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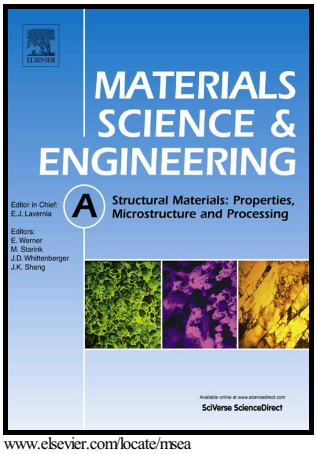

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ABSTRACT

A sufficient level of toughness at low temperatures is paramount for the use of structural steels intended for arctic applications. Therefore, it is important for the steel industry to identify the factors that control brittle fracture toughness. In this study, the quantitative effect of microstructure on the impact toughness transition temperature has been investigated with 18 different thermomechanically rolled and direct-quenched low-carbon ultra-high-strength steels with varying martensite and bainite contents. The steels were produced by altering their chemical composition, the finish rolling temperature and the total reduction of the prior austenite grains in the non-recrystallisation temperature regime, i.e. austenite pancaking, and characterised in terms of microstructural constituents, grain size distributions and texture as well as by using Charpy-V impact and tensile testing. It is shown for the first time that the impact toughness transition temperatures T_{28J} and T_{50} closely follow a *dynamic reference toughness*, defined by yield strength and the size of the coarsest grains in the effective grain size distribution at 80th percentile. Decreasing the area fraction of {100} cleavage planes oriented within 15 ° of the macroscopic fracture plane by increasing austenite pancaking is also shown to improve T_{28J}. The best toughness is achieved with the lowest finish rolling temperatures that are nevertheless high enough to avoid the subsequent formation of granular bainite, which weakens both the toughness and strength. The results show that it is perfectly possible to produce untempered ultra-high-strength martensitic and martensitic-bainitic