Gradient Structure of Microalloyed Steel produces superior Mechanical Behavior under Dynamic Loading

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Abstract

The ultrafine-grained (UFG) and bimodal structures produced by an advanced thermomechanical processing, namely rolling, in microalloyed steel were subjected to the dynamic compression tests. It has been shown that these gradient-structured steels have many superior dynamic properties over homogeneous counterparts. Applied schedules of the thermomechanical processing allow produce UFG microstructures with high inhomogeneity in the final products. The dynamic work-hardening behavior of produced in such way specimens has been study as a function of solute atoms and fine-scale, second-phase particles. The substantial complexity of the phenomena, which occur through the evolution of microstructure and texture in response to the dynamic loadings, presents formidable challenges to theoretical model development of plastic deformation of UFG and bimodal-structures. The gradient structure was found to delay the nucleation of stress concentrations at the polygonal ferrite-to-bainite or martensite boundaries and to reduce the propagation of dynamic loading induced cracks by an order of magnitude as compared with homogeneous structures. The presented findings may provide insights for designing impact-tolerant gradient structures with excellent dynamic properties.