Deformation behavior of Mg-Y-Ni alloys containing LPSO phase during tension and compression through in-situ synchrotron diffraction

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Abstract

The deformation behavior of the as-extruded Mg-Y-Ni alloys with different volume fraction of long period stacking ordered (LPSO) phase during tension and compression was investigated by in-situ synchrotron diffraction. The micro-yielding, macro-yielding, tension-compression asymmetry and strain hardening behavior of the alloys were explored by combining with deformation mechanisms. The micro-yielding is dominated by basal slip of dynamic recrystallized (DRXed) grains in tension, while it is dominated by extension twinning of non-dynamic recrystallized (non-DRXed) grains in compression. At macro-yielding, the non-DRXed grains are still elastic deformed in tension and the basal slip of DRXed grains in compression are activated. Meanwhile, the LPSO phase still retains elastic deformation, but can bear more load, so the higher the volume fraction of hard LPSO phase, the higher the tensile/compressive macro-yield strength of the alloys. Benefiting from the low volume fraction of the non-DRXed grains and the delay effect of LPSO on extension twinning, the as-extruded alloys exhibit excellent tension-compression symmetry. When the volume fraction of LPSO phase reaches ∼50%, tension-compression asymmetry is reversed, which is due to the fact that the LPSO phase is stronger in compression than in tension. The tensile strain hardening behavior is dominated by dislocation slip, while the dominate mechanism for compressive strain hardening changes from twinning in the α-Mg grains to kinking of the LPSO phase with increasing volume fraction of LPSO phase. The activation of kinking leads to the constant compressive strain hardening rate of ∼2500 MPa, which is significantly higher than the tensile strain hardening rate.

Keywords: Mg alloys, LPSO phase, In, situ synchrotron diffraction, Micro, yielding, Tensile, compression asymmetry, Strain hardening

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