particular affects the shaped structures. Due to minimal differences in

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Fig. 2. The new process gives the chrome layer both the look and the feel of a brushed surface. It creates a high-quality overall impression and enables a selective distinction to unstructured areas (at the top of the picture) (© BIA)

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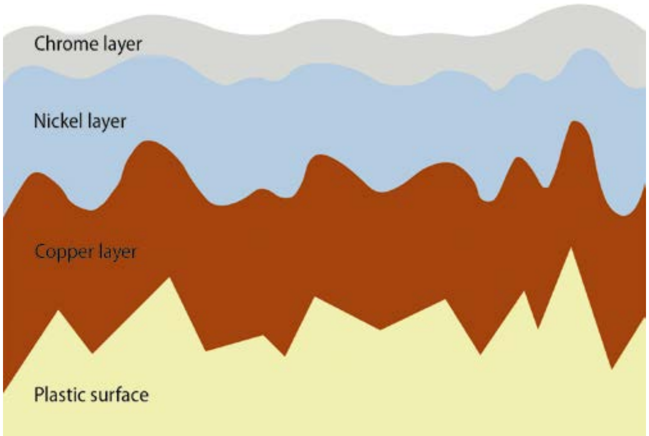

Fig. 3. Schematic layer composition of an in-mold structured plastic component. Up to 60 % of the fine graining originally applied in the mold is leveled off by the layers. The main segment consists of the approx. 25 µm thick copper layer and the subsequent nickel layer (© BIA)

the deposit of metal layers on specific part areas, as well as in the arrangement of the parts on the goods carrier, the structure optic thus created is not suitable for direct sale. The structures become irregular and lose the clear separation sharpness of a brushed structure. On a 2000 mm^2 surface, a 30 to 60 % leveling of the structures must be taken into account. **Figure 3** schematically shows the composition of a structure shaped in a mold as well as the leveling of the electroplated layer system.

To increase the optical effect, a rise in the roughness of the tool structure was considered. However, such an increase has its limits because it reduces the layer adhesion and heightens the capillary action during coating and can thus cause defects. Uneven leveling cannot be compensated for here either. Of course, the proposed system would retain the haptic of a brushed metal surface.

Laser Structuring Enables Optical Effect

The decisive step for the success of the BIA laser brushing process follows the electroplating. Laser treatment creates a uniform brushed optic that superimposes the unevenness of the electroplating. The surface structure maintains the haptic impression, while the optical effect arises from the laser structuring treatment. Since the brain cannot match these impressions precisely, anyone looking at the surface perceives a brushed surface. The laser treatment is set in such a way that it has no removal effect on the layer structure, thus precluding any negative influence on adhesion and corrosion resistance. A cut through the layer structure illustrates this effect (**Fig. 4**).

Laser treatment alters the microstructure of the chromium layer. This affects the color of the layer, thereby resulting in color change. Microstructure change occurs in metals due to corresponding energy input and the short-term temperature increase. By special focusing of the laser, the process succeeds in generating the optical effect of an oriented structure and a color change by short-term energy input in the laser focus. This phenomenon takes place exclusively in the border layer of the layer structure and affects neither the composite layer nor the plastic base body.

Achievements and Requirements

Until now, the BIA laser brushing process has been evaluated on prototype parts. Common requirements of the automobile industry with regard to adhesion, media resistance, and corrosion protection have been tested successfully. The system has been proven resistant in corrosion tests, such as the CASS test, as well as in climate change tests, such as PV1200 – 8 cycles [5].

There are two limitations regarding the part geometries possible. To begin with, the mold cavity must be capable of structuring. This applies for mechanical or chemical reworking, but also as an optical criterion, that is, whether the structures satisfy requirements regarding wall thickness changes and the like. The second limiting factor is laser focusing. Until now, tests have been performed in areas on flat surfaces with only very small height differences and on parts measuring up to 120 mm by 120 mm. This limitation is of course dictated by the technology of the laser system used, and the tests could be performed on equipment with a larger laser field.

Process Potential

Due to the start-up laser, the working range of the laser is currently limited to a small focus range. When the focus range changes color, discrepancies could result due to conditions altered by heat input. That is why bars in the instrument panel area or interior door panels would be appropriate first applications. Three-dimensional key geometries can also be performed. Within the surface, this process can clearly separate high gloss fields from structured zones. This offers new design approaches to accentuate areas optically and to increase component value by means of haptic impression.

It is intended to expand the working range of the laser further in order to enable the production of free form surfaces with larger height differences, but without visibly impairing structural details. ■

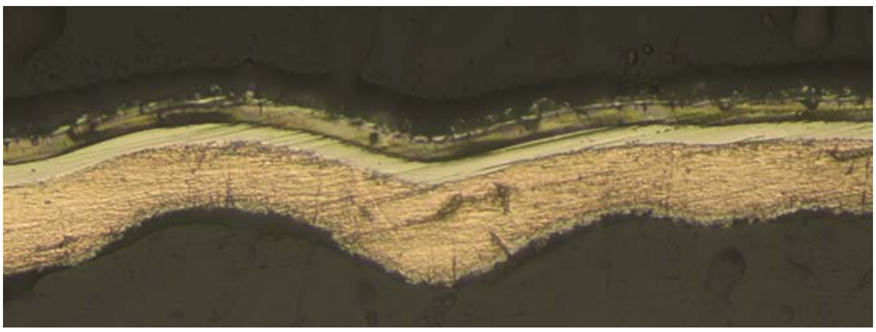

Fig. 4. Microscopic image (magnified 10,000 times) of a cut through the layer composition of a brushed surface subsequent to electroplating. All layers are uniformly intact and not damaged by subsequent laser treatment (© BIA)

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