ADVANCES IN WROUGHT MAGNESIUM ALLOYS FOR LIGHTWEIGHT APPLICATIONS

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ABSTRACT. The drive towards increased fuel efficiency and a reduction in harmful emissions of greenhouse gases associated with energy generation and transportation has led in recent years to a resurgence of interest in light alloys based on aluminum, magnesium and titanium. In automotive, the need to reduce overall vehicle weight has led to major international efforts to develop aluminum and magnesium alloys for structural car body parts. Major research activities in Australia, USA, Canada, Germany, China, South Korea, and Japan have been established in the past 10 years to develop these alloys for applications in automotive, aerospace, and power generation. In magnesium research alone, MAGNET in Canada, the MAGIC center in Germany, POSCO Mg R&D Program in South Korea, and the Australian ARC Centre of Excellence for Design in Light Metals are all multimillion euro research programs specifically developing magnesium alloys for transport applications. While aluminum has already established a leading role in automotive applications, the use of wrought magnesium as parts of the automobile structure is still rather limited. Present applications are thus limited to components, which are reasonably processed via casting due to excellent die casting performance of select magnesium alloys and the resulting potential to offset material cost through design strategies. Present magnesium alloys show limited room temperature formability due to a shortage of independent deformation modes that can accommodate deformation along the *c*-axis of the hexagonal close-packed unit cell. During rolling deformation of magnesium a strong basal texture forms rapidly, which negatively affects subsequent sheet formability. In aluminum, depending on alloy composition and processing conditions, dramatic texture changes are observed, due to strong selective recrystallization mechanisms during nucleation and nucleus growth. Such dramatic but characteristic orientation changes are missing in conventional magnesium alloys, where in most cases the deformation texture is preserved during annealing. To improve magnesium sheet formability one needs to depart from standard basal textures. The current talk highlights the role of microstructure and texture engineering through a combination of intelligent processing and alloying, which was proven to have broad potential for enhancing the mechanical behavior of wrought magnesium alloys by achieving a superior combination of strength and ductility. The deformation texture evolution, as a result of different slip and twinning mechanisms, and its impact on properties will be analyzed. Special attention is given to recent magnesium alloy development through microalloying with rare earth elements to obtain weaker and deformable textures. The presentation discusses the basic mechanisms involved in deformation and recrystallization of these alloys. The role of alloy additions, solute segregation and second-phase precipitates, initial textures, deformation and annealing conditions, microstructure heterogeneities and related recrystallization mechanisms will be addressed, and possibilities derived for their modification to guide potential strategies of alloy design and microstructure engineering for optimal material properties.

KEYWORDS. Magnesium; Lightweight applications; Automotive; Microstructure; Mechanical properties