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Development of A MG-Gd-Er-Zn-Zr Alloy with Ultrahigh Strength and Ductility via Extrusion, Pre-Deformation, and Two-Stage Aging

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Abstract : Due to the great potential for weight reduction in aerospace and automotive industries, magnesium-rare earth (Mg-RE) based alloys with outstanding mechanical performance have been widely investigated for decades. However, magnesium alloys are still restricted in engineering applications because of their lower strength and ductility. Hence, there are large spaces and challenges in achieving high-performance Mg alloys. This work reports an Mg-Gd-Er-Zn-Zr alloy with ultrahigh strength and good ductility developed via hot extrusion, pre-deformation, and two-stage aging. The extruded alloy comprises fine dynamically recrystallized (DRXed) grains and coarse worked grains with a large aspect ratio. Pre-deformation has little effect on the microstructure and macro-texture and serves primarily to introduce a large number of dislocations, resulting in strain hardening and higher precipitation strengthening during subsequent aging due to more nucleation sites. As a result, the alloy exhibits a yield strength (YS) of 506 MPa, an ultimate tensile strength (UTS) of 549 MPa, and elongation (EL) of 8.2% at room temperature, showing superior strength-ductility balance than the other wrought Mg-RE alloys previously reported. The current study proposes a combination of pre-deformation and two-stage aging to further improve the mechanical properties of wrought Mg alloys for engineering applications.

Keywords : magnesium alloys, mechanical properties, microstructure, pre-deformation, two-stage aging
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