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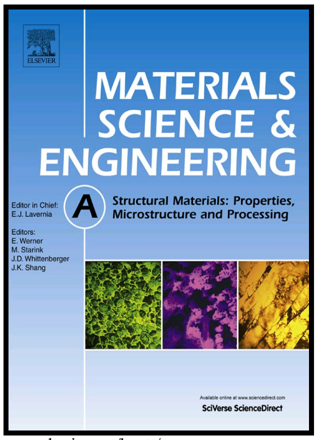

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On the origin and contribution of extended kinks and jogs and stacking fault ribbons to deformation behavior in an ultrahigh strength cobalt-free maraging steel with high density of low lattice misfit precipitates

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Abstract

We elucidate here the deformation mechanisms and underlying reasons that contributed to high ductility (10.2%) and high static toughness (112.5 MJ·m^{-3}) in an ultrahigh strength (1860 MPa) cobalt-free 19Ni3Mo1.5Ti maraging steel characterized by high density (2.3×10^{24} m^{-3}) of η-Ni_3(Ti,Mo) and B2-Ni(Mo,Fe) nanoscale precipitates with low lattice misfit of ＜1% with the martensite matrix. Multiple deformation processes occurred during plastic deformation. Lath-morphology of martensite was dramatically segmented with angles of 30^o, 60^o or 120^o with large pile-up of dislocations at the segmented boundaries. This occurred because of the interactive ability of edge and screw dislocations along the martensite habit planes, which led to kinks and jogs. The low lattice misfit (0.6% ~ 0.9%) precipitates interacted with dislocations leaving stacking fault ribbons within precipitates that build a large long range of back stress producing a high strain-hardening response. Additionally, nanoscale twinning occurred. The above contributions to ductility are envisaged to be in addition to the significantly reduced elastic interaction between the low lattice misfit nanoscale precipitates and dislocations that reduces the ability for crack initiation at the particle-matrix interface.

Keywords: ultrahigh strength steel; deformation behavior and mechanism; wavy martensite lath; dislocation mobility; nanotwins;