High Quality Interior Components at Low Unit Cost

DecoJect Process Combines In-Mold Graining with Injection Molding

Decorative films are increasingly replacing painting in order to flexibly combine a high quality surface finish of the vehicle interior with small batch sizes and low unit costs. With DecoJect, systems integrator Engel presented the next development step in collaboration with partner companies at K 2016: the combination of injection molding with in-mold graining in a highly-automated roll-to-roll process. The film solution makes it easier to harmonize the vehicle interior when using different base materials.

The DecoJect materials were specifically developed for vehicle interior applications. Whether leather grain, seams or a carbon look: they transfer a wide variety of desired structures, colors and haptical features to the component surface (© Engel)

The DecoJect surface finish materials, developed by Benecke-Kaliko AG from Hanover, Germany, ensure a visual and functional enhancement of molded parts (**Title figure**). In contrast to conventional IMD (in-mold decoration) processes, the layer of paint is not simply transferred from the film onto the component in in-mold graining (IMG). Instead, the film is sucked into the cavity, punched out and remains fully on the component. This approach adds surface structures and haptical features to the color and pattern. At the same time, the scratch resistance of the components is substantially improved.

It was at K 2016 that Engel Austria GmbH, Schwertberg, Austria, presented a fully-automated DecoJect for the first time, in collaboration with several system partners. An Engel duo 5160/1000 injection molding machine was deployed in the production of door panels with a large surface area for the use in passenger vehicles (**Fig. 1**). In order to demonstrate the broad spectrum of capabilities of the new process, the parts exhibited different surface finishes, including a sophisticated leather grain with a seam and a modern carbon look. A ready-to-fit polypropylene (PP) decorative part left the production cell every 60 s.

The film, which has a thickness of just 0.2 to 0.5 mm, is based on TPO. A thin PU layer makes it particularly resilient to scratching and wear, and thus predestines it for use in the door and panel area. It is offered in many colors and with effect paint to support flexible matching with other components in the vehicle. The DecoJect film thus provides a cost-efficient method of harmonizing vehicle interior components consisting of different base materials. Because the desired surface properties, such as color, structure and haptical features are defined by the film, the process makes it possible to precisely adjust the carrier material to the mechanical values required by the individual application.

The production cycle in the DecoJect process starts with feeding the smooth, unstructured film through the open mold (**Fig. 2**). To allow this to happen, a film winding device (manufacturer: ICO System international coating GmbH, Lüneburg, Germany) is mounted on the »

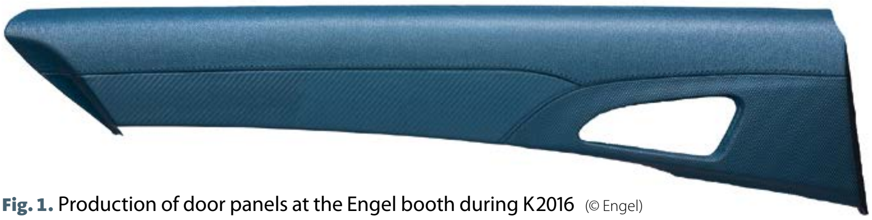

Fig. 1. Production of door panels at the Engel booth during K2016 (© Engel)

moving mold mounting platen. The servomotors on the rollers ensure a constant film tension and make it possible to precisely control the take-off speed.

Highly Integrated and Fully Automated Process

The film is held in place in a clamping frame for the thermoforming process and heated by infrared heaters (**Fig. 3**). The heating fields are located in the grippers of a linear robot (type: Engel viper 60). The compression process starts during heating up with the film being drawn into the IMG mold by an air intake mechanism (**Fig. 4**). To avoid exposing the very thin film to excessive thermal load, the heater fields can be individually controlled. At the same time, the film's surface temperature is monitored by pyrometers. Heating up directly in the mold, and immediate deep drawing minimizes the thermal loss and ensures an optimal grain transfer. After completing the deep drawing process, the gripper retracts so that the machine can clamp the mold and punch the film while doing so.

The pre-formed surface film is now back injected with a polypropylene optimized for the automobile interior (manufacturer: Borealis AG, Vienna, Austria). The MuCell process is used for this purpose. Physical foaming significantly decreases both the use of raw material and weight, while at the same time reducing the warpage of the part. Engel integrates the T350 gas supply unit by Trexel with the injection molding machine's CC300 control unit to be able to centrally manage the entire process. The system automatically calculates the important process parameters, e.g. gas injection time, on the basis of the known shot weight, the screw position, the screw's peripheral, and a defined gas content.

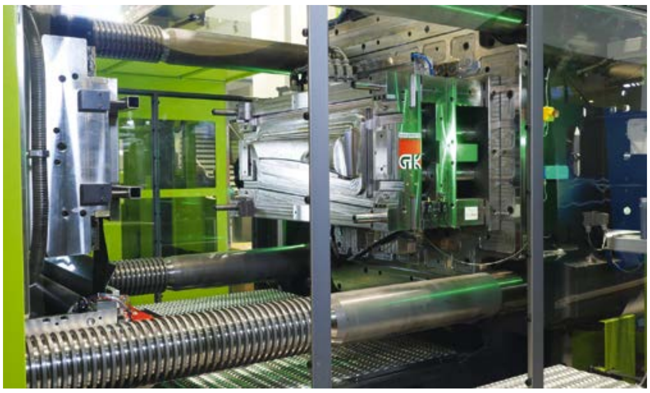

Fig. 2. Looking into the mold: in-mold graining gives the film the desired surface structure (© Engel)

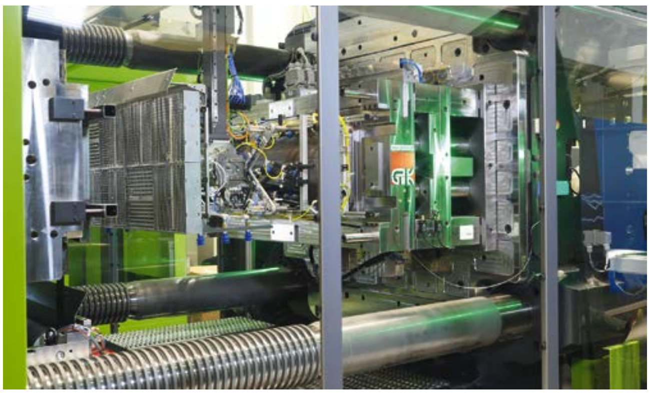

Fig. 3. The infrared heaters for heating up the film are integrated into the linear robot's grippers (© Engel)

IMG Mold for High Pressures

The challenges faced in developing the manufacturing process included constructing an IMG mold capable of withstanding the high pressures involved in the injection molding process. The nickel shell, which has funnel shaped pores for the vacuum process during deep drawing of the film, was finally mounted on a steel frame and backed with a microporous, air-permeable resin. This helped to achieve a pressure tightness of up to 300 bar. The mold manufacturers involved in the project are Georg Kaufmann Formenbau AG, Busslingen, Switzerland, and Galvanoform Gesellschaft für Galvanoplastik mbH in Lahr, Germany.

The hot runner system for injecting the polypropylene is supplied by HRSflow, San Polo di Piave, Italy. To avoid damaging the DecoJect film at the injection point, sensitive control of the individual needles in the hot runner nozzles must be guaranteed. HRSflow ensures this through the use of a servo-electric needle control in the hot runner.

After the injection molding process, a linear robot takes off the part and transports it to the easiCell automation cell, where the handover to a multi-axis robot (type: Engel easix) occurs for fine trimming of the demonstrator (**Fig. 5**). The multi-axis robot and the laser cutting module are combined in the processing cell on a very compact footprint. Thanks to its standardized, modular design, the extension unit presented for the first time at K2016 facilitates the integration of robots and other process steps upstream and downstream of the injection molding step.

The laser cutting process completes the production cycle. The multi-axis robot deposits the ready-to-fit part on the conveyor belt and immediately proceeds to pick up the next part, which was created in the injection molding machine parallel to the laser processing step.

Cost Benefits of 14 %

Benecke-Kaliko – a Continental Group company – analyzed the costs of manufacturing DecoJect components during the development phase and compared these with producing painted molded parts. The analysis took into consideration

Fig. 4. The compression process starts during heating up by drawing the film (here: black) into the IMG mold (© Engel)

the total costs including those of the production cell and molds, and the logistics overhead for painting. If the costs of manufacturing the painted parts are equated with 100% as a reference, then the DecoJect component achieves 86%. The actual injection molding process – without finish optimization – accounts for 44%. This means that the DecoJect achieves cost benefits of 14% compared with the painted molded part.

The film solution is thus a cost-efficient alternative to the conventional method for producing premium visible components. On top of this, it offers the required flexibility in the production of small batch sizes. Only the roll of film needs to be replaced to change the color or styling. After just a few minutes, the production cell can carry on working without producing scrap in the process. The batch size thus no longer has any impact on unit costs. ■

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Fig. 5. For the DecoJect process, the easiCell automation cell (left) integrates a multi-axis robot and the laser station for trimming the demonstrator. The robot moves the component contour along the laser (right) and then places the ready-to-fit component on the conveyor belt (© Engel)