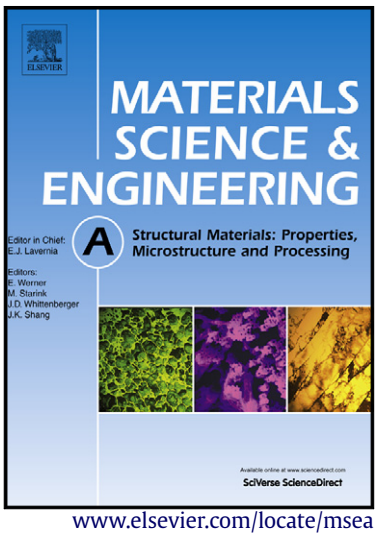

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Effect of two-pass friction stir processing on the microstructure and mechanical properties of as-cast binary Al-12Si alloy

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Abstract

The effect of two-pass friction stir processing (FSP) on the microstructural evolution, mechanical properties and impact toughness of as-cast Al-12Si alloy was investigated systematically. Severe plastic deformation imposed by FSP resulted in a considerable fragmentation of the needle-shaped eutectic silicon particles into the smaller ones. The length of eutectic Si particles decreased from 27±23 μm to about 2.6±2.4 μm. The average aspect ratio of 6.1±5.1 for eutectic Si particles in the as-cast state decreased to about 2.6±1.0 after FSP with a corresponding increase in their roundness. The hardness, strength, ductility and impact toughness of the alloy increased simultaneously after two-pass FSP. The increase in the yield and tensile strength values after FSP was about 20% and 29%, respectively. The FSPed alloy exhibited 25% elongation to failure and 15% uniform elongation which were almost seven times and five times higher, respectively, than those of the as-cast alloy. The hardness of the alloy increased from 58 Hv0.5 for the as-cast state to about 67 Hv0.5 after FSP. The absorbed energy during impact test increased to about 8.3 J/cm^2 after FSP, which is about seven times higher than that of the as-cast alloy. Improvements in all mechanical properties were mainly attributed to the radical changes of the shape, size and distribution of the eutectic silicon particles along with the breakage and refined of the large α-Al grains during two-pass FSP.

Keywords: Friction stir processing, Al-12Si alloy, microstructure, hardness, tensile properties, impact toughness.

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