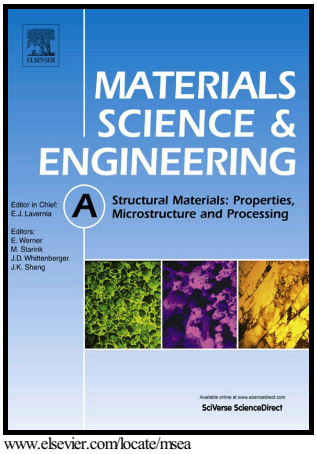
Dynamic mechanical behaviors and failure thresholds of ultra-high strength low-alloy steel under strain rate 0.001/s to 10^6/s

Jie Ren, Yuxin Xu, Xiaoxu Zhao, Pengduo Zhao



www.elsevier.com/locate/msea

PII: S0921-5093(18)30204-1
DOI: https://doi.org/10.1016/j.msea.2018.02.019
Reference: MSA36106

To appear in: *Materials Science & Engineering A*

Received date: 20 November 2017
Revised date: 3 February 2018
Accepted date: 5 February 2018

Cite this article as: Jie Ren, Yuxin Xu, Xiaoxu Zhao and Pengduo Zhao, Dynamic mechanical behaviors and failure thresholds of ultra-high strength low-alloy steel under strain rate 0.001/s to 10^6/s, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.02.019

Dynamic mechanical behaviors and failure thresholds of ultra-high strength low-alloy steel under strain rate 0.001/s to 10^6/s

Jie Ren[a], Yuxin Xu[a,*], Xiaoxu Zhao[a,b], Pengduo Zhao[c]

[a]*State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, 100081, P.R. China*

[b]*College of Information Engineering, Capital Normal University, Beijing, 100048, P.R. China*

[c]*Naval Academy of Armament, Beijing 100161, P. R. China*

[*]Corresponding author. Tel.: +86 010 68914557. E-mail address: xuyuxin@bit.edu.cn

Abstract

In this study, the dynamic mechanical behaviors of the typical ultra-high strength low-alloy martensite steel 35CrMnSiA under strain rate 0.001/s～10^6/s were studied through quasi-static compressive tests (0.001/s), SHPB tests (2000/s～5000/s) and planar plate impact tests together with DISAR tests (10^5/s～10^6/s). The XRD analysis and metallographic observation were conducted to investigate the microstructure evolutions and failure mechanism of 35CrMnSiA under different stress states. Under uniaxial stress state, the adiabatic shear failure occurs as long as the rise rate of plastic strain energy density reaches 10.58×10^6 J·m^{-3}· μs^{-1} and the plastic strain energy density is above 4.51×10^8 J·m^{-3}. For 35CrMnSiA samples under uniaxial strain state, the critical pressure for reversible phase transformation ($\alpha \rightarrow \varepsilon$, BCC→HCP) falls in the range of 17.57GPa to 19.19GPa. Characterized by prominent temperature rise and volume shrinkage, the $\alpha \rightarrow \varepsilon$ phase transformation induced by continuous dynamic recrystallization contributed to increasing the strength but weakening the ductility of 35CrMnSiA. In addition, the Hugoniot coefficients for 35CrMnSiA under a wide range of pressures have been determined. Moreover, the failure thresholds for 35CrMnSiA were obtained by dynamic fracture experiments and high velocity impact experiments: 35CrMnSiA projectiles fractured over impact pressure of 2.59GPa, and when the impact pressure exceeded 21.25GPa above which 35CrMnSiA suffered phase transformation, the projectiles had severe mass abrasion.