Progress in the development of new Mg alloys for the low force TRC process

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Magnesium (Mg) is the lightest of the structural metals and is widely available. This makes alloys based on Mg ideal for applications where lightweighting is of high importance, such as automotive. Many of the desired weight savings for automotive could be achieved using Mg alloys for sheet applications, for example in potential application to body panels.

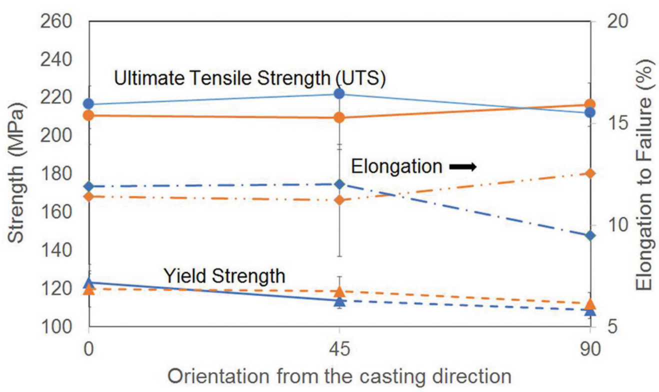

FIGURE 1. Mechanical properties of TRC processed ZASM1100 alloy in the as-cast and homogenised conditions.

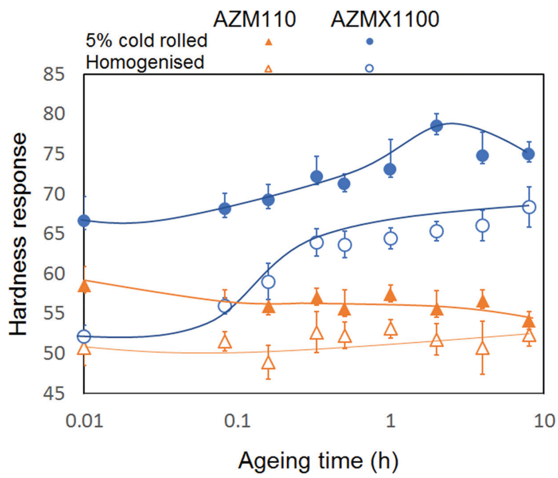

FIGURE 2. Age hardening response of AZM110 and AZXM1100 following thermomechanical processing.

Conventional twin roll casting (TRC) has shown some promise as a pathway to producing Mg sheet products, although this conventional TRC process can only be used to produce very dilute alloys, due to centre line segregation defects, which requires subsequent rolling passes to achieve the sheet thicknesses required for automotive and personnel electronics applications. At present, a majority of the research on TRC of Mg alloys concentrates on AZ31 (Mg-3Al-1Zn) alloy or other dilute Mg-based alloys that cannot be thermomechanically processed further to allow strength enhancement. Conventional TRC sheets show large anisotropies in strength both in and out of the sheet plane and in the case of AZ31, a strong basal texture that does not allow for subsequent forming operations without subjecting to elevated temperature, leading to the loss of mechanical properties.

Hence, there is a need to develop Mg alloys suited for the TRC process that may be subsequently strengthened through solute segregation or precipitation hardening to allow production of a high strength final product, while imparting a high level of ductility during processing. The low force TRC process developed within BCAST (currently optimised) allows for faster processing of TRC strip with a thinner gauge which does not require subsequent rolling steps to reduce the thickness of the sheet via rolling. ZASM1100 (Mg-1Zn-1Al-0.2Si-0.4Mn) alloy was developed as a dilute TRC alloy while AZMX1100 (Mg-1Al-1Zn-0.5Mn-0.3Ca) was developed as a possible heat treatable alloy based on previous investigations of Mg-Al-Ca system [1]. The low force TRC process combined with alloy development is used to investigate the mechanical property evolution of the ZASM1100 alloy, while the role of thermo-mechanical processing such as heat treatment in the homogenised AZMX1100 alloy is investigated.

The TRC ZASM1100 alloy showed a fine scaled microstructure (not shown here) in the as-cast and the homogenised conditions, while the mechanical properties remained similar between the two conditions, as shown in Figure 1. This alloy exhibits relatively isotropic mechanical properties in the plane of the TRC sheet both in the as-cast and the homogenised conditions which would allow for homogeneous deformation during any subsequent mechanical processing. The yield strength and ultimate tensile strength (UTS) could be further improved to ~240 MPa and ~260 MPa, respectively, following a 25 % cold rolling reduction (not shown in Figure 1). The AZM110 did not show any appreciable hardening response following homogenisation (to mimic the final structure achieved after twin roll casting and homogenisation) nor following a 5 % cold rolling reduction (pinch rolling reduction or forming operation), while the AZMX1100 alloy with 0.5wt% Ca shows an appreciable hardening response following both processing paths, as shown in Figure 2. Further investigations on the modified thermomechanical processing schedules as well as microstructure evolution and mechanical property evaluations will be conducted in the future to establish the processing/microstructure/properties relationships for this newly developed Mg-Al-Zn-Mn-Ca alloy system.

REFERENCES:

[1] J. Jayaraj, C.L. Mendis, T. Ohkubo, K. Oh-ishi and K. Hono. Enhanced precipitation hardening of Mg–Ca alloy by Al addition. *Scripta Materialia*, 63 (2010), 831-834. DOI: 10.1016/j.scriptamat.2010.06.028.

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