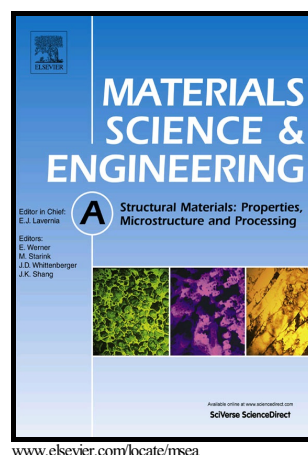


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Influence of final rolling temperature on microstructure and mechanical properties in a hot-rolled TWIP steel for cryogenic application

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Abstract

Three hot-rolled TWIP steels with different grain size were obtained by changing final rolling temperatures. The results show that the recrystallization microstructure can be obtained at the final rolling temperature range of 966 °C ~ 1083 °C and the grain size can be refined from 17.3 μm to 8.5 μm by decreasing final rolling temperature from 1083 °C to 966 °C. Moreover, the correlation between yield strength and grain size obeys Hall-Petch relation. However, surprisingly, the larger the grain size is, the higher the ultra low-temperature Charpy impact absorbed energy, and the reason may be is that the number fraction of austenite grains occupied by nano-twins formed in two or more twinning systems is relatively high for the steel with larger grain size, thereby leading to stronger dynamic grain refinement effect and heavier plastic deformation.

Keywords: TWIP steel, grain size, twinning, mechanical properties

1. Introduction

Body centered cubic (BCC) steels always exhibit a ductile–brittle transition [1-4] because of limited slip systems and single plastic deformation mechanism. Hence, in order to enhance ultra low-temperature toughness (Charpy impact toughness at -196 °C), one mode is to introduce retained austenite and 9Ni steel was widely applied in LNG (liquefied natural gas) tank building. The other one is to use face centered cubic (FCC) metals, such as aluminum alloys, austenitic stainless steels and Invar alloys [5]. However, these conventional cryogenic materials have some disadvantages, such as high cost, complex process, or manufacturing difficulties. Therefore, there is an increasing interest in high manganese austenitic twinning induced plasticity (TWIP) steels owing to their application potential in LNG tank building [6-10].

Recently, the study by Sohn et al. [7] on effects of Mn and Al contents on Charpy impact toughness in four high manganese austenitic steels shows that the formation of ε- and α-martensites in 19Mn and 22Mn steels deteriorated impact toughness whereas the martensite transformation can be effectively suppressed in Al-added steels and the high Charpy impact energy was obtained. Lee et al. [10] reported effects of Mn contents on Charpy impact toughness in Fe-Mn-Al-C steels. The 22Mn steel possessed highest Charpy impact energy at -196 °C owing to its stacking fault energy (SFE) situated in the TWIP regime. These

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