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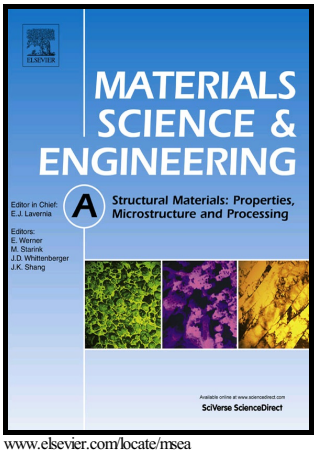

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Impact Toughness of Friction Stir Processed Low Carbon Steel Used in Shipbuilding

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Abstract

Effect of single-pass friction stir processing (FSP) on the impact toughness of a low carbon steel mainly used in shipbuilding was investigated via Charpy impact test at different temperatures, and the results were correlated with the radical microstructural alterations during processing. A fine-grained (FG) microstructure was achieved in the processed zone by both large deformation and simultaneous dynamic recrystallization of coarse-grained (CG) structure during FSP. The grain size of ferritic phase decreased from 25 μm down to about 3.0 μm after processing. This microstructural changes brought about a considerable increase in strength values of the steel with a slight decrease in its ductility values. More importantly, significant refinement in the FSPed steel increased the impact energies in the upper shelf and partially lower shelf energy regions, and it considerably decreased the ductile-to-brittle transition temperature (DBTT) from -40 °C for the CG steel to about -65 °C for the FG steel. The improvement in the impact toughness of the steel was attributed mainly to the substantial microstructural refinement with grains separated mostly by high-angle grain boundaries.

Keywords: Friction stir processing; low carbon steels; impact toughness

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