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Tensile creep behavior and microstructural analysis of a die-cast Mg-4Al-4RE alloy modified by Ca-substitution of half RE

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There exists a threshold stress identified as 38 MPa through the commonly adopted threshold stress approach in the studied alloy and the true stress exponent n and the activation energy Q are approximately 7 and 217 kJ/mol, respectively, under stresses of 75-110 MPa and at temperatures of 185-215°C. After creep, no discernible changes were observed on components, shapes, sizes, and distributions of the dominant phases identified as $Al_{11}RE_3$ and C36, and also the grain sizes, except that the lattice parameters of the C36 phase were decreased and numerous C15 particles precipitated in the grain interior during creep deformation. Under relatively lower stresses, the operative creep mechanism is cross-slip of <a> dislocations in ALaX422 alloy, while both cross-slip of <a> dislocations and climb of <c> and <c+a> dislocations under relatively higher stresses. Also, both twinning, precipitates of C15 phase, and twin-twin interaction of different (10.2) twin variants are closely related to the creep behavior of the studied alloy. The underlying causes of why substituting half RE of AE44 alloy with Ca resulted in significant deterioration on creep resistance but without changes on creep mechanisms, were revealed as the thermally instability of the C36 phase whose lattice parameter decrease will promote grain boundary sliding and the precipitation of the disc C15 particles which provides more interfaces that allow for basal gliding of <a> dislocations. In addition, dislocation substructure observations reveal that the rate-controlling creep mechanism is dislocation cross-slip at relatively low stresses while both dislocation cross-slip and climb at relatively high stresses.

Biography

Jian Meng has completed his PhD from Toyohashi University of Technology. He is the Professor and Director of Light Alloy Research Group, State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences. He has published more than 115 papers in reputed journals, has 36 authorized patents and has been serving as an Editorial Board Member of Journal of Rare Earths.

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