Illuminated backmoulded stainless steel doorsill plate on the new Mercedes-Benz C-class car, moulded by WPT

Day/night designs with metal-plastic backmoulding were a core part of the 2014 VDI injection moulding conference, writes **David Vink**. Ravensburger's case study at VDI is over the page

Decorating with plastics day and night

At the 2014 VDI injection moulding conference in Baden-Baden, Germany, in February, Steffen Reuter, vice president R&D and technology for automotive and industrial businesses at Swiss moulder Weidmann Plastics Technology (WPT), described challenges in design and production of metal-plastic decorated parts.

Reuter discussed steel-clad plastic car door sills on the Mercedes C-class (W205), which have an illuminated day/night design. These are produced by 4-cavity backmoulding by WPT in Rüti, Switzerland, along with non-illuminated sills.

WPT supplies the sills to Mercedes plants in Bremen (Germany), Tuscaloosa (US), Beijing (China) and East London (South Africa). WPT supplies all four of the M-B production locations, "as there is too much risk in producing the door sill plate beyond the WPT production site in Rüti", Reuter said. The new version of the car containing the latest sills went on sale in March 2014.

In evaluating materials, WPT had to reject some high performance plastics with a similar coefficient of linear thermal expansion to steel as they were too expensive for the application. A good compromise was found with a glass fibre reinforced ABS/PC blend. Coil-coated steel is hydroformed by CAWI Carl August Wirth, and the final shape is obtained in WPT's injection mould.

"The OEM wanted six LEDs, but we are happy doing it with four," Reuter said. While there are challenges with using LED lights, it has some advantages compared with electro-luminescent foil light. The plastic part of the moulded sill plate strikes a balance between better diffusion (homogeneity) with thicker plastic and corresponding lower light transmission, and therefore translucence (brightness).

Reuter said interactions between the components of thermoplastic, metal film and the adhesive system need to be considered. The adhesive needs to cope not only with thermal expansion of metal and plastic, but also with anisotropy of plastic and isotropy of metal.

He added that a common failure is underestimation of the effect of tension in plastic/metal hybrid parts, whether due to part design, injection moulding parameters, shrinkage or tool design. But part design can at least partially compensate for these "weaknesses".

Overall sill thickness is 150-200µm, compared with conventional 2mm all-metal sills. The LEDs are integrated within an injection-compression moulded light guide which is less than 0.8mm thick. Backmoulding enables letters such as B, O, P, D, etc to be produced without use of bridges by firmly fixing the "island" parts of such letters, avoiding a "cheap" appearance.

Example of the BEP electroplating process used by Gerhardi

WPT submitted and displayed an illuminated backmoulded aluminium door sill with Chinese and European lettering at the SPE Central Europe Automotive Awards Night in October 2013, which was made on a Krauss-Maffei injection moulding machine. It was due to go into serial production in 2014 in an unspecified vehicle. Amcor Flexibles Singen supplied the fingerprint resistant aluminium foil.

Other metal/plastic doorsill plates are known. For example, Adoma won a Tecpart 2010 award for a highly integrated 3-component, 4.5mm thick sill light module with 2 x 2 LEDs. This is made in three PMMA grades and appears on the BMW 7-series car (*EPN* February 2011).

Day/night design was also described by Dirk Kieslich, product and process development manager of chrome-plated moulding specialist company Gerhardi, at VDI's 2014 injection moulding

and plastics in automotive engineering conferences. Alongside four competing technologies, Kieslich listed five chrome plating day/night solutions. He focussed however on two selective chrome plating techniques on multi-component mouldings with functional integration and through-illumination, especially on back electroplating (BEP).

BEP provides B, O, P, D, etc letters without bridges, in which "islands" are produced against unplated backgrounds by selective electroplating via electrical contact at the rear of the platable plastic component. Another technique uses a thin chrome plated layer for through-illumination followed by selective full chrome plating of other areas.

A new structured chrome technique at Gerhardi produces day/night surfaces by application of a thermal transfer film, leaving areas uncovered for subsequent chrome plating, and unplated film areas allowing through-illumination. Kieslich said it is "an economically interesting, highly flexible and high performance process when the decoration is applied automatically in an injection mould".

Aside from conventional etching, Stefan Krüth, managing director of mould maker J & F Krüth, described the use of seven 5-axis laser engraving machines to engrave moulds weighing 0.3 to 14 tonnes. The equipment removes metal in 3-6µm layers, the number of levels (from 5 to 70) determining depth and the extent of 3D dimensions. Krüth said laser engraving is "somewhat more expensive" than etching, but it offers design freedom for new surfaces – and processing time is being optimised in order to cut engraving costs.

Fabian Kollmann, senior product and technical design manager at Phoenix Design, said design of the Raindance showerhead for sanitary products company Hans Grohe was an example of where "lateral thinkers changed the world".

He said Grohe broke a tradition of producing narrow, increasingly more complex and deep shower heads with a multitude of different jets, when in 2001 it introduced a large diameter, extremely flat hand shower head with 86 basic and three massage jets. This was expanded to a wider range, including rectangular Raindance shower heads.

Lateral thinking was used in the design of Hans Grohe's Raindance showerhead

The original Raindance product was designed with a shape like a tennis racket, but with a shorter handle. Weidmann Plastics Technology moulds it as a multi-component part incorporating soft grips on the core showerhead and integrated handle.

Reviewing high gloss plastics part production, Stefan Schmidt, managing director of Kunststoff Institut Lüdenscheid (KIMW), also mentioned the new Greenmold close contour mould heating process, described at a KIMW April 2013 event as the "temperature control system of the future".

Greenmold only heats the mould surface via a thin electrically heated conductive mould coating. Together with an insulating layer and a protective titanium-chrome wear-resistant coating that may be surface-structured, overall thickness of the three layers amounts to 2-3µm.

A 50 x 36 x 10mm mould surface heats up at the same fast 34 K/s rate as with induction and other electrical heating methods, raising surface temperature from 32°C to 99°C within 2 seconds. However the Greenmould process consumes only 430W at 30V, as opposed to 2,000W at 400V with induction. Greenmould is highly "dynamic", as the coating, rather than the bulk mould steel rapidly cools on its own when no longer heated. Greenmold will be the main KIMW focus on the institute's Fakuma 2014 stand.

In a separate paper, KIMW process development specialist Marius Fedler presented work with glass, including the new Glasskin project, involving injection moulding of low melting glass (300-450°C) in powder form. Fedler said there are as many glass types as there are for plastics and hydrolysis (with glass melting below 300°C), chemical media resistance and post-moulding stress need to be assessed before moulding complex glass parts "without geometric limits".

The Glasskin project started in December 2013 and presently also involves St Gallen university in Switzerland and mouldmaker Kronawetter working on coatings to prevent glass adhesion to injection moulds.

Wolfgang Müller at Kunststoff Helmbrechts Foliotec (KH Foliotec) described the company's latest versions of in-mould labelled capacitive technology control demonstrators: MyWave Variolum (2013) with complimentary colour capability, and SmartWave (2014) with a black panel effect and flexible film circuitry replacing the previous thicker moulded (MID) circuitry, for which serial application is planned for 2016.

MyWave Variolum can for example provide a symbol in one colour by touching the multilayer foil surface, then another symbol or lettering in another colour in the same position. This capability is achieved by use of colour filters in multilayer film layers, allowing red-green and red-blue colour pairs. KH says high precision printing is needed so that colour filters do not slide against each other. ■

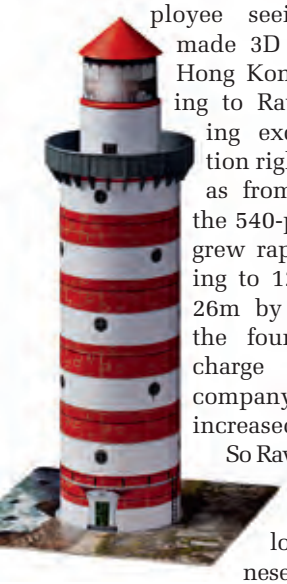
KH Foliotec's 2013 MyWave Variolum (above) in-mould labelled capacitive sensor control and new slim 2014 SmartWave solution (below)

Solving the puzzle

Available since 2004, a 22cm diameter Puzzleball, spirally assembled with 540 individual 3D digitally printed curved conical-edged plastic parts

Florian Knell, board member at children's media publisher, toy and puzzle producer Ravensburger, who is responsible for material flow and the information chain from procurement through to production and distribution, made a presentation at the 2014 VDI injection moulding conference, talking about "digital printing and plastic in fast moving consumer goods (FCMG)".

Knell focussed on Puzzleball, a 3D world globe puzzle. Its story goes back to a Ravensburger employee seeing a Chinese-made 3D globe puzzle in Hong Kong in 2002, leading to Ravensburger gaining exclusive distribution rights for the puzzle as from 2004. Sales of the 540-part globe puzzle grew rapidly, accumulating to 12m by 2006 and 26m by 2010. But after the founder's son took charge of the Chinese company, the price was increased, said Knell.



So Ravensburger thought about making the puzzle itself. It looked at the Chinese producer's patent, finding it to be "nothing more than noise and smoke", as Knell described it. The producer had not looked closely at the geometry, so "we decided to introduce our own patent to get round it", Knell recalled.

Above all, it had to be made "at least as cheaply with an automated process in Germany, as manually in China – since material prices are similar in Germany and China", Knell said. The aim: to produce in Germany at 30% lower cost than delivered prices from China, providing leeway to react to competition. One puzzle part should cost less than €0.01 for 55m parts/year.

Knell said a €4.75m investment, amortised over 10 years, was "the largest cost of our technology".

The 3D digital printing element proved to be challenging. Trials made with Leonhard Kurz's in-mould labelling films didn't get the cost below one Euro cent, even though "Kurz was phenomenally committed and €1m was invested in looking at IML", Knell recalled. A technology scout, taken on to find a solution within one year, recommended a 5-6 person company with expertise in digital printing heads.

With the Chinese contract expiring in December 2008, pressure mounted to find a solution and a decision "to stop or rush forward". Ravensburger rushed forward.

Globe puzzle sets were moulded initially in 15s, placed on a "baking tray" and printed within 7s. There were soon two moulding machines feeding the 3D printer. This early production cell cost €0.55m.

Knell said he regrets that it did not work out with Leonhard Kurz. Later partners involved hot runner system producer Günther Heißkanaltechnik and mouldmaker Hoefer & Sohn. Ravensburger then installed four fully automated production cells with Kuka articulated robots and Arburg moulding machines that started up in 2011 and were producing 500m 3D puzzle parts per year by 2012.

"It wasn't a stroll," said Knell. "We had to solve immense problems; printing around edges without overspray, getting sharpness. We scraped paint off the baking tray every 10 minutes before using brushes for this."

Knell: Fully automated production of the Puzzeball in Germany takes 35 staff, compared with 800 in China

Sunset pyramid features hinged parts

With moulding followed by 3D digital printing, UV-protective lacquering and drying, Knell said drying in a "black box" is the real innovation in the process, so "we let no-one into the factory".

It all has to run smoothly: with a 3D digital printing head costing €15,000, costs can run up to €100,000 if a part rubs against the print head. The printed image was "super", but it didn't hold at the injection point, needing the injection nozzles to be changed.

Production at Ravensburger in Germany is highly efficient, with 35 staff compared with 800 in China. But Knell told *EPN* unavoidable manual puzzle assembly and packaging costs led the company to start construction of a moulding plant in 2012 in Ravenburger's facility in Policka, Poland, to benefit from lower wage costs there. The plant is due to start up in 2014.

Ravensburger introduced a smaller 24-part Puzzleball globe for pre-school children in Autumn 2010, but "it was a flop", Knell said. As dramatic as that may sound, it is nothing new for Ravensburger: the group introduces 2,600 new products/year, accounting for 30% of turnover (€359m in 2013).

Since 2012, the company has launched similar 3D puzzles of buildings such as Brandenburg Gate, Empire State Building, Taipeh 101, Tower Bridge, Taj Mahal, Eiffel Tower, Big Ben and the leaning tower of Pisa. ■