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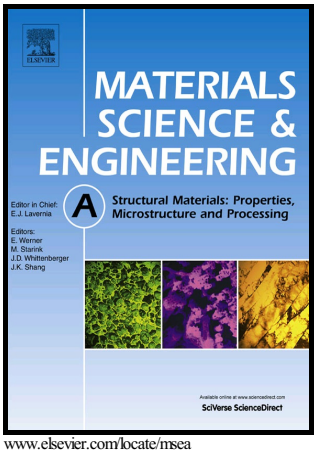

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Effect of thermal ageing on microstructure, tensile and impact properties of reduced activated ferritic-martensitic steel

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Abstract

Effects of thermal ageing on tensile and impact properties of India-specific Reduced Activated Ferritic-Martensitic (INRAFM) steel (9Cr-1.4W-0.06Ta-0.22V) have been studied by correlating with microstructure. The tempered martensitic steel received in the normalized and tempered (N&T) condition was thermally aged at 873 K for 5000 hours. Thermal ageing was found to decrease hardness and tensile strength and the decrease was accompanied with increase in ductility. The steel displayed plateaus / humps in the temperature variation of yield stress and ultimate tensile strength and dip in ductility over the range 473 – 673 K, which is considered due to the occurrence of dynamic strain ageing (DSA). The prevalence of DSA activity was found more on thermal ageing. Increase in ductile to brittle transition temperature (DBTT) and decrease in upper shelf energy (USE) of the steel were observed on thermal ageing. Detailed microscopic investigation of the steel revealed coarsening of martensitic sub-boundaries and $M_{23}C_6$ carbides along with the precipitation of Laves phase on thermal ageing. Coarsening of microstructural features on thermal ageing is considered to influence the reduction in strength and USE of the steel; whereas coarsening of $M_{23}C_6$ and precipitation of Laves phase is considered to cause the increase in DBTT. SEM fractographic study of the impact specimens revealed three distinct zones as shear lip, fibrous dimple and cleavage in an ordered away from the notch tip. With decrease in test temperature, the widths of the shear lip and fibrous dimple zones deceased whereas width of the cleavage zone increased progressively. Thermal ageing increased the widths of the shear lip and fibrous dimple zones and decreased the cleavage zone in the N&T steel at relatively higher temperatures but at lower test temperatures cleavage zone became more predominant. TEM study of the specimens extracted from the impact fractured samples at the vicinity of fracture surface, revealed substantial activity of dislocations manifested as dislocation debris in N&T

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