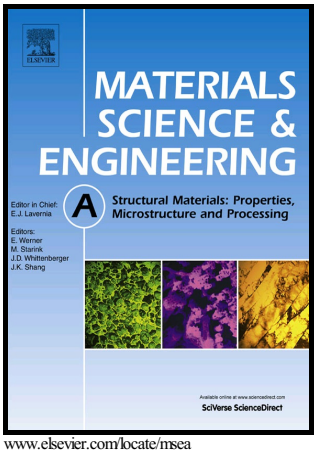
Twin Nucleation in Cold Rolled Low Carbon Steel Subjected to Plate Impacts

W. Visser, H. Ghonem



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Twin Nucleation in Cold Rolled Low Carbon Steel Subjected to Plate Impacts

W. Visser, H. Ghonem*
Mechanics of Materials Research Laboratory, Department of Mechanical, Industrial and Systems Engineering, University of Rhode Island, Kingston, RI 02881 USA

*Distinguished Professor of Engineering, , 401-874-2909. ghonem@uri.edu

Abstract

Shock loading tests have been carried out on low carbon steel specimens using a single stage gas gun with projectile velocities ranging from 200 to 800 m/sec. In addition to dislocation slip, twinning was observed to be a contributing deformation mode. Similar impact tests were performed on specimens that have been previously subjected to cold rolling and it was shown that pre-straining increases the threshold stress for twin formation under shock loading. Efforts are made to determine the critical stress and strain rate required for twinning in cold rolled specimens. For this purpose a set of compression tests were performed on as-received and pre-strained specimens using a split Hopkinson pressure bar at various strain rates. These tests were carried out at liquid nitrogen temperatures where the thermal activation of dislocations is assumed to be higher than that for twin nucleation. Results of these tests are combined with FE analysis to provide knowledge of the twin stress as a function of pre-strain and strain rate. In addition, post-impact specimens were examined to identify characteristics of the deformation induced twins. It is shown that more than one {112} <111> type twin system is active at high stress levels as evident by the non-parallel nature of twins formed at the higher impact pressures. This observation was incorporated into a constitutive model based on one dimensional wave and conservation equations for predicting twin volume fraction by resolving the shear stress in multiple directions and applying twin growth equations for each plane. Results of this model