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A study on the relationship between microstructure and mechanical properties of acicular ferrite and upper bainite

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Abstract

Acicular ferrite and bainite are microstructural constituents commonly found in ferritic weld metal and many other ferrous alloys, in highly localised volumes. These constituents are known to have a significant impact on the mechanical properties of the bulk material. It is well established that acicular ferrite and bainite have substantially different morphologies and features, which determine their intrinsic mechanical behaviour. This work utilises micro-testing techniques to evaluate and compare the mechanical properties of these two micro-constituents with an ultimate objective to understand their impact on bulk properties of ferrous alloys. Microscopic regions consisting of either acicular ferrite or upper bainite were first selected and then characterised using a high resolution Scanning Electron Microscope (SEM) and Electron Backscattered Diffraction (EBSD). Conventional nano-indentation and an advanced characterisation procedure were implemented to evaluate elastic modulus, yield strength, hardness and strain hardening exponent of both micro-constituents. The fracture resistance was estimated from micro-fracture tests that were conducted within these selected regions. The experimental studies have indicated that, at the micro-scale, despite their different microstructures, acicular ferrite and upper bainite have very similar mechanical properties. Nevertheless, the fracture resistance of upper bainite was more dominated by the contribution of plastic deformations.

Keywords: EBSD; mechanical characterization; nano-indentation; bainite; acicular ferrite; fracture.

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