Neue Materialien
Fürth

Developing Magnesium Alloys by Thixomolding

MAGNESIUM – A LIGHTWEIGHT MATERIAL

Magnesium has become increasingly popular as material for lightweight construction. Especially in the two main markets automotive and electrical industry, it is substituting aluminium and polymeres more and more.
In serial production, magnesium parts are mainly produced by die casting. The alloys AZ91 and AM60 have proven to be highly beneficial for most applications due to their good castability. Whereas AZ91 offers a high strength at room temperature, AM60 is characterized by its high ductility. However, both alloys are not suitable for use at temperatures higher than 120 °C due to their low creep strength.

POTENTIAL OF NEW MAGNESIUM ALLOYS

In the last few years, new alloys with increased creep strength have been developed, which could expand the field of application for magnesium in the automotive industry onto powertrain applications. Up to now sufficient creep strengths have been reached. However, concerning castability, hot cracking or ductility, these alloys are far behind conventional alloys like AZ91 and AM60.
Apart from the good mechanical features, other specific values like dynamic and physical properties, corrosion behavior, castability or recyclability are as important as the costs of the alloy.
A special potential for further developments lies in the use of class A cast surfaces with a high demand on the surface quality.

ALLOY DEVELOPMENT WITHOUT MELT METALLURGY

Conventional alloy development always demands high melt metallurgical efforts. For each alloy system, the corresponding amounts have to be provided in the melting furnace. Melt metallurgical features like oxidation, melting loss, evaporation, solubility or macro segregations complicate or limit the choice of suitable alloying elements. Thixomolding overcomes these restrictions, and therefore expands the possibilities and even simplifies alloy development.
In Thixomolding (as in plastics injection molding) the precursor material are granules. The magnesium granules are fed into the screw, heated up to the liquid or semi-liquid state during transport and finally injected into the mold (as in die casting).
NMF has enhanced this process especially for alloy development. By using a patented dosing system, granules of various alloying elements can be added to the basic alloy (fig 1). The constant shearing of the material guarantees intensive mixing of both alloy components and therefore a uniform distribution of the elements.
This method offers a convenient possibility of producing cast parts from a variety of alloys in very short time and with a low melt metallurgical effort.
NMF has realized a number of alloy systems, e.g. on the basis of AZ91 with Ca-additions. Investigations concerning the microstructure (fig 2) and the creep strength (fig 3) as well as the processability and the castability of the alloy systems in Thixomolding are part of the comprehensive characterization

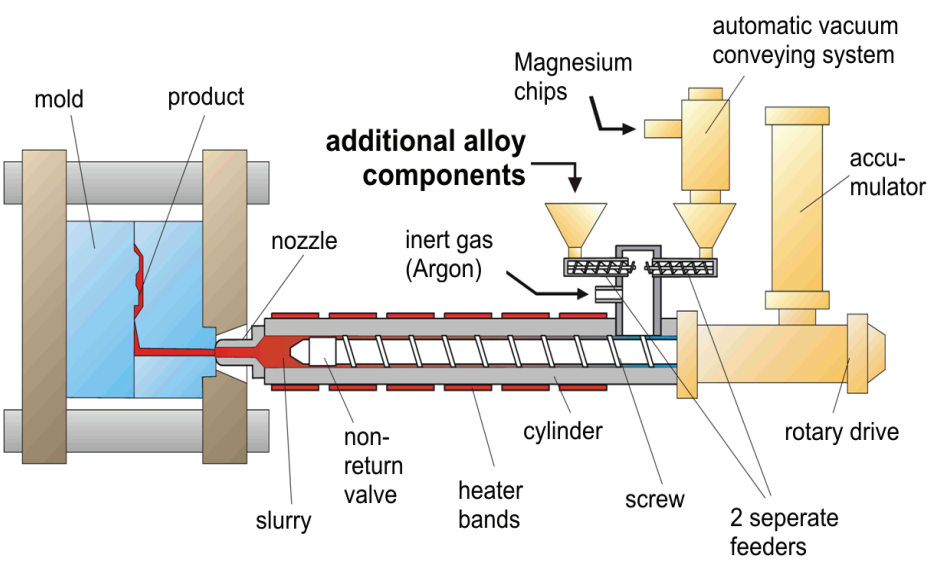

Fig 1: Schematic drawing of the Thixomolding process with patented, additional dosing system for alloying additions (DE 10301363).

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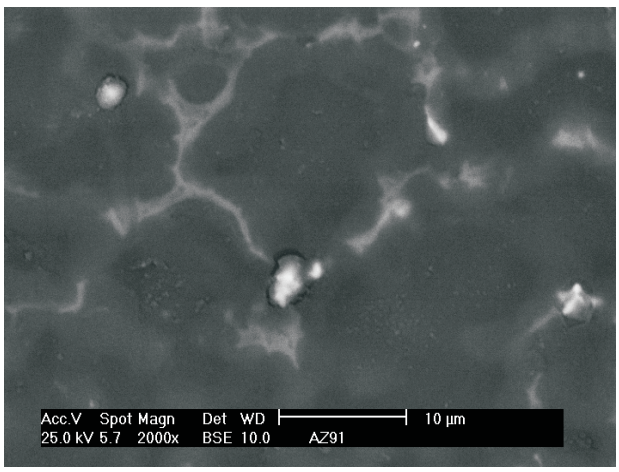

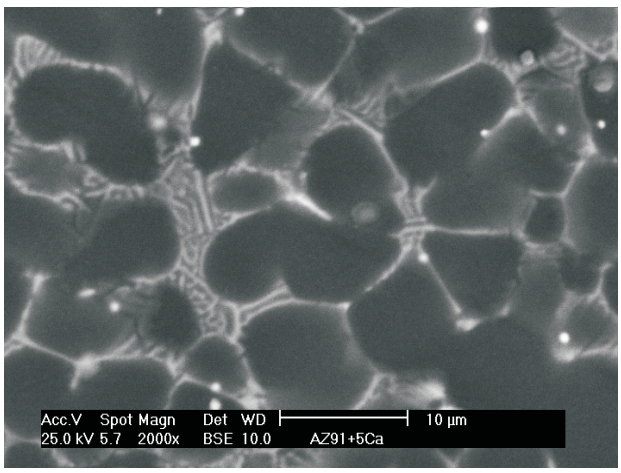

Fig 2: Microstructure of AZ91 (left) and AZ91 with 5% Ca-addition (right).

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the design of customer-specific alloys by Thixomolding.

We offer numerous characterisation methods especially for magnesium alloys:

- Element analysis of magnesium alloys by glow discharge optical emission spectroscopy (GDOES) with up to 15 elements
- Investigation of rheological properties of magnesium melts
- Manufacturing of granules from casting ingots in small quantities by machining
- Evaluation of static mechanical properties from 20°C to 250°C under tensile load, compressive load or bending load
- Investigation of the creep properties under tensile load and compressive load
- Qualitative and quantitative metallographic characterization of the microstructure
- Evaluation of the solidification process by use of comprehensive thermodynamic databases.

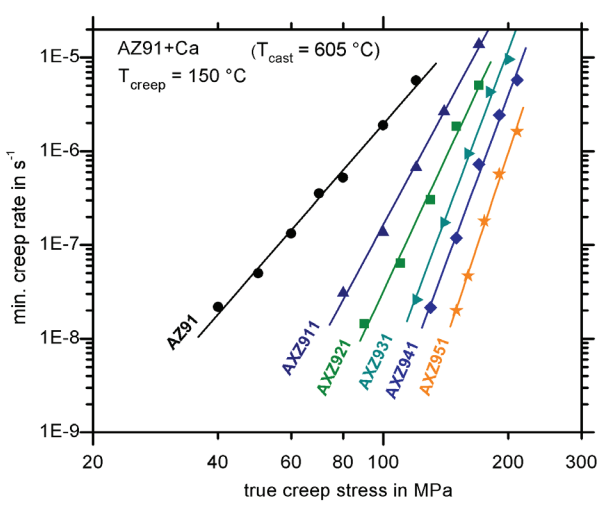

Fig 3: Minimum creep rates at a testing temperature of 150 °C versus stress for Mg-alloys based on AZ91 with various Ca-content processed by magnesium injection molding. Increasing the Ca-content improves the creep strength significantly.

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