Mechanical properties and fatigue behaviour of magnesium alloys for castings used in e-mobility applications based on different casting processes

M. Schütze[1], J. Ganzenmüller[2], M. Becker[3], C. Mangos[1], G. Piazza[2], L. Kallien[1], E. Beeh[2]

[1]Aalen University; [2]German Aerospace Center (DLR), Stuttgart; [3]Oskar Frech GmbH + Co. KG, Schorndorf

The industrial shift towards e-mobility is an opportunity for the economic production of high pressure die castings (HPDC) components, such as motor housings, gearboxes and covers. Those parts are mainly manufactured in large serial numbers from aluminum alloys. Although the use of high strength magnesium alloys for structural castings has the potential of further weight reduction in lightweight constructions [1].

To manufacture high quality castings with low amounts of internal defects the casting processes have been upgraded over the past years. One of these improvements is the Vacural® die casting process from Oskar Frech GmbH which provides the best possible casting quality for aluminum alloys [2]. The process differs from vacuum-assisted die casting. The vacuum is applied continuously from the beginning of the dosing process until the mold is completely filled. In the process the molten material is sucked directly from the furnace via a pipe into the casting chamber. The closed system reduces oxidation of the melt while dosing. Until the mold is filled, a vacuum of around 70 mbar is achieved, which reduces air inclusions in the die casting parts.

The Vacural® die casting process provides the same benefits for magnesium. In the project InDrutec-E, funded by the BMWK, three different alloys - AZ91, AS31 and AE 44-2 - were casted and afterwards tested. For this study all alloys were casted in 4 mm plates via vacuum-assisted and compared to the Vacural® die casting. Afterwards flat samples were tested for static and fatigue strength.

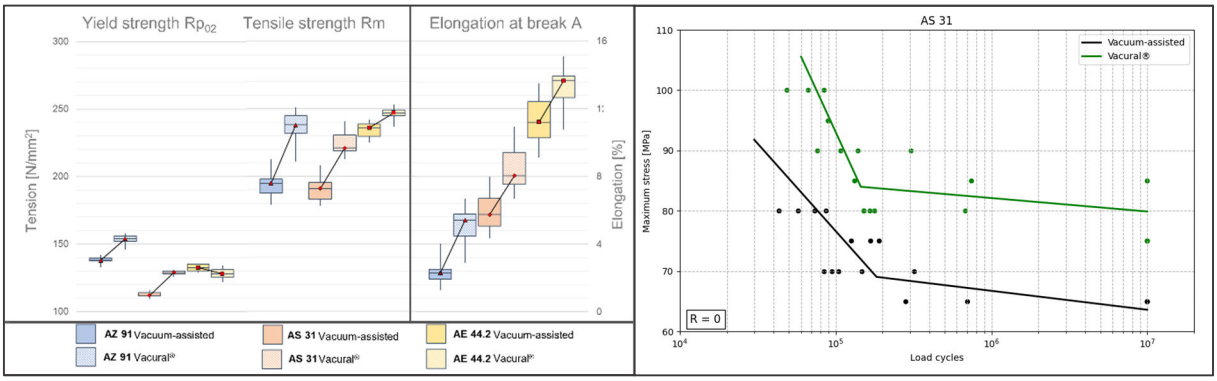

Figure 1: Change of the mechanical properties of the three magnesium alloys (left) and fatigue strength increase of AS 31 (right) due to Vacural® die casting

The results in Figure 1 (left) shows the increase of static properties like tensile and yield strength as a result of Vacural® die casting. For all three alloys a significant increase in strength and ductility was investigated. For the AZ 91 and AE 44-2 no mentionable increase of the fatigue strength due to the advanced casting process were visible. On the other hand, a significant elevation of the fatigue strength for AS 31 was observed. The fatigue behavior comparison for the two casting processes of AS 31 is shown in the right plot of Figure 1.

The investigation shows, that the Vacural® die casting process has a high influence on the mechanical properties of magnesium alloys. For further investigation the alloy AS 31 in combination with the Vacural® process was used to show the light weight potential of a gearbox cover for electrical powertrain applications [3].

References

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