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Improvement of Strength-Toughness Combination in Austempered Low Carbon Bainitic Steel: The Key Role of Refining Prior Austenite Grain Size

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Abstract

A low carbon bainitic steel with ultrahigh strength of ~1650 MPa and elongation and toughness of ~16% and ~72 J/cm^2 respectively, was obtained through austempering. The resulting microstructure and mechanical properties for varying prior austenite grain size (PAGS) are described. The refinement of the PAGS resulted in finer packet/block size, higher volume fraction and higher stability of retained austenite. The coalescence of bainitic laths was effectively hindered when the prior austenite grain size (PAGS) was refined to ~10 μm. On the other hand, the coalescence of bainitic laths with crystallographically homogeneous characteristic was accompanied by disappearance of film-like retained austenite and crack can propagate without inhibition, which is detrimental to toughness. Eliminating the coalescence of bainite and increasing the volume fraction of retained austenite and its stability by means of refining PAGS contributed to ultrahigh strength – high ductility and toughness combination.

Keywords: bainitic steel; austempering; strength-toughness combination; coalescence; prior austenite grain size

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