Liu M., Degen C., and Wang Y.Y., Ota S., Shimamura J., Yasuda K., Ishikawa N., "Multi-scale ductile fracture modeling for dual-phase high strength steel - part 2: damage mechanics analysis on Charpy impact toughness of dual-phase high strength steel," Materials Science & Technology 2015, October 4-8, 2015, Columbus, OH, USA.

Abstract

For pipelines that traverse remote areas of potential ground movement, it is desirable to have high strength linepipes with excellent deformability and high toughness to arrest running ductile fracture. Dual-phase steel is a good candidate for meeting both requirements. This is the second paper in a two-paper series for investigating the effect of Bainite-MA dual phase microstructures on Charpy impact energy. In the first paper, detailed experimental characterization of the effect of the microstructure on the mechanical properties of the dual-phase steel was conducted. In this paper, the Gurson-Tvergaard-Needleman (GTN) model, a damage-mechanics-based finite element method was used to simulate the Charpy impact test. The focus was given to quantifying the void evolution processes and precisely determining the physical values of GTN parameters from direct measurement of the void volume fraction. The simulated Charpy test results matched the actual test results very well which demonstrates that the GTN model is a viable tool for predicting the Charpy impact test and therefore the Charpy energy.

Keywords

Bainite, MA, Dual-phase steel, Stress-strain curve, Y/T ratio, Charpy energy, Ductile crack initiation, Void nucleation and growth, Damage mechanics, Finite element analysis, GTN models