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Effect of Cryogenic Pre-stretching on the Room Temperature Tensile Behavior of AZ61 Magnesium Alloy and Dominant Grain Growth Mechanisms During Subsequent Annealing

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Abstract : This study explored the influence of pre-stretching temperature on the microstructural characteristics and deformation behavior of AZ61 magnesium alloy and its implications on grain growth during subsequent annealing. AZ61 alloy was stretched to 5% plastic strain along rolling (RD) and transverse direction (TD) at room (RT) and cryogenic temperature (-150 oC, CT) followed by annealing at 320 oC for 1 h to investigate the twinning and dislocation evolution and its consequent effect on the flow stress, plastic strain and strain hardening rate. Compared to RT-stretched samples, significant improvement in yield stress, strain hardening rate and moderate reduction in elongation to failure were witnessed for CT-stretched samples along RD and TD. The subsequent EBSD analysis revealed the increased fraction of fine {10-12} twins and nucleation of multiple {10-12} twin variants caused by higher local stress concentration at the grain boundaries in CT-stretched samples as manifested by the kernel average misorientation. This higher twin fraction and twin-twin interaction imposed the strengthening by restricting the mean free path of dislocations, leading to higher flow stress and strain hardening rate. During annealing of the RT/CT-stretched samples, the residual strain energy and twin boundaries were decreased due to static recovery, leading to a coarse-grained twin-free microstructure. Strain induced boundary migration (SBIM) was found to be the predominant mechanism governing the grain growth during annealing via movement of high angle grain boundaries.

Keywords : magnesium, twinning, twinning variant selection, EBSD, cryogenic deformation
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