



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

**New:**

## **The IMD process using UV-curable screen printing ink**

**A cooperation with Niebling Formtechnologie, Bayer MaterialScience, and Marabu**

- 1. Summary**
- 2. Cooperation partners**
- 3. The IMD process with UV-curable screen printing inks using the example of an IMD produced business card box**

### **1. Summary**

For the first time, a UV-curable ink for the IMD process is available, offering a true alternative to today's solvent inks. Based on the immediate post processing features without tempering, a huge productivity gain is achieved.

It is important to mention that the adhesion-force of the complex built-up of foil/ink/injection material depends on many processing parameters. Therefore, it is essential to carry out suitable tests for the respective field of application.

This documentation „The IMD Process with UV-curable Screen Printing Inks“ is meant to give you all the necessary information for a successful use of Ultramold UVPC. This project is a close cooperation between Niebling GmbH, Bayer MaterialScience and Marabu.

### **2. Cooperation partners**

#### **2.1 Niebling Formtechnologie**

**Kunststoffverarbeitung – Werkzeugbau e.K. & HDVF Kunststoffmaschinen GmbH**  
**– specialized to produce Forming-Machines for plastic films –**

By inventing High Pressure Forming in 1989, Curt Niebling set the course into a new, extensive area for decorating plastic parts with films. In a close cooperation with Bayer, fundamental aspects in system- and material technology have been developed in a first approach. Step by step those basics have been complemented and extended through an ingenious process technology and a vast variety of materials.

Both the solution of critical problems in the area of printing technology, ink system development and coating technology created additional possibilities, such that High Pressure Forming offers nowadays multiple options for the decoration and functional integration of plastic parts.

Niebling GmbH builds machines and systems to manufacture 3D formed foil parts both in semi- and fully automated manner. The in-house tool shop assembles the necessary forming and trimming tools on customer request and technical requirements. An internal prototype lab enables testing and adjustment of the entire process chain prior to its delivery.

Niebling systems use high pressure up to 300bar, allowing the forming of almost all substrate materials in thicknesses of up to 12mm. Essential characteristic of all Niebling systems is the non-contact heating system, providing the option to generate part specific temperature profiles. The interaction of such temperature profiles with the continuous pressure control and the precise tooling technology can attain very low positioning tolerances (<0,3mm) in the production of imprinted motifs in combination with short cycle times (15 sec).

## **2.2 Bayer MaterialScience**

The first prerequisite for producing a molded part by means of film insert molding is, of course, the film material itself. Bayer MaterialScience offers a comprehensive portfolio of polycarbonate films with a wide range of properties under the Makrofol® and Bayfol® names. These films can do far more than the properties of the plastic of which they are made would suggest. Structured surfaces, additives or coatings imbue the films with additional useful functions and capabilities, such as high scratch resistance, excellent UV and chemical resistance or specific light diffusion properties. The film also serves as the substrate for the printing ink during printing, the first step in the IMD process.

## **2.3 Marabu GmbH & Co. KG Printing Inks**

The visual impression of a moulded part is mostly dependant upon the colour scheme, apart from the material characteristics. Nowadays, physically drying solvent-based inks are being used for the decoration of these parts. A water-based finish coat may be advisable in order to improve the adhesion to the injection moulded material.

Intensive research and development now allows us to proudly present our very first UV-curable ink system for the production of moulded parts: Ultramold UVPC, the true alternative to the commonly used solvent-based inks. Ultramold UVPC combines all the properties necessary for the IMD process with the benefits arising from UV-curing.

This UV-curable ink system is absolutely free of solvents and allows post-processing steps like forming, punching and back injection moulding immediately after UV-curing.

Post-tempering the printed films for 80° C up to 5h in a drying furnace is no longer required.

Also during the printing process, UV-curable inks allow a significant increase in productivity thanks to the fact that they do not dry in the mesh. This saves you from cleaning the screens repeatedly, and therefore clearly reduces the number of machine stops. We particularly recommend the use of ScreenX! Hybrid screening technology: it truly sets standards in terms of fineness, details, and tonal range, for high-resolution and quality prints. For further details about ScreenX! please visit [www.rastersiebdruck.de](http://www.rastersiebdruck.de).

### **Conditions for the successful use of Ultramold UVPC**

The great properties of this ink like flexibility for the forming process, and stability against "wash-out"-effects, can only unfold if the ink film is completely cured. A UV-curing unit with at least 2x120 Watt/cm is necessary, and the choice of mesh also crucial. Ultramold UVPC contains no volatile substances, so the ink film thickness is higher compared to solvent-based inks. For this reason, a fine mesh count of 150-31 or even 180-27 for very fine details is recommended.

### **Ultramold UVPC – all benefits at a glance**

- good adhesion on polycarbonate films
- very good printability featuring all the benefits arising from UV-curing
- no time-consuming post-tempering of the printed films
- highly flexible ink film with excellent formability
- no „wash-out“-effect after back injection moulding (displacement of the ink film)
- good adhesion to the injection moulded material without finish coat
- common climate-chamber change tests were passed successfully
- multi-layer structures were tested with up to 9 layers of ink

### **Differences compared to IMD solvent inks**

Based on chemical and physical characteristics, UV inks may appear different when testing adhesion between foil and ink film, and the ink film's adhesion to the injection material. Instead of having a split within the ink film as known from solvent inks, it is often that thanks to a better inner cohesion, UV inks stick partly to the foil, and partly to the injection material. This effect is also known as a "tiger skin effect".

With the IMD process, a wide range of part geometries for different applications with corresponding characteristics can be fulfilled. Just like solvent inks can be adapted to specific projects, our comprehensive experience has enabled us to create a UV platform which can be adapted to customer requirements with Ultramold UVPC.

### 3. The IMD process with UV-curable screen printing inks using the example of an IMD produced business card box



#### 3.1 Foil

Bayer Makrofol DE-1-4; 250µm

#### 3.2 Printing Parameters

Mesh	see below, "ink layers"
Mesh tension	18 N
Squeegee angle	75°
Printer	¾-Automat Thieme 3010
UV-Dryer	2x 120 W/cm; 15 m/Min.

#### Ink layers Second Surface

1. Print	ScreenX!	Varnish + Silver	Mesh: 180-27/12°
2. Print	ScreenX!	transparent; grey	Mesh: 180-27/12°
3. Print	ScreenX!	Grey; opaque	Mesh: 150-27/22°
4. Print	Full area	Opaque White	Mesh: 150-31/0°
5. Print	Full area	Opaque White	Mesh: 150-31/0°
6. Print	Full area/Blocking layer	Block-out silver	Mesh: 150-31/0°
7. Print	Text positive	Opaque Black	Mesh: 180-27/12°

#### Print First Surface – "Effect printing on carbon":

8. UVIMD-Varnish (matt)	Mesh: 180-27/12°
-------------------------	------------------

### 3.3 Forming

**System:** SAMK 400-42, max. forming area 400-245mm, max. forming height 58mm

**Temperature Heating:** top 300°C, bottom 300°C

**Heating time:** 10s

**Tool temperature:** 90°C

**Forming pressure:** 100 bar

**Cycle time:** 24s

The printed films are formed on an SAMK 400-42, with 42 individually controllable heating elements from upper- and lower side.

In the first step, the films are attached to a transport palette, carrying them through the single process step (fig. 1).

In the heating zone, the substrates are tempered to a level of 145°C (fig. 3). This temperature equates to the glass transition temperature of Polycarbonate, which enables a smooth forming of the substrate and is a substantial criteria to achieve a low distortion and low positioning tolerances.

After tempering, the films are being moved into the forming station, where they are formed into the 3D shape under a pressure of 100bar. The formed films can be detached from the palette in the unloading position (fig. 4).

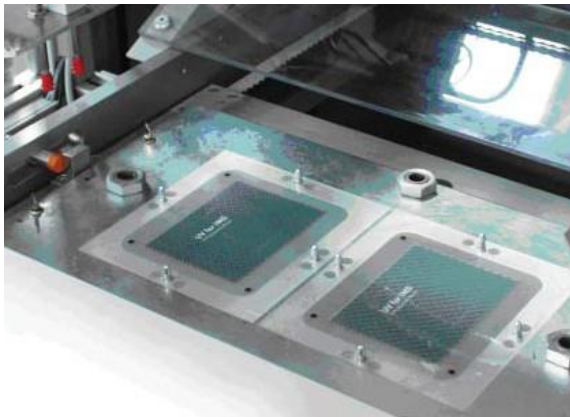


Fig. 1

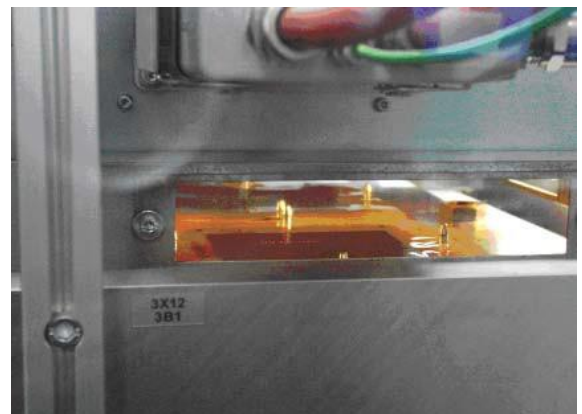


Fig. 2

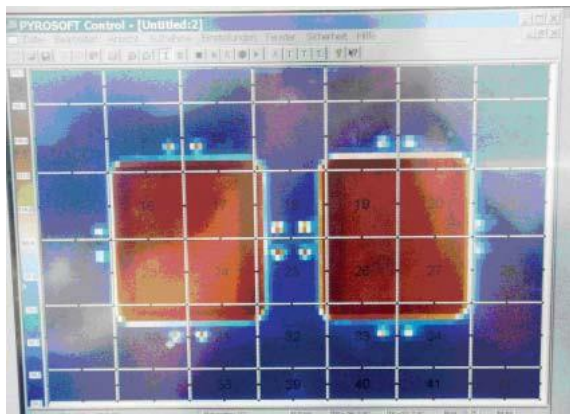


Fig. 3

Temperature scan of the heated substrate via integrated IR camera. The pictured squares mark the position of the 42 heating elements

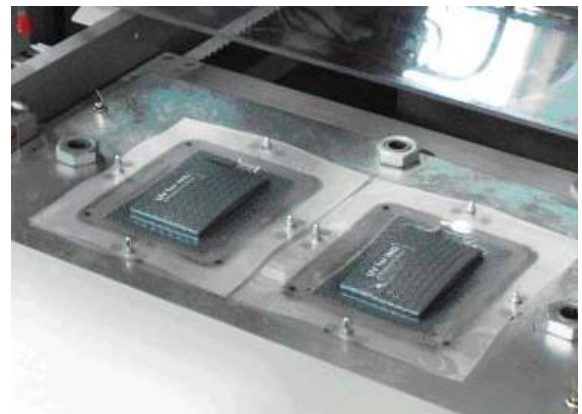


Fig. 4



### 3.4 Trimming

Prior to overmolding, the films need to be trimmed fitting the final part geometry. A first vertical step trims the surrounding film, followed by a 2-stage horizontal punching to shape the final 3D contour (fig. 7).

After forming, the films are trimmed, usually by means of punching. The inserts thus produced are then positioned in the injection mold and back-injected with a thermoplastic. Makrolon® and Bayblend® injection molding polycarbonates from Bayer MaterialScience are ideal products for this application.<sup>1</sup>



Fig. 5 Top side



Fig. 6 Back side



Fig. 7



Fig. 8 Trimmed 3D film Top side



Fig. 9 Back side

<sup>1</sup> Further reading: *Oberflächentechnik in der Kunststoffverarbeitung*, Markus Lake, Hanser Verlag, Chapter 9.3 Klassisches Folienhinterspritzen

### 3.5 Overmolding

**Molding pressure:** 1400 bar, 80 cm/s

**Molding time:** 1,2s **Dwell**

**pressure:** 500 bar **Melt**

**temperature:** 270° C

The trimmed film is inserted in the mold cavity and overmolded.



Fig. 10 Mold tool



Fig. 11 Cavity with inserted foil

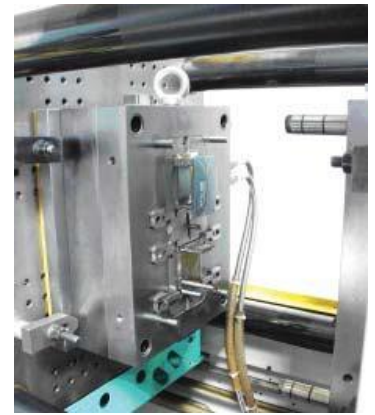


Fig. 12 Decorated part

### 4. Contact Partners



#### Niebling

Mr. Harald Bader

[h.bader@niebling-form.com](mailto:h.bader@niebling-form.com)

Phone: +49-8856-9239113



#### Bayer MaterialScience

[makrofol@bayer.com](mailto:makrofol@bayer.com)

Phone: +49-214-30-1



#### Marabu

Inks and Coatings  
Screen · Digital · Pad

#### Marabu

Mr. Mario Mertens

[mario.mertens@marabu.com](mailto:mario.mertens@marabu.com)

Phone: +49-7141-691234