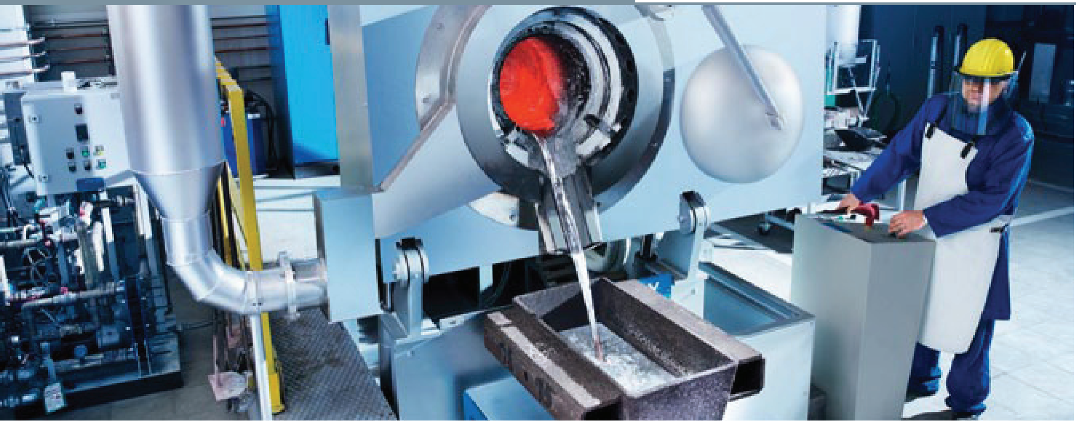

Alloy development: increased heat resistance in casting alloys

Aluminium casting alloys are finding a growing number of applications in the automotive industry. Apart from increasing use in structural applications, they occupy a firm place as a material for crankcases and cylinder heads. However, this situation could change quickly if the development of heat resistant aluminum alloys were to be allowed to stand still, especially in view of the growing demands on materials emanating from the trend towards engine downsizing.

Accordingly, although conventional alloys such as AlSi4CuTi or AlSi17Cu4Ti possess high levels of heat resistance and good mechanical properties at elevated temperatures, they display weaknesses with regard to their suitability for casting and machining.
As a consequence, AMAG Casting GmbH is working intensively in the field of heat-resistant, aluminum casting alloys and is involved in extensive research within the framework of a multi-year FFG project (FFG = Forschungs-Förderungs-Gesellschaft). Moreover, collaboration with the universities of Zurich, Leoben and Vienna ensures a profound knowledge of the complex interrelationships between the mechanisms that come into play during the high-temperature loading of aluminum parts.
The aim of the FFG project is to develop a hypo- or near-eutectic aluminum alloy that is competitive in price and provides good casting properties. Ideally this alloy should be produced using a high scrap percentage. With this in mind, the most important question to be answered is: "What makes an alloy heat resistant"? In simple terms, metal deformation can be described as the "movement of dislocations" and in order to prevent this phenomenon, dislocation mobility has to be reduced by increased material strength or hardness. The principle of dispersoid hardening represents the state of the art and is successfully applied in heat treatable alloys. Using the right temperature regime, fine secondary phases precipitate and obstruct dislocation movement to a considerable extent. However, at higher temperatures and in time Ostwald ripening occurs, which results in a coarsening of the strengthening dispersoids and hence a reduction in their contribution to material hardness. This is why heat-resistant alloys require secondary phases that do not coarsen with time at elevated temperatures, a characteristic that is achieved by the appropriate alloying of the aluminum.
AMAG uses simulation tools to assist its development work. Solidification simulation (e.g. Pandat), the modelling of the kinetics of the heat treatment and the utilization time at elevated temperatures (e.g. MatCalc) are all employed.
Another method of increasing heat resistance involves the "pinning" of the grain boundaries, which prevents, or reduces significantly the relative movement between the grains. This can be achieved via the precipitation of coarse, planar phases.
The α-Si-eutectic plays an important role in Al-Si alloys as a supporting frame that channels stress. In fact, the targeted use of such frame-supporting elements improves high temperature stability. Heat treatments can also enhance the strength of a material, but the choice of an incorrect set of parameters, which can have adverse effects on heat resistance, must be avoided. ■

In 2011, AMAG is to launch a series of publications related to this subject. Fixed dates in this regard are provided by the LMT 2011, Lüneburg/Germany, from 19. - 22. July 2011 and the ECAA 2011, Bremen/Germany, from 5. – 7. October 2011. In addition, several articles in journals and periodicals are to be published and are currently at the review stage. So be on the look out for the upcoming results of our project!

Recycling casting alloys for crash-relevant structural parts

Currently used Aluminium casting alloys for automotive structural parts are made from primary metal with very low tolerances for Iron, Copper and Zinc impurities. High energy use in their production leads to high carbon footprint.
AMAG Casting currently develops together with leading OEM´s a number of alloys with acceptable characteristics for the use in automotive structural parts and which are eco-friendly. The influence of the main alloying elements Silicon and Magnesium on the mechanical and casting properties as well as the acceptable impuritiy levels for e.g. Iron, Copper and Zinc are investigated. This will allow the use of scrap as input material. Great attention will be turned to the interaction between those elements. Together with the industry partners also the corrosion-, processing- and crashrelevant properties are investigated. ■