Achieve high levels of production quality, but save time and money thanks to Direct Croning

by **Ray Wünsche, ACTech**

Direct Croning® is an application-specific development of the well-known laser-sintering technique that has been used for plastic powder for several years. Direct Croning is named after the molding sand used in this process that is very similar to conventional Croning sand (this molding material has been applied in foundries for a long time and the resulting casting quality is recognised the world over).

The mold segments and cores produced by using Direct Croning, on EOSINT-S machines show exactly the same characteristics and provide the same level of quality as conventionally produced sand castings. Therefore, castings produced with the Direct Croning Process serve as functional prototypes of later series production of sand castings because the same alloy and melting, gating and rising technology is applied.

When using Direct Croning to produce sand molds and cores ready for casting, a hot-curing molding material is needed. After applying a flat, uniform 0.2mm-thick layer of this material, the particles are fused together by laser beam. The energy from this beam initiates an exothermal chemical reaction that binds the sand particles together. After hardening the molding material in this way, the production table is lowered and the next layer applied. This process operates automatically, while parts with a volume greater than 720 x 380 x 380mm are typically produced in segments and sometimes combined with exterior patterns made by any Rapid Tooling technologies.

The first dimension check of the mold is already made when assembling the mold segments at the casting location. If all the segments fit together and can be assembled without any problems, the sand mold device must therefore have the correct dimensions. The first visual check is followed by standard quality check procedures as is usual for casting prototypes, and the last dimension and properties checking in the laboratory.

Properties and benefits:
In sandcasting configurations with intricate internal passageways, the most time-consuming process generally involves designing and building the tools that are necessary to assemble the core arrays. A key benefit of Direct Croning is that unlike other layer manufacturing technologies it uses no supports. This design makes it possible to produce extremely difficult and complex parts with several undercuts or freeform surfaces together with intricate casting systems. Since the mold or core does not have to be withdrawn from a pattern plate or core box, there is no need for draft angles that normally have to be designed in a time-consuming manner. Intricate cores that are conventionally assembled from several pieces can be built all-in-one,
and multisegment mold assemblies for complex castings can be obtained with fewer parts to raise the dimensional accuracy of the casting. Such molds and cores are extremely difficult, or even impossible to manufacture using conventional tooling or other Rapid prototype technologies. Direct Croning minimises the number of tools and eliminates the core assembly phase of a difficult-to-produce casting. Due to the nearly unlimited geometrical possibilities when producing cores and molds, and the narrow tolerances in the laser sintering process, high requirements of customers from all industries can be met. The ability of Direct Croning to produce molds and cores for sand casting without any previous tooling can speed up the development process drastically at reasonable costs. Alternative designs can be compared and improved within a time and cost frame that is comparable to what was previously needed for one loop on the traditional method.

Since the mold segments and cores are produced by using the same material as conventionally produced sand castings, the final castings show completely the same characteristics and quality, and the suitability for any testing is perfect. Having built and finished the parts, mold segments and cores are ready to be used directly in the foundry. All conventionally used sand-casting alloys can be poured in these molds, such as aluminium, steel, cast iron and magnesium.

Crankcase prototyping: The following example will show a complete project show, starting with CAD-work and finishing with the ready-for-machining casting, demonstrating the efficiency of the design.

Normally Direct Croning starts with the design of the gating and risering system for the pouring system of the prototype part after repairing possible data losses during the data transfer. The designed pouring systems are very similar to series production and therefore comparable results can be obtained even in the pilot-plant stage.

All sand-casting materials, beginning from aluminium or magnesium alloys up to high-alloy steels or grey cast iron, can be cast in the produced molds. Before starting Direct Croning all designed mold segments and cores are checked for easy and error-free assembly.

When the post-cured mold and core set are ready for assembling the mold, the Direct Croning combines the speed of Rapid prototyping with all the properties and possibilities of conventional manufacturing, allowing the complement of additional foundry equipment such as coolers. For optimal surfaces, in particular for inner geometry's, mold segment and cores can be coated, meaning the roughness of the final parts will be less then 70 µm. Also, the use of liners for the castings is possible.

After transferring the completed mold to the prototype foundry, also operated by ACTech, the casting will be poured, and few hours later fettled and cleaned. If necessary, the casting can be delivered fully machined, otherwise the prototype casting is shipped to the customer.

Getting benefits in combination with Rapid Tooling or Direct Mold Milling (DMM): Occasionally the combination with any technologies of Rapid Tooling decrease the costs and manufacturing time of prototypes, especially when larger quantities are needed or the part size exceeds the building area of the EOSINT S machine. In this case Direct Croning is usually used to produce the intricate parts of the molds and cores which are then assembled with mold-halves made from a conventionally-built pattern plate.

Take, for example, the customer who required a whole tailgate as a small prototype series of a magnesium alloy part. The internal structure of the part was very complex with undercuts and small rips. The design was not finished and did not include the necessary adaptation to the casting process. Nevertheless this part and its design level was not a big challenge for the abilities of Direct Croning, because this technique is mainly used together with non-finished parts. Direct Croning is a time-efficient means of adapting any parts to existing manufacturing technology necessary for conventionally used soft-tooling. The dimensions of the part exceed the available building area considerably, and the expected building time of all segments also exceed the given timetable and cost targets of the customer. Therefore the engineers at ACTech decided to use a combination of an accurately CNC-milled pattern plate as a soft tool, and segments made by Direct Croning for the complex part such as the suspension area of the tailgate. These segments would be assembled with the conventionally-made mold, and a combination between both technologies was used for the whole series.

The ability of Direct Croning to reproduce a difficult geometry cost effectively, together with the well-known features of Rapid Tooling technologies, gave this project technological benefits. The internal geometry of the tailgate cold be easily changed at any time with costs less than any other technology initiate, because only data had to be altered to produce new laser-sintered segments.