



Marabu

## The in-mold decoration process with *Ultra Mold UVPC* – UV-curable screen printing inks

In-mold decoration (IMD) has a number of advantages: it is suitable for a broad variety of decorations, including visual and tactile effects, and creates tough surfaces. The technology is ideal for durable manufactured parts used in a wide range of applications and sectors. For example, IMD is increasingly popular in the automotive, aerospace and sports industries, and for medical devices and consumer products.

The combination of film, ink and injection molding material enables diverse geometric shapes. And the benefits of IMD-produced parts go beyond the surface. In addition to decoration, they are leveraged for increasingly diverse functions, such as enhancing strength, minimising weight, and allowing indirect lighting.

IMD comprises multiple steps, from the initial screen printing to the final back-injection molding. These steps can vary greatly in duration and expense. In particular, printing with solvent-based inks entails tempering the printed PC material – a time- and energy-consuming process that drives up costs.

Marabu's *Ultra Mold UVPC* product line combines the benefits of IMD with those of UV-curable inks. Polycarbonate films that are freshly screen-printed and UV-cured are immediately ready for downstream processes. As a result, *Ultra Mold UVPC* increases productivity and cost-efficiency – benefits that were not previously possible with processes as complex, and involving as many technologies, as IMD.

In addition, it is important to note that the ideal bond strength between film, ink and plastic depends on multiple process parameters. Consequently, IMD parts should be tested according to their specific application.

# The IMD process with UV-curable screen printing inks



| Materials and equipment     | Manufacturer | Type                                  |
|-----------------------------|--------------|---------------------------------------|
| Film:                       | Covestro     | Makrofol DE-1-4; 250µm                |
| Printer:                    | Thieme       | Thieme 3010; ¾-automatic              |
| Screen printing mesh:       | Sefar        | PET 1500; 150-34 with 18 N/cm tension |
| UV dryer:                   | Natgraph     | 22x120 W/cm at 13 m/min               |
| Squeegee:                   | Serilor      | Triplex 75 shore / 75° angle          |
| Ink:                        | Marabu       | Ultra <i>Mold</i> UVPC inks           |
| Injection molding material: | Covestro     | Makrolon 2405                         |

## Screen printing

For the best results from Ultra *Mold* UVPC products, the printed ink film must be fully cured. This ensures that the film retains all its key properties, such as the flexibility required for the forming process, and the strength to prevent wash-out during back-injection molding. The ideal UV dryer delivers at least 2x120 watts/cm<sup>2</sup>. In addition, the correct screen printing mesh, final colour coating, and printing sequence all play an important role during printing and downstream processes. Unlike solvent-based inks, Marabu's Ultra *Mold* UVPC inks do not contain volatile compounds, which evaporate and reduce the thickness of the printed ink film's layers as it dries. In fact, up to 100% of the ink layer remains intact following UV curing, and is therefore far thicker than with solvent-based products. In light of these attributes, finer screen printing meshes with a mesh count of 140-31 are recommended.

### Benefits of Ultra Mold UVPC inks at a glance:

- very good adhesion to polycarbonate films
- high opacity and colour strength
- proven print quality, with all the advantages of UV-curable technology
- no time-intensive tempering of printed films required
- flexible, heat-resistant ink film with excellent molding properties
- no wash-out effect (displacement of ink film) during back-injection molding
- strong bond formed between film and PC injection molding material
- successfully passes cyclic corrosion testing
- multiple ink layers (up to nine) tested

Because of the specific properties of UV-curable inks, Ultra Mold UVPC delivers different results across various adhesion tests with PC films, inks and PC injection molding materials. Some results vary widely from those of the solvent-based products previously used for IMD.

### Punching, forming and back-injection molding

SAMK 400-42 high-pressure equipment from Niebling Formtechnologie is used to form the printed film. The PC film is placed on a carrier, and the process begins. At the heating station, two infrared heat zones, each with 42 individual elements, raise the temperature of the film to the 145°C required for forming. This is within the range of polycarbonate's glass transition temperature (T<sub>g</sub>), where the material is suitably malleable but not yet liquefied. The glass transition temperature is key to preventing deformation during pressure forming – whereas the material's melting point is paramount in two other methods, thermal and vacuum forming.

Once the material is heated, it is transferred to the forming station, and molded at a pressure of 100 bar.

|                               |   |                            |                   |
|-------------------------------|---|----------------------------|-------------------|
| <b>Equipment type:</b>        | SAMK 400-42;<br>max. forming surface 400-245 mm;<br>max. forming height 58 mm | <b>Cycle time:</b>         | 24s               |
| <b>Heating temperature:</b>   | 300°C, upper and lower zones  | <b>Injection pressure:</b> | 1400 bar, 80 cm/s |
| <b>Heating time:</b>          | 10s   | <b>Injection time:</b>     | 1.2 s             |
| <b>Equipment temperature:</b> | 90°C  | <b>Stress:</b>             | 500 bar           |
| <b>Forming pressure:</b>      | 100 bar   | <b>Melting point:</b>      | 270°C             |

The molded and punched film is placed in the mold cavity non-printed side up. The mold is then closed and the exposed ink film back-injection molded.



### Niebling Formtechnologie

Curt Niebling developed his high-pressure forming process in 1989, creating the basis for a new, wide-ranging field of plastics decoration. Working hand-in-hand with the previous "Bayer MaterialScience AG" (now operating under "Covestro AG"), Niebling Formtechnologie has developed and honed key aspects of the corresponding system and material technologies. Over time, this expertise has yielded a refined process technology and vast range of materials.

Udo Weustenhagen  
sales@niebling-form.com  
Tel.: +49 8856 9239-113  
www.niebling-form.com



### Covestro Deutschland AG

The film material itself has an important impact on back-injection molding. And that is where Covestro comes in: its broad portfolio of Makrofol® and Bayfol® brand polycarbonate films feature a wide array of properties. The film serves as a substrate for ink during screen printing – the first step of the IMD process. Surface texturing, additives and coatings provide the films with additional, desirable attributes, such as high scratch resistance, excellent UV and chemical resistance, and special light diffusion properties.

Specialty Films EMEA/LATAM  
41538 Dormagen  
films@covestro.com  
www.films.covestro.com



**Marabu**  
Inks and Coatings  
Screen · Digital · Pad

### Marabu GmbH & Co. KG

The look-and-feel of a molded film is influenced by the properties and colouration of the substrate. Drawing on its extensive experience as a manufacturer of solvent-based and UV-curable screen printing inks, Marabu identifies and acts upon new market trends as they emerge. It continuously improves and evolves the properties of its inks, in line with customer and technical requirements.

Contact us to discuss your new IMD projects – we offer you proven expertise, and our tried-and-trusted *Ultra Mold* UVPC (UV-curable) and *Mara Mold* MPC (solvent-based) inks for the IMD process.

Gerhard Löffler  
automotive@marabu.com  
Tel.: +49 7141 691 - 344  
www.marabu.com