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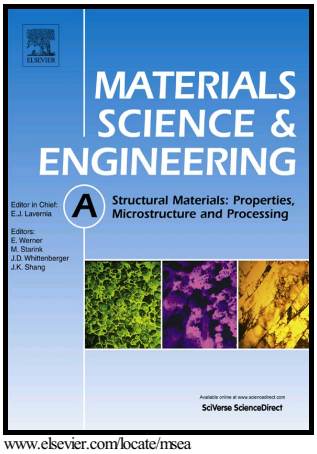

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The important role of martensite laths to fracture toughness for the ductile fracture controlled by the strain in EA4T axle steel

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Abstract

The Hall-Petch relationship was used to investigate the role of martensite lath on fracture toughness (K_{IC}) during ductile fracture in a low-carbon EA4T axle steel. The hierarchical structures of lath martensite was clarified by means of optical microscope (OM), field emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM) and electron backscattering diffraction (EBSD). Firstly, in such hierarchical structures, packet size (d_p) and block size (d_b) increase significantly with the size of prior austenite (d_r), while the martensite lath width (d_l) decreases. Subsequently, K_{IC} was measured and follows the Hall-Petch relationship with d_l. It depends on the rotation, bending and direct shear during crack propagation of laths, confirmed by EBSD. Besides, fracture toughness (K_{IC}) is proportional to a parameter ε_v, the matrix strain, which is related to the plastic deformation of laths. Therefore, the martensite lath in hierarchical structures is the effective control unit of K_{IC} during ductile fracture controlled by the strain.

***Keywords*:** EA4T axle steel; martensite; fracture toughness; effective control unit; ductile fracture.

1. Introduction.

High strength and ductile structural material are always the purpose to increase the massive savings and fulfill safety for scientists. And it is worth noting to reduce the weight and enhance the loaded capacity in usage. The strength and toughness for most steels can be simultaneously improved by grain refinement. However, the capacity of grain refinement is limited with the grain