

Mirror-Finish Painting in the Mold

Painting without Runs – Cycle Time Less than One Minute

For several years a quartet of developers has been working on a new technology for painting thermoplastic parts in the injection mold. The process of flow coating in the injection mold using reaction system technology has now started into series production for the first time. The new Peugeot SUV 3008 is the first car in the world to feature elegant deep piano black A-pillar trims with a mirror finish – manufactured in a fast one-step process that does not require either solvents or release agents.

Mirror-finish parts for the exterior and interior – injection molders frequently receive such requests from the automotive industry and other design-oriented sectors. Deep black parts with a mirror finish are all the trend, but also visible parts with high-quality depth effects due to a clear coat. In addition, demand is growing for plastic parts with high scratch and UV resistance, as well as improved resistance against sweat and certain chemicals.

Against this background, the Swiss automotive supplier Weidplas discussed some years ago about what manufacturing processes would be suitable for economically manufacturing top quality parts that meet these specifications. Steffen Reuter, Vice President Innovation & Technology at Weidplas's parent company Techniplas remembers – especially as regards the mirror finish: "At that time, it was customary to use traditional injection molding with subsequent pretreatment of the parts to remove these release agent residues, followed by wet painting. Since we had neither the necessary equipment nor practical experience

here, we attended the K show specifically to scout for alternatives. The Weidplas team found what it was looking for at a trade show booth on which an injection molding machine manufac-

tured demo parts which were still flow-coated with a polyurea reaction lacquer in a turning platen mold.

For Steffen Reuter, the young Color-Form technology from KraussMaffei, »



The Peugeot 3008 is the first SUV in the world to be launched with innovative A-pillar trim.

All four parts of the over one-meter-long trims, two of them with additional TPE sealing elements, are injection molded in a single shot. The two visible parts are flow coated with a mirror-finish reaction coating while still in the mold (© Panadur)

Steffen Reuter, Vice President for Innovation and Technology at Weidplas's parent company Techniplas played a key role in the first series deployment of the one-step ColorForm process (© Panadur)



an injection molding process with integrated 2-component flow coating with a Panadur lacquer system, pointed in the right direction. "We saved the costs of investing in a new wet-painting system as well as complicated drying processes and high reject rates because of paint runs and orange peel surfaces. Collaboration with the paint manufacturer Panadur, the injection molding process developers from KraussMaffei and the Hofmann Innovation Group, a manufacturer of technically sophisticated turning plate molds, was already clinched at the trade show.

This "alliance of progress" then led to the first series application of the process, in which, at the instigation of Steffen Reuter's crew, the process was made even more sophisticated than originally planned, especially as regards the degree of automation and the cycle time. Reuter wanted to achieve one-step production of high-gloss parts in a completely automated production cell. The specification formulated in 2014 formed the basis for the injection molding cell, which then started the series production of A-pillar trims for the new Peugeot SUV 3008 at the end of 2016.

From the start, Steffen Reuter and his team liked the fact that, because of the swivel platen technology, a relatively small injection molding machine with a clamping force of 6500 kN is adequate for the manufacture of parts that, after all, are one meter long. Furthermore, the specialists of Weidplas liked the fact that the reaction paint system from Panadur that KraussMaffei employed works without re-

lease-agents or solvents, and that it cures within seconds with no need for expensive oil or gas heating.

Iterative Modification of the 2-Component Paint

The fully automated cell, which now produces ready-to-install trim pairs for the left and right A-pillars in a cycle of about a minute, has an impressive scope in which some of the process steps are now performed in succession, but also in

parallel in some cases. First the left and right lower part and the two upper parts of the A-pillar trims of the Peugeot 3008 are injection molded in one step and, at the same time, TPE sealing elements are overmolded with the aid of a second plastification unit. Then the mold opens, is turned around by 180°, and docks on the mirror polished coating cavity to flow coat the visible parts with the two-component reaction paint in piano black.

In parallel, the next trim pairs are already being injection molded at the opposite mold side. After the mold is opened, a six-axis robot removes the parts and places them in a buffer. A short time later, the robot inserts, set by set, a device for removing the sprues and the assembly of the parts in pairs. Last but not least, it carefully places the ready-to-install trims into transport containers, with which the parts are supplied onto the assembly belt just in time.

Before the series production with an outstanding quota of acceptable parts, all the development partners had to solve numerous detail tasks. Nanoparticles in the paint made it necessary to modify the pump bodies for injection of the two paint components in order to avoid cavitation damage to the pumps, and the mold manufacturer had to find ways of



In a cycle of about a minute, the fully automated injection molding cell at Weidplas produces ready-to-install A-pillar trim parts, with upper and lower parts welded together while still in the cell. The one-step process provides ready-to-install parts without secondary finishing

(© KraussMaffei)



For manufacturing the thermoset polyurea paint, Dr. Thomas Moch had a new manufacturing line with process-integrated quality management installed at Panadur (© Panadur)



The Panadur coating – integrated into the ColorForm process – offers design freedom such as high gloss, matt, depth and light effects (© Panadur)

sealing the coating cavity since the polyurea is very free flowing. According to Dr. Thomas Moch, CEO of Panadur, “For the first series application, we had to formulate our 2-component polyurea paint with a very fluid consistency, especially since the trims are about one meter long and roughly three centimeters wide. In addition, the flow coating space is only 0.5 millimeter high.” To avoid air bubbles or visible streaks, the coating cavity must be flow coated from an apex.

Advantages over Wet Coating

The 2-component polyurea coating must thus be uniformly distributed over the entire part length in the coating cavity immediately after its two components, polyamine and polyisocyanate, are mixed. “If the viscosity of the coating were too high, the curing would have started before the coating cavity had been completely filled,” says Moch.

It demonstrates the competence of the plastics processor Weidplas that Steffen Reuter and his team did not avoid the problems. According to Reuter, “Our vision of manufacturing high-gloss parts faster and more reliably than is possible with wet coating was a strong driving force. We saw the many advantages of the new ColorForm process in combination with polyurea flow coating. They can be subdivided into three categories, design freedom, coating quality and process engineering. In terms of quality, it

shows impressive optical appearance and chemical and mechanical resistance. It also convinced us that a uniform paint thickness can be achieved even at extremely tight radiuses and edges.

Furthermore, compared to wet coating, thicker coats offer the possibility of repeatedly polishing out scratches in a smart repair process, particularly in the case of exterior parts. As regards process technology, the one-step, almost completely automated process, scores with a cycle time of less than a minute, calculated from the first shot until stacking of the ready-to-install strips in the conveying devices – without pretreatment of the parts to be coated, without painting and drying systems, without exhaust air purification, without the use of solvents, without the provision of cleanroom conditions, and without expensive secondary processing. “The decisive factor, however, was the various possibilities that the ColorForm process and polyurea coatings open up to designers,” said Steffen Reuter. Thomas Moch adds, “In principle, the process also permits different paint thicknesses, for example at vulnerable edges.

Technology for Greater Design Freedom

Reuter sees the design freedom, in particular, as a clear sign that the process will become established on the market. “The two megatrends of electromobility and

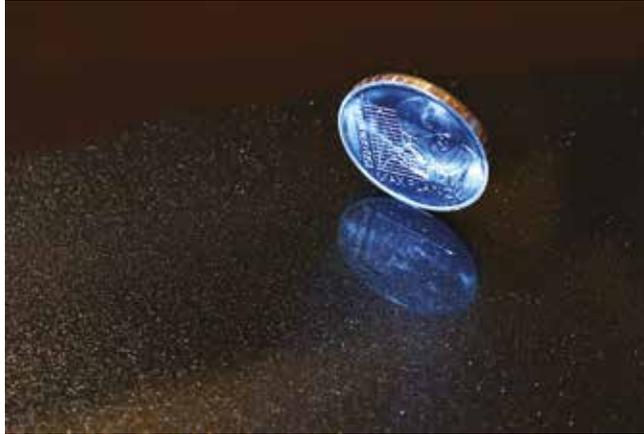
autonomous driving will change the market. The traditional core competences of the auto manufacturers are no longer sufficient on their own, they now have to give way to new values such as battery range and interior/exterior design.

It is particularly in this field that flow coating of thermoplastic parts with polyurea paint has a lot to offer. High-gloss surfaces can be created in seamless “neighborhood” to matt or textured surfaces. The surfaces offer high scratch resistance, are weathering and UV resistant, and insensitive to many chemicals, sweat and much more. Text, logos or decorative elements of any size – including micro-fine – can be integrated as matt surfaces in high-gloss surfaces. Conversely, text or logos can also be represented as glossy features on a matt ground, and stand out as raised areas. “Even light effects can be integrated in the parts if the basic elements are injection molded from transparent or translucent polymer,” adds Jochen Mitzler, Head of Strategic Product Management at KraussMaffei.

“However,” Steffen Reuter points out, “the designers have to work together closely with us if they want to employ the fascinating possibilities of this plastics processing technology proficiently.” He is also thinking of boundary conditions concerning the geometric shape of the flow coating cavity, explains Reuter. To give customers important tips during part design, Weidplas, with its Technical Competence Center (TCC) offers a »

Even mirror-finish metallic surfaces and antimicrobial surfaces can be realized with the resistant polyurea. Suitable carrier materials include PC+ABS and ASA systems

(© Panadur)



platform for preliminary tests and development projects.

PSA Recognized the Advantages of Flow Coating at an Early Stage

The two visible parts of the A-column trims emerge from the turning platen mold with a mirror-gloss piano finish – with a coat thickness that is always uniform, even at radiuses and edges, and with an almost 100% quota of good parts. Despite the short cycle time of less than a minute, the two-component coating, which is only applied to the visible sides, is already sufficiently cured after demolding that the lower parts of the trim, which are located in non-visible areas, can be welded to the eye-catchingly deep-black glossy upper parts while still in the injection molding cell. Every minute, two two-part trims with integrated sealing lips are fully assembled, welded together and inserted in the shipping boxes.

Steffen Reuter has supported the project from the beginning and skillfully

steered the heterogeneous developer team to the solution, which not only emanates technical finesse, but also has impressive economic potential. “After all, our customers expect that we will provide even better and more attractive visible parts for the interior and exterior, and we have little scope to charge premiums for outstanding attractiveness. At any rate, additional benefits are rewarded, which can be achieved through, for example, the functional integration stresses the board member in charge of innovation. An extremely scratchproof exterior mirror housing, which emerges from the injection molding cell complete with an indicator light and a ground light, could be one example of this.

Since the 2-component reaction coating is more expensive than conventional wet coatings because of the required ingredients, only the process advantages can unleash savings potential. Thomas Moch summarizes the advantages: “The bodies are coated with a constant coating thickness and emerge from the mold with a mirror finish. Almost 100% good parts, without secondary finishing, are supplied onto the assembly belt. One-step production using the turning platen mold and the high degree of automation of KraussMaffei’s robot cell enable Weidplas to offer molded parts of higher functional and optical quality at fair market prices. Steffen Reuter adds to the list of advantages: “The reaction paint is solvent free and there is no overspray when painting in the injection mold. It is an energy-efficient, environmentally compatible process that does not release any air emissions.”

Development Partners

Four partners, working over several years, developed the ColorForm process into a mature series process, with which thermoplastic parts can be painted directly in the injection mold with a precisely controllable coating thickness, including at narrow radiuses and edges.

- Paint manufacturer: Panadur GmbH, Halberstadt, Germany
- Mold maker: Hofmann Innovation Group, Lichtenfels, Germany
- Injection molding machine manufacturer: KraussMaffei Technologies GmbH, Munich, Germany
- Automotive supplier: Weidplas GmbH, Küsnacht, Switzerland

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All four parts of the A-pillar trim are injection molded in this swivel-platen mold and, after the swivel of the mold are flow coated in the coating cavity – in a one-step, solvent- and release-agent-free process

(© Panadur)

Polyurea – Curing within Seconds even without Catalysts

Of course, potential users always ask how it is possible to cure the coating so quickly while still in the injection mold, without external heating. Moch replies, “The reaction of the principal components polyamine and polyisocyanate within seconds is made possible due to the high reactivity of the amine group with the isocyanate group. Our polyurea is therefore so highly cured shortly after flow coating of the thermoplastic part that the finished part can be demolded. Reuter admits that he was doubtful at first whether the finished parts can really be easily demolded despite the fact that no release agent is used. “We were really surprised that the polyurea coating feels tacky in a liquid state, cures within a few seconds and then the flow-coated parts emerge from the mold without the slightest tackiness.

Hofmann Innovation Group, which was responsible for mold making, reported that the high fluidity of the mixed polyureas represents a particular challenge. The two-component coating must be pumped with a water-like viscosity into the coating cavity of the injection mold. For this reason, the mold manufacturer, together with Weidplas, initiated design measures to distribute the poly-



The two components of the reaction coating are circulated between the reserve tanks and the mixing head on the mold. The entire production cycle for the parts coated in the injection mold with a 2-component high-gloss system takes less than one minute, including trimming and ultrasound welding of the upper and lower parts of the A-pillar trim

(© KraussMaffei)

urea bubble-free in the cavity without increasing the clamping pressure and also rapid enough to prevent polyurea escaping from the mold. “To achieve this, even the shaping of the flow-coated parts had to be optimized,” remembers Jochen Mitzler from KraussMaffei. And he makes it clear that further experience with different part geometries and process parameters must be gathered step by step. According to Mitzler, “In-mold coating with reaction paint holds such great potential

that is worthwhile completing the learning steps.

Steffen Reuter ventures a prediction of the innovations could become feasible in the near future: “With our new manufacturing technology, we will soon be able to manufacture parts that look like copper or bronze. And it will also become possible to process coatings with high-quality glitter effects, highly scratchproof surfaces and even antimicrobial surfaces. So, further pioneering innovations are on the cards. ■