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Fracture behaviour of HPT processed Maraging steel 250

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Maraging steels are a class of precipitation hardened steels wherein different micro-mechanisms of deformation such as planar slip, interaction with coherent/incoherent precipitates, and reverted austenite controls the overall mechanical behavior of the material. High Pressure Torsion (HPT) processing adds to this complexity by pumping in a large density of dislocations that form sub-grain boundaries and cellular structures, leading to changes in precipitate morphology and stability upon ageing. This results in a drastic change in the deformation accommodation mechanism. While these steels are known to display high fracture toughness in the hot rolled condition (hereafter referred to as: as-received), this study reports for the first time their K_{IC} values after deformation processing, including the effect of grain size refinement, dislocation density and texture induced anisotropy. To accomplish these measurements in the small volume discs that are produced by HPT, small-scale clamped beam bend geometries were utilized for the first time. K_{IC} measurements were carried out for both cases in the unaged, peak-aged and over-aged conditions. DIC strain mapping has been made use of to quantify the crack tip opening displacement and process zone evolution ahead of the crack tip. We have observed that the as-received maraging steels display crack branching at initiation that stabilizes the crack and leads to an R-curve behavior, as a consequence of slip planarity. While initiation fracture toughness of HPT processed samples are found to be lower than as-received ones, they are seen to exhibit toughening due to micro-cracking and crack deflections in the axial direction.

Keywords: Maraging steels; HPT processing; DIC strain mapping

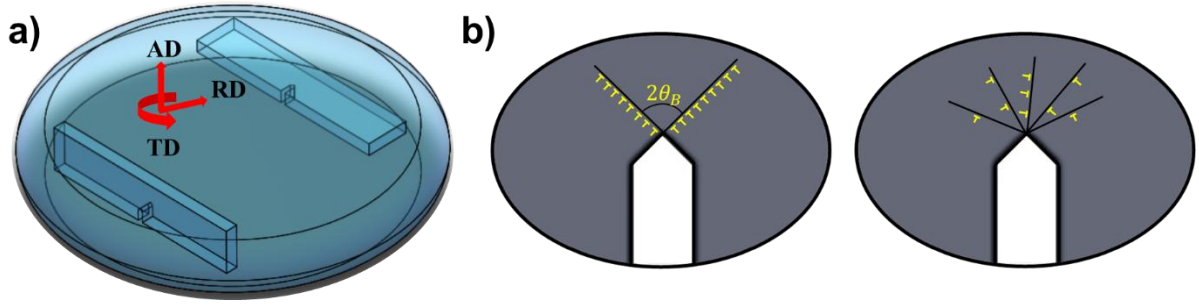

Fig.1 a) Schematic representation of different orientation available for crack propagation b) Effect of planar and wavy slip mechanism on crack propagation