New non-stick coating improves shaping processes in injection molding and die casting

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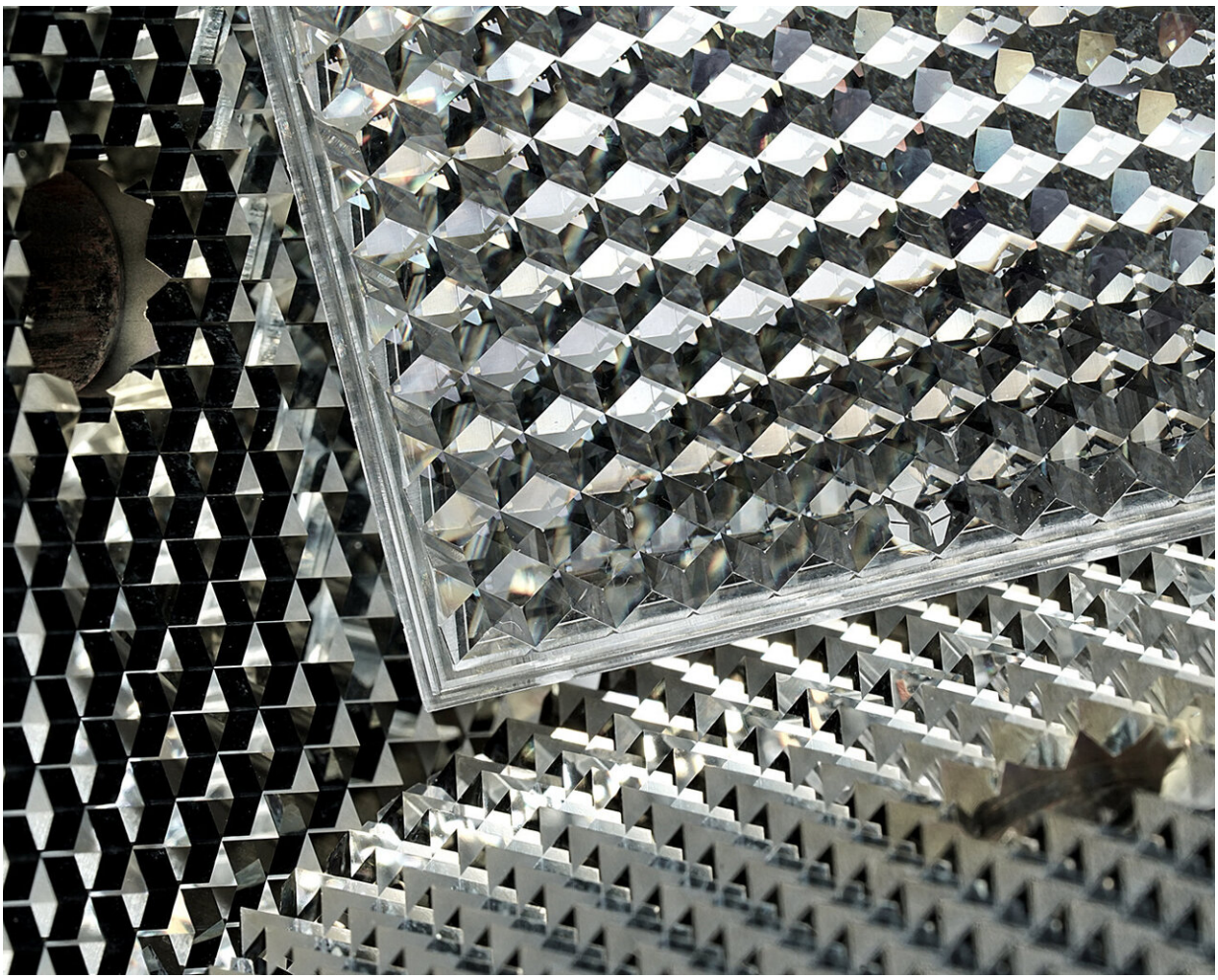

UltraPLAS enables perfect reproduction of mirror-finish surfaces. Release-coated tool (l.) with injection-molded element. Credit: Fraunhofer IFAM/Wolfgang Hielscher

A new UltraPLAS coating developed by Fraunhofer researchers has proven to be an innovative solution to the challenges of primary forming processes. This advanced release and easy-to-clean coating is applied as a gradient layer using a cold plasma process and is suitable for materials such as tool steel, stainless steel and aluminum.

The unique physical properties of UltraPLAS enable perfect molding of even nano-scaled and reflective surfaces. By reducing the number of post-processing steps and renouncing external release agents, the application is classified as highly economical.

How can high-quality and sophisticated tool surfaces be coated in such a way that production is improved, and cleaning processes are significantly delayed or simplified? Researchers at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM investigated this question together with partners in the "GlossyCast" and "UltraTrenn" projects.

The aim of the research projects was to reduce the demolding forces and the formation of deposits while permanently withstanding the specific stresses of zinc high-pressure die casting and plastic injection molding.

Specifically, the injection molding of technical plastic parts requires solutions to reduce demolding forces and the formation of deposits. This applies to the production of components with high-gloss surfaces or highly defined microstructures, such as plastic lenses, decorative trims or connectors with high dimensional accuracy.

Similarly, in zinc high-pressure die casting, deposits on the mold surface as well as deposits of release agents and lubricants prevent the production of high-quality, glossy zinc castings. This results in

considerable costs for post-processing of the cast parts. Irrespective of this, the application of release agent alone can account for up to 20% of the cycle time, meaning that there is considerable potential for savings if release agents are not required anymore.

UltraPLAS enables outstanding coating properties

To meet the aforementioned requirement-profile of ultra-smooth, optical surfaces (Ra coating itself must be smooth and structureless. In order to achieve this, the cold plasma process, the so-called PE-CVD process (plasma enhanced chemical vapor deposition), was used.

By building up a gradient layer, this process enables excellent layer adhesion to the product body on the one hand and exceptional non-stick properties with excellent physical characteristics on the product side on the other.

The coating produced in this way is characterized, for example, by a high modulus of elasticity (28–32 GPa) and a high density (1.5 g/cm^3). This results in a Mohs hardness range of 5.5, which is therefore on par with glass or enamel. Characteristically, as a non-stick coating, it also has a low surface energy (

This behavior is supported by the fact that the Fraunhofer researchers have succeeded in producing the UltraPLAS coating with a particularly thin layer thickness of less than 100 nm. This even proved to be necessary in the GlossyCast project to provide a good non-stick effect. In addition, the thin, structureless layers allow both nanoscale surface structures, e.g., for the nanoimprint process, and mirror-gloss surfaces to be perfectly reproduced.

Sustainable quality and economical production

guaranteed

Extensive practical tests carried out as part of the projects at various industrial companies have shown that demolding forces and the formation of deposits are reduced in the field of injection molding. It has also been shown that the reduction in adhesion forces reduces the total demolding forces. As a result, the demolding temperature can be increased, and the amount of friction reduced.

In contrast to the state of the art, the coatings can be removed both effectively and gently using plasma technology so that, if necessary, a new coating can be applied several times without any loss of quality. This is particularly interesting for high-gloss tool surfaces, as it eliminates the need for time-consuming polishing or ultra-precision machining.

It has also been shown that the direct production of high-quality zinc die-cast surfaces using casting technology can significantly increase economic efficiency. By significantly improving the surface quality of the cast parts, costly and time-consuming mechanical post-processing steps such as blasting, grinding, and polishing can be simplified or even avoided altogether.

In addition, the individual process steps of electroplating can be shortened or reduced. The development of this durable UltraPLAS release coating for zinc die casting stands for a significant advance in foundry technology. The possibility of cutting release agents opens new potential for improving casting quality, reducing production costs and making production more environmentally friendly.

As the cast products are manufactured without release agents, the pre-treatment time for electroplating is reduced and material consumption is lowered. The manufactured components have the desired roughness.

Due to the smoother surface, bright copper plating can be dispensed with, which leads to savings in materials, time and wastewater. Reducing the layer thickness of copper (cyanide) and bright nickel by 50 percent each led to further savings in materials and time.

The development of UltraPLAS was preceded by the PLASLON non-stick coating, which is characterized by high hardness (Mohs hardness 4.5–5.5) and excellent temperature resistance up to 230°C. This property profile has made PLASLON a popular PFAS-free easy-to-clean coating for cookware.

Through continuous innovation and the development of products such as UltraPLAS and PLASLON, our institute makes a significant contribution to improving production processes and promoting sustainability in the industry.

Provided by Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung IFAM