

Deformation behaviour of rare-earth free creep resistant magnesium alloys

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Cost effective and creep resistant magnesium alloys are exciting alternative materials for automobile powerhouse components due to their high specific strength. In this context, rare-earth-free Mg alloys with good creep resistance are the most sought after Mg-base alloys. The creep resistance of the cast magnesium alloys depends on the synergetic effect of microconstituents viz. eutectic phase, precipitates, and particles and their fraction. There have been efforts to assess the contribution of eutectic fraction and morphology to various strengthening mechanisms by experimentation and micromechanical modeling. However, the role of microconstituents on plastic deformation vis-a-vis on damage accumulation is not addressed. Therefore, the present study was taken up to understand the role of microconstituents on plastic deformation in Mg-Ca-Sn series alloys between room temperature to 175 °C ($\sim 0.5 T_m$). With this objective, a few Mg-Ca-Sn alloys were designed with and without the addition of Al and Zn to have distinct variations in the prominent and influencing microconstituents. Creep characterization of all the designed alloys was investigated at 175 °C at various stress range. Besides, compression tests were carried out at room temperature to understand the damage accumulation with strain. Post-deformation microstructural characterization at various stages of the study was carried out using SEM and TEM. Plausible plastic deformation mechanisms at room temperature as well as at high temperatures while considering the damage in cast Mg alloys was proposed.

Keywords: Magnesium alloys, Creep, Eutectic morphology, Microconstituents, Strain hardening