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Achieving room temperature superplasticity in Zn-5Al alloy at high strain rates by equal-channel angular extrusion

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Abstract

Multi-pass equal-channel angular extrusion/pressing (ECAE/P) was applied to the eutectic Zn-5Al alloy to achieve high strain-rate (HSR) superplasticity in that alloy at room temperature (RT) by producing ultrafine-grained (UFG) microstructure. ECAE processing transformed the coarse-grained lamellar/spherical microstructure into a unique bimodal structure having equiaxed Zn-rich η-phase with a mean grain size of 540 nm and spherical Al-rich α-phase with an average grain size of 110 nm. The α-phase particles accumulated mainly along the η-phase boundaries. This unique microstructure brought about an extraordinary improvement in HSR superplasticity of the alloy even at RT. While the strength values decreased after ECAE, the elongation to failure increased substantially. The maximum elongation was 520 % at the strain rate of 10^{-3} s^{-1}, still high elongation of about 400 % was achieved at a high strain rate of 10^{-2} s^{-1}. This extraordinary improvement in HSR superplasticity of Zn-5Al alloy was attributed to the morphologically unique bimodal microstructure in UFG regime formed after ECAE. The grain boundary sliding (GBS) was found to be the main deformation mechanism for this alloy in superplastic regime.

Keywords: High strain rate superplasticity; Zn-Al alloys; ultrafine-grained microstructure

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