# Cost effective Magnesium and Aluminum cast parts in forged quality

The Stolfig Group has been manufacturing metal components for a wide range of industrial sectors since 1984. More than 30 years, we contribute in particular to the improvement of magnesium casting and extrusion technology. Thanks to our decades of cooperation with Chinese partners and our own Chinese locations, we are at the cutting edge of magnesium and aluminum casting technology and have a production network even for the largest supply quantities of state-of-the-art die-cast components.

Unfortunately, this state of the art still has serious disadvantages, such as porosity, contamination with release agents and oxides in the material, flow skins and weld lines in the component as well as a coarse-grained microstructure with relatively low ductility.

In addition, the tool life in conventional systems is not optimal, as the piston rod is abruptly stopped at the end of the insertion process, which converts the kinetic energy into a very short, but high pressure peak on the material and the casting mold. This leads, for example, to premature wear of the mold, excessive burr formation due to elastic deformation of mold and rig.

Most of the above-mentioned disadvantages can be overcome with a new die casting process that is ready for large-scale production, the so-called liquid die forging.

**Liquid-Die-Forging (LDF)** has aligned the casting tube with the piston rod not classically horizontally, but vertically upwards and fills the mold from bottom to top. By swivelling sideways, the pouring tube is filled from above, swivels back to the vertical position, docs pressure-tight to the bottom of the mold and the casting piston "pushes" the material relatively slowly into the mold. As soon as the mold is completely filled, the back pressure in the casting piston rises steeply. At this point, the very strong forge-cylinder takes over and presses the casting piston from below with a surface pressure of up to 1000 bar, whereby the casting material is compressed (forged) with up to 100MPa.

The vertical "slow" uniform filling means that the material fills the mold with low turbulence, the air remains in front of the material, hardly any release agent from the mold walls mixes INTO the material and no kinetic pressure shock is generated by the slowly moving casting piston.

This improved LDF die casting process:

a. allows a throughput comparable to that of conventional die casting
b. provides non-porous, gas-pressure-tight microstructures with a density very close to the raw material density
c. results in significantly higher strength and ductility than with classic die casting
d. brings extremely improved corrosion resistance, especially with magnesium, because the surfaces are free of pores and with hardly any release agent impurities

Combined with a melt in a thixotropic (or semi-solid) state, the result is the so-called Semi-Solid-Die-Forging (SSDF), which delivers components with even better properties.

**Semi-solid** melt, or thixotropic melt, is a slush in which both liquid and already crystallized particles are present. As early as 1970, Prof. Flemings from MIT (USA) discovered and investigated that by vigorously stirring and shaking a thixotropic melt, one can delay solidification and produce a slush with very finely distributed globular (spherical) particles, which then has very good flow properties. At the same time, the finely distributed particles are nothing but condensation nuclei, so that a very fine-grained ductile structure forms when the melt finally solidifies. The higher viscosity of such slush

compared to a complete melt eliminates any turbulence during mold filling in conjunction with the liquid die forging process almost completely.

The additional benefits of combining the two technological changes mentioned above are:

1. The globular, thixotropic slush guarantees a relatively long time window with very good mold filling, so that even complicated and thin-walled components can be manufactured reliably.
2. The fine microstructure of the components has strengths close to forgings and allows fracture strains of 20%, e.g. for AM50
3. The surfaces are so free of pores and contamination that they can be mirror finished reliably with relatively little effort

## Summary

Our partner and inventor of these two new cast processes **Liquid-Die-Forging (LDF)** and **Semi-Solid-Die-Forging (SSDF)** has optimized these processes with many details and innovations to series production readiness and has now 3 systems in operation. Today, both LDF and SSDF are significantly cheaper than forging and are ready for series production for very large quantities.

Feel free to visit us at our booth no. 7-155 in hall 7 at Euromold 2024 in Nuremberg!

We would be happy to explain further details to you and show you some components in LDF and Thixomolding, among others.