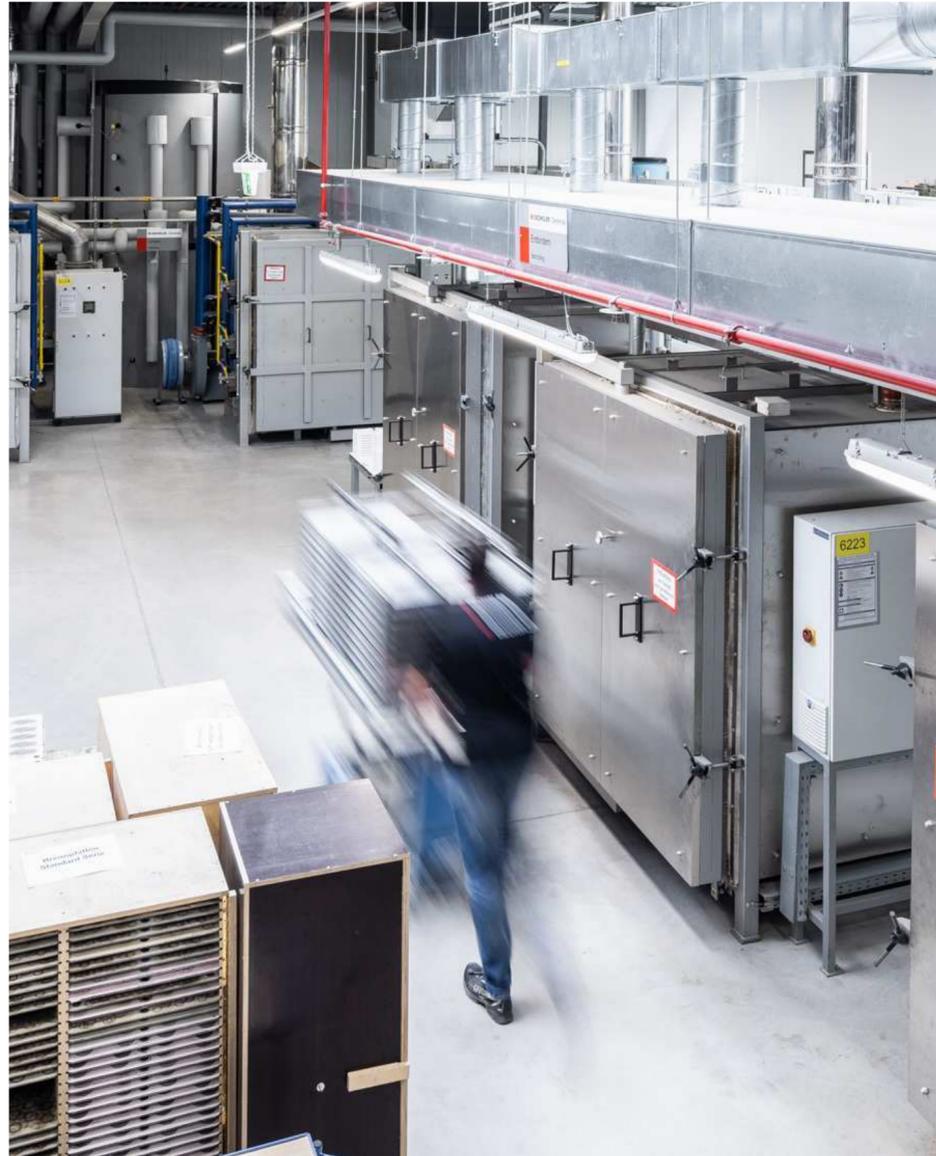


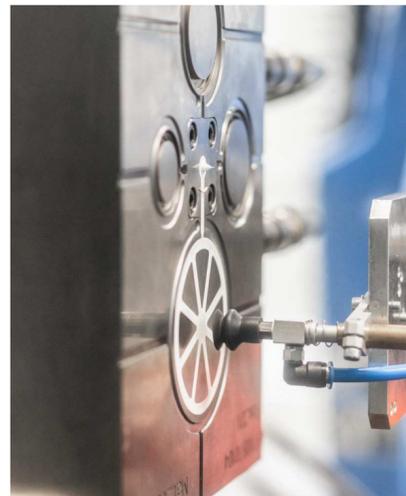
CERAMIC INJECTION MOLDING AT OECHSLER



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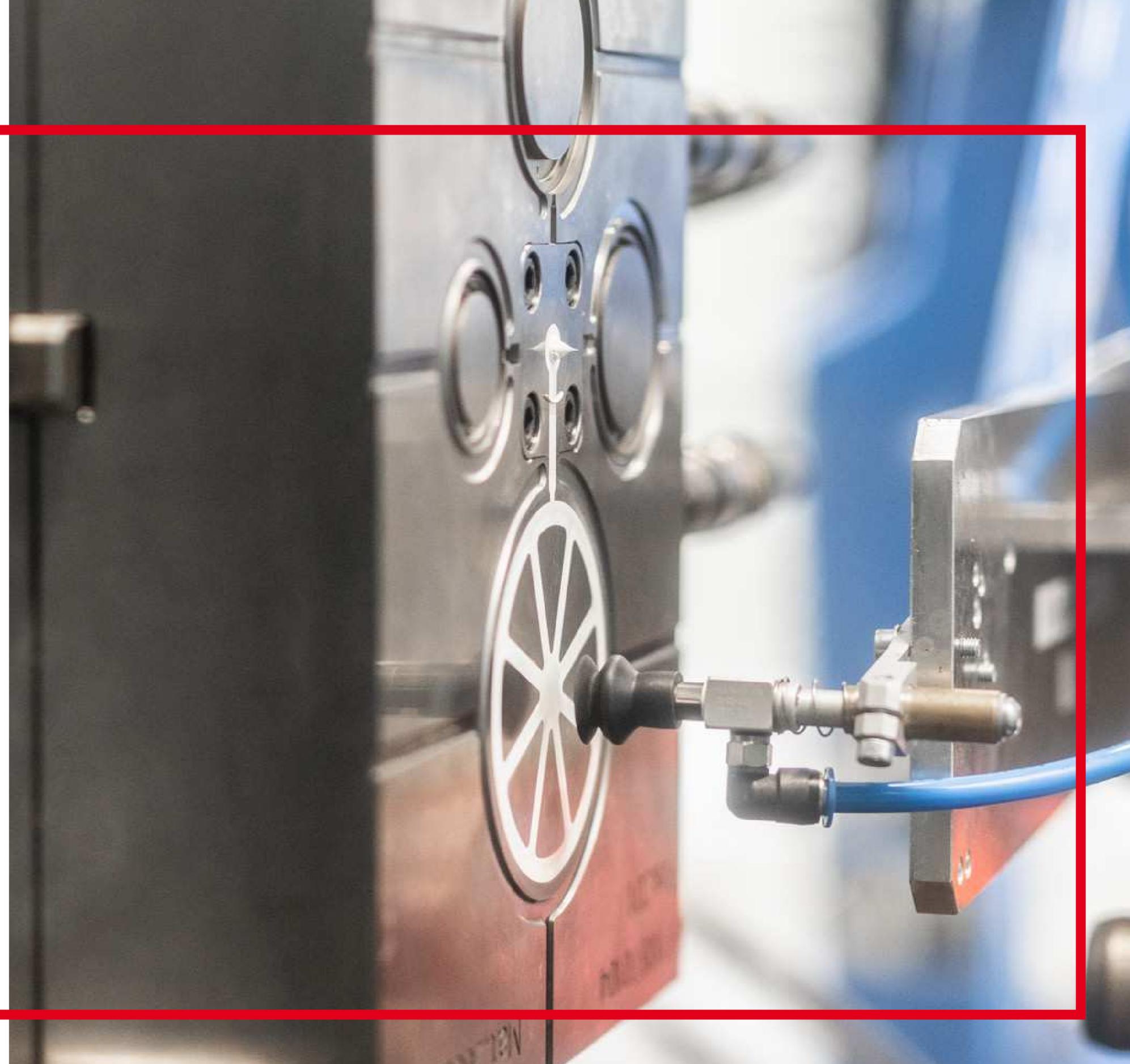
INTRODUCTION

Injection molding has been the DNA of OECHSLER for more than 70 years and paved the way to become a global and pioneering supplier. Today OECHSLER serves a broad material portfolio of polymer, metal, and ceramic injection molding.

Of these, ceramic injection molding (hereafter: CIM) combines material properties and application-relevant benefits with the manufacturing perks of industrialized injection molding.

It enables the groundbreaking combination of functionality and design, leading to high-quality parts with excellent material characteristics, outstanding haptics, and a unique visual appearance.

With the introduction of CIM, OECHSLER has developed a scalable, linked, and automated production process and additionally created manufacturing synergies within the technology portfolio through a unique hybrid approach in combining ceramic and polymer injection molding.



POWDER INJECTION MOLDING

END-TO-END MANUFACTURING

OECHSLER established the first CIM production in 2005 based on the experience in industrialized molding and tooling.

Following the one-stop-shop approach, OECHSLER built up technical expertise and testing capabilities along the entire production process and acquired extensive property rights and patents e.g., for a back-injection molding technology.

Today, the CIM production stepped up to an end-to-end manufacturing line in a separate building at the site in Weißenburg. Seeing the long-term potential in powder injection molding OECHSLER expands its capabilities for metal injection molding with the start of series production in 2022.

WHY CERAMICS?

TECHNICAL CERAMICS

Ceramics is one of the eldest substances and has evolved into one of the most advanced technological materials. It consists of crystalline minerals that are much purer than porcelain. When reinvented as technical material in the 1970s its excellent properties paved the way for applications in the automotive, chemical, and medical industries, as well as consumer goods. Compared to other materials, ceramics provide several benefits: It stands out for higher resistance to chemical, mechanical, and thermal

stress. Especially its stability when working in high temperatures allows for utilization in harsh conditions. As a very rigid material, it is not susceptible to wear corrosion. Furthermore, ceramics also perform convincingly with wear resistance and scratchproof surface that can appear as a matte or high-gloss finish, providing high-quality haptics that characterizes the aesthetics of any component. Procedural advantages of injection molding enable industrialization while focusing on quality and precision.



FEEDSTOCK & COLOR PALETTE

One key step in application development is choosing the right ceramic powder. The feedstock is a homogenous mixture that mainly consists of ceramic powder, supplemented with thermoplastic binder systems, such as polymers and processing agents.

As a full-stack manufacturing partner, OECHSLER offers ceramic products based on various minerals like yttria-based zirconia and aluminum oxide in several modifications. In addition, OECHSLER provides different grades of cordierite or silicon nitride for technical purposes.

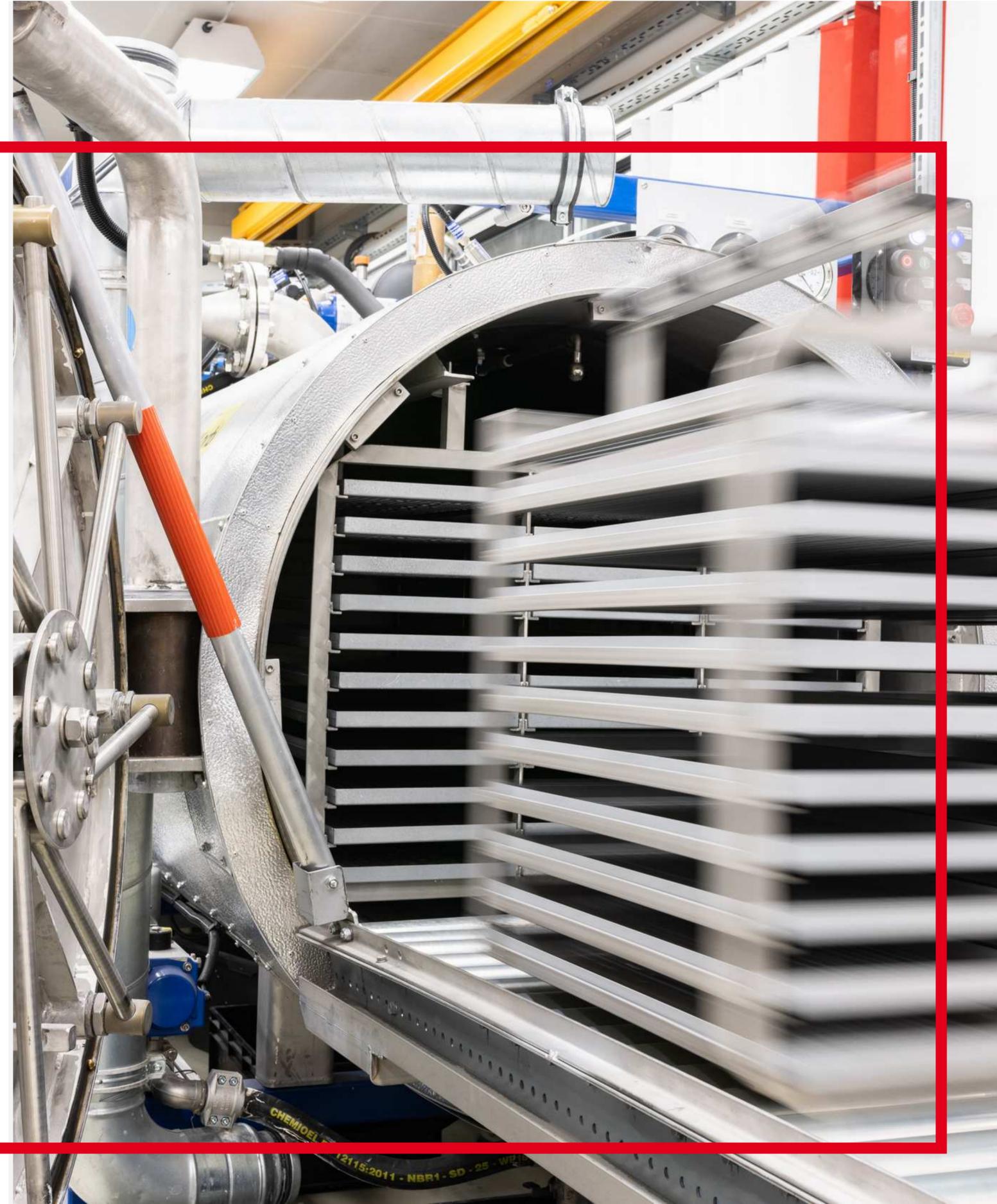
To fulfill any aesthetic requirements OECHSLER established a diverse supplier base to offer the entire color palette. These clear, intense, and deep colors allow for individualization.

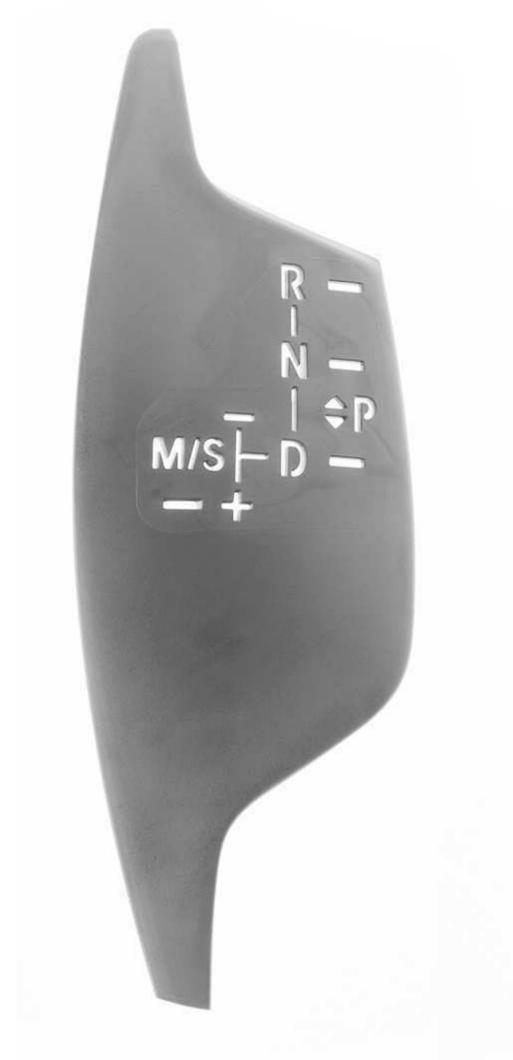


PRODUCTION

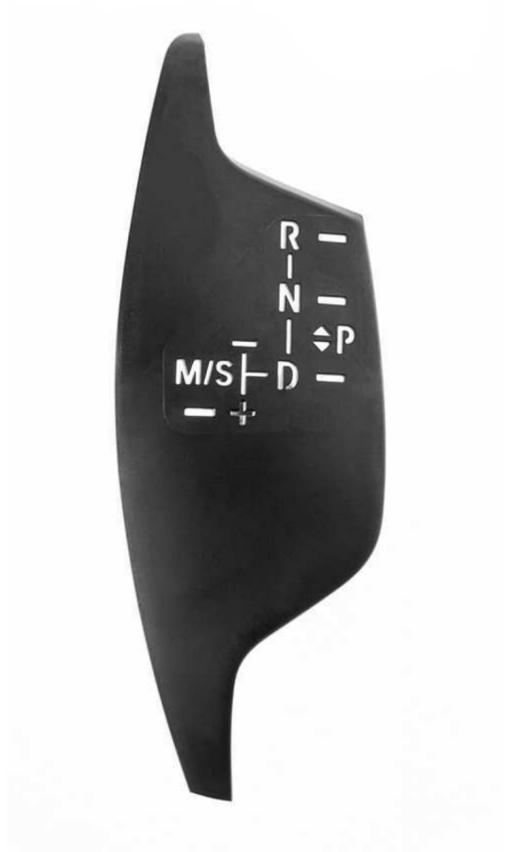
OECHSLER performs an end-to-end ceramic injection molding process at its state-of-the-art production site in Germany, driving customers' ideas into high-scale serial production, alongside development, tool design, molding, and several other manufacturing technologies. Special expertise is required to successfully carry out the shaping process due to the abrasion of ceramic materials. Initially, the mixture of ceramic powder and thermoplastic binding systems is heated up and molded, resulting in the green part, which needs sensitive handling due to its brittleness. During this production stage, the component already obtains its final body geometry and texture.

Subsequently, polymers and processing agents will be removed in a two-stage debinding process. Firstly, the component will be soaked in alcohol for several days to remove waxes. The product is then subject to a heat treatment eliminating polymer constituents. To induce the final properties the product is fired for more than 24 hours at up to 1500 degrees, resulting in a shrinking of about 20 to 30 percent. To successfully sinter ceramic parts at such high temperatures, complete control, and management of the process are required. If performed properly, homogenous densification and shrinkage of the component can be achieved, thus giving the part its durability and hardness.

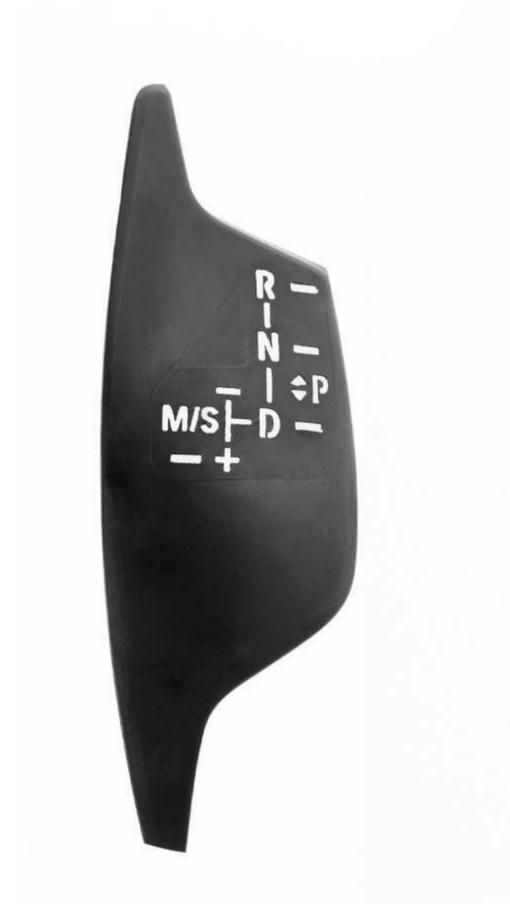




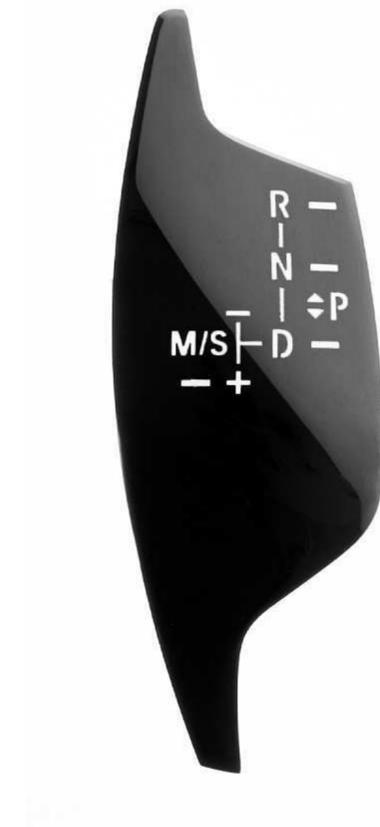
1 Ceramic Injection Molded Green Part



2 Debinded & Sintered Part



3 Polymer Back Injection Molded Details



4 Polished Finished Part

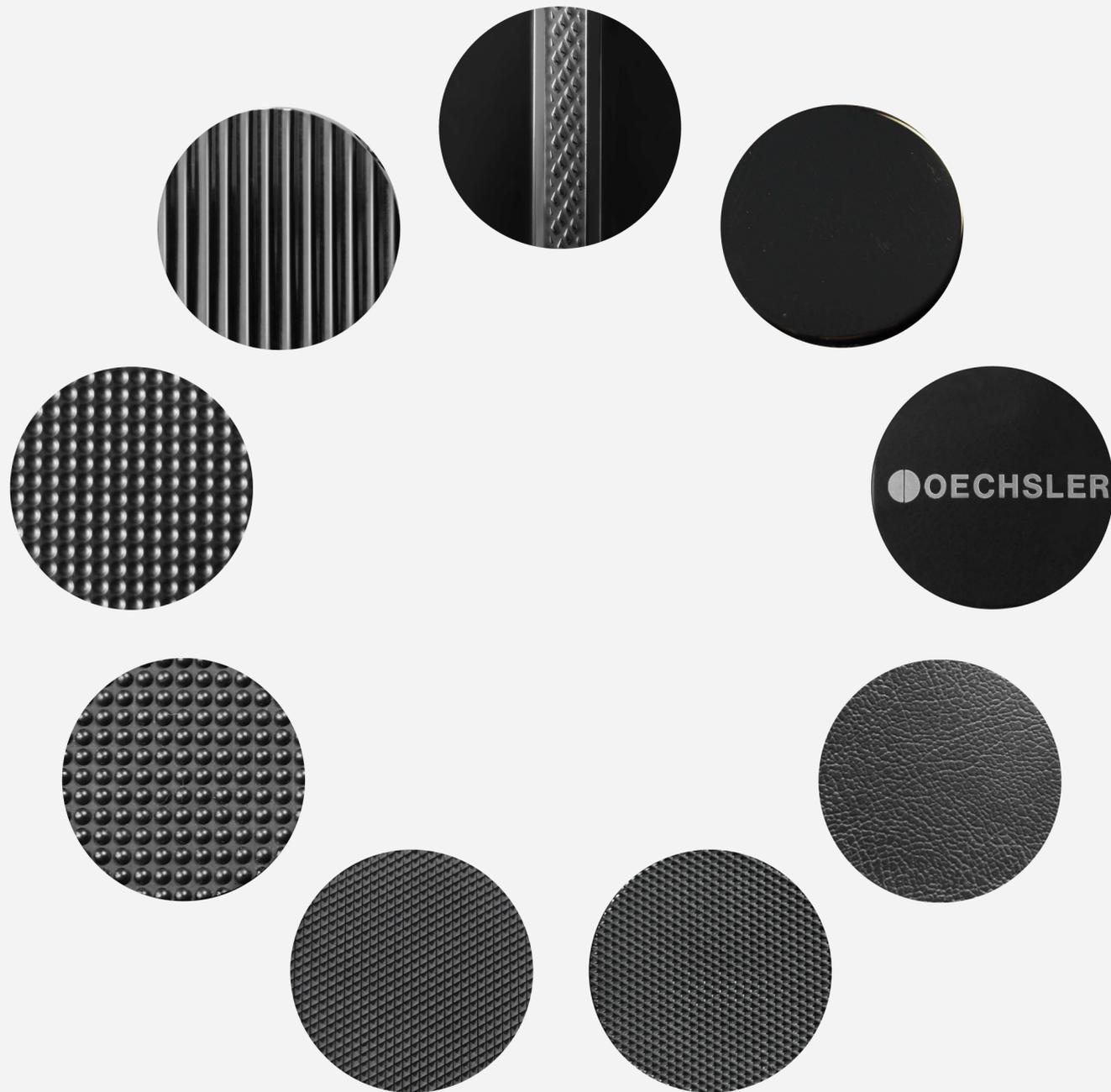
POST-PROCESSING

The post-processes must be individualized for every application and are based on flat grinding, tumble grinding, sandblasting, CNC grinding, and polishing.

The precision grinders create a perfectly even surface, which is then polished either by the means of a six-axes robot or in other polishing systems. The post-production itself can take several days.

OECHSLER has built a reputation for manufacturing high-quality parts only. Machine measuring assures that all products have the exact size, and the skilled team performs a 100 percent inspection, either manually or fully automated.





PRODUCT DESIGN

SERIES PRODUCTION & SURFACES

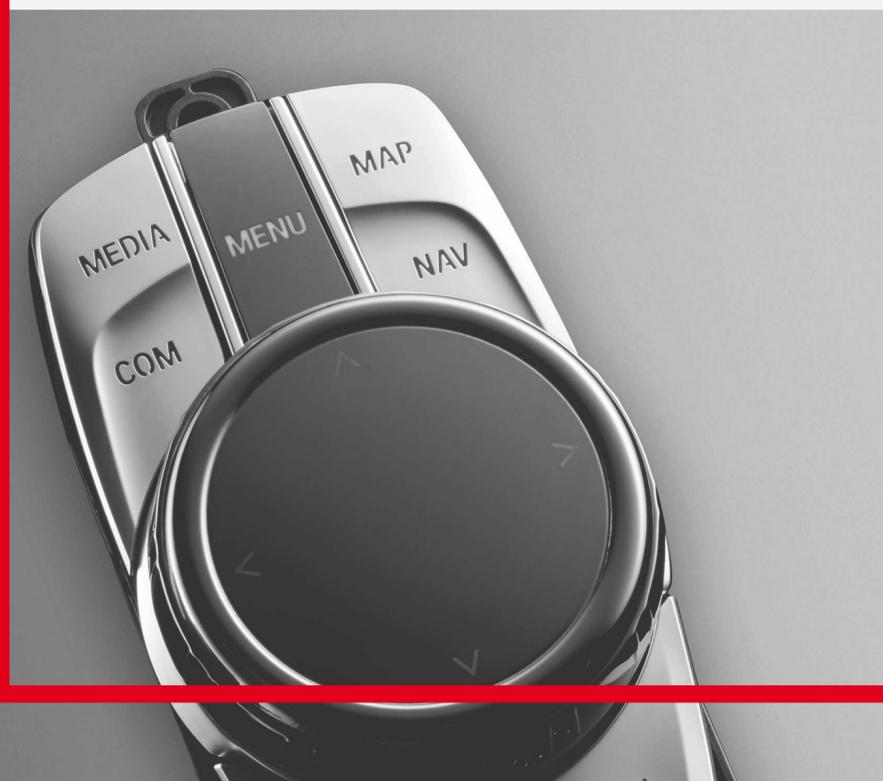
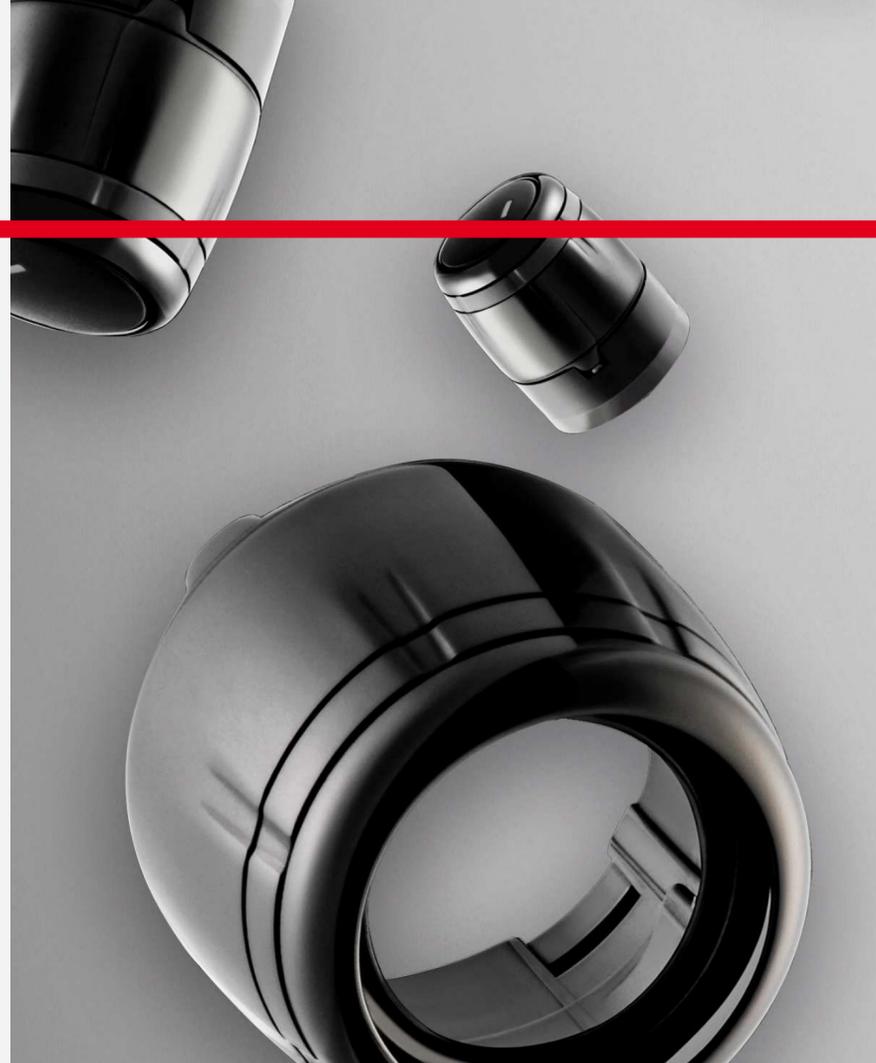
Ceramic Injection Molding is a highly complex technology that requires multi-stage production and post-process. OECHSLER established a standardized series production workflow with exceptionally high reliability on 2.100 square meters producing more than 15 million powder-based parts at automotive quality consciousness per year.

In conventional ceramic manufacturing, the surface typology is applied in a complementary subtractive process stage. The surface structure is already implemented during the tool making and put into practice during the molding process. Therefore, OECHSLER's expertise in defining the right parameters during the product design is inevitable, for example when enabling complex shapes and surfaces more uniformly and efficiently on a series basis.

CASE STUDY: CERAMIC INJECTION MOLDING FOR AUTOMOTIVE INTERIOR

OECHSLER's extended expertise in injection molding has always gone hand in hand with successfully supplying the automotive industry with high-quality components. For BMW – one of Germany's most prestigious car manufacturers – OECHSLER has successfully developed and produced a ceramic-based luxurious interior experience, which is available in the 5 and 7-series.

The ceramic set includes the iDrive, a control element for the entertainment system, a gear selector, and climate controllers. These interior parts combine design, with high-quality haptics and a scratch-resistant surface.



HYBRID APPROACH – BACK-INJECTION

Due to the integration of ceramic injection molding, OECHSLER enabled the unique combination of polymer and powder injection molding, that has already been realized in serial production for BMW's gear selector and iDrive. For the gear selector, a shell is molded out of grey ceramic and features a designated surface typology for a translucent label. Subsequently, the sintered compound is subject to another molding process – this time based on polymers. White and grey polymer is inserted via two-component technology, which will then undergo our post-processing and testing procedure.

One of the main challenges is the hybrid approach of ceramic and polymer injection molding while fulfilling the quality standards of the automotive industry. That includes tight tolerances within the CIM process ensuring repetitious accuracy after sintering and high-precision polymer injection molding, sweep tests, and recognizing touch interactions. To make such innovations happen, extended development capabilities, stable series processes at a large scale, and nonetheless well-educated staff are essential and have been driving hybrid approaches to perfection.



**ARE YOU INTERESTED IN OUR CIM-PRODUCTION?
DO NOT HESITATE TO CONTACT US AT
POWDERINJECTION@OECHSLER.COM**