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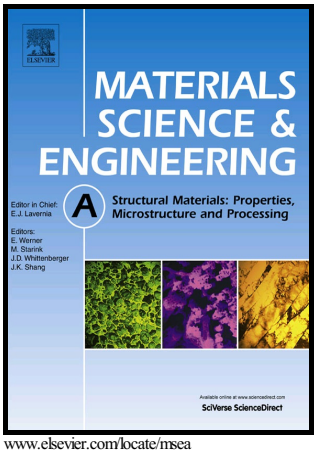

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Ductility and formability of three high-Mn TWIP steels in quasi-static and high-speed tensile and Erichsen tests

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Abstract

The ductility and formability properties of three high-Mn TWIP steels were investigated under quasi-static and high-speed deformation conditions. The ductility was evaluated from conventional and Hopkinson split-bar tensile tests at 1250 s^{-1} and the stretch formability was evaluated using Erichsen tests made with a special high-speed electro-hydraulic forming machine at about 1000 s^{-1}. The data were related to microstructural features revealed using electron backscatter diffraction and X-ray diffraction. Furthermore, the stacking fault energy (SFE) was estimated using a thermodynamic approach. It was found that the 0.6C-22Mn and 0.2C-21Mn-0.23N steels (compositions in wt. %) with SFEs of 23–24 mJ/m^2 exhibited good elongation and a large Erichsen index at both low and high strain rates. These were attributed to intensive mechanical twinning though partly replaced by dislocation slip in deformation bands in the high-speed tests. However, it was noticed that the high-speed stretching failure of these TWIP steels occurred in the uniform elongation range without diffuse necking. In the austenitic - ferritic 21Mn-3Al-3Si steel strain-induced martensite was formed, but the ferrite phase seemed to impair formability.

Keywords: High-Mn TWIP steel, split-Hopkinson tensile test, ductility, high-speed Erichsen test, stretch formability, deformation twinning.

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