Impact resistance of high-entropy alloys

Zezhou Li, Shiteng Zhao, Senhat Alotaibi, Marc Meyers
Bingfeng Wang, Yong Liu, Haoyan Diao, Peter Liaw
University of California, San Diego
Central South University
The University of Tennessee, Knoxville

Impact resistance of the CrMnFeCoNi high-entropy alloy

Summary

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

Acknowledgements

Dynamic testing

Introduction and Objectives

Microstructure

Impact resistance of the Al_{0.3}CoCrFeNi high-entropy alloy

Dislocation Generation (10^{4} s^{-1})

Entangled dislocations and deformation twins (1800 s^{-1})

The combination of multiple strengthening mechanisms such as solid-solution hardening, forest dislocation hardening (Figs. 2(a) and 2(b)), as well as mechanical twinning (Figs. 2(c)) leads to a high work-hardening rate in this alloy. No adiabatic shear band could be observed at a shear strain ~1.1 as depicted in Fig. 2(d). Figs. 2(e) and 2(f) show the formation of profuse mechanical twins near the inserted tip in the hat-shaped specimen, indicating twinning-induced continuous strain-hardening, which suppresses shear localization in competition with the thermal softening effect.

Deformed specimens

Continuous deformation-twinning hardening near the inserted tip

Dislocation Generation (10^{4} s^{-1})

Entangled dislocations and deformation twins (1800 s^{-1})

The combination of multiple strengthening mechanisms such as solid-solution hardening, forest dislocation hardening (Figs. 2(a) and 2(b)), as well as mechanical twinning (Figs. 2(c)) leads to a high work-hardening rate in this alloy. No adiabatic shear band could be observed at a shear strain ~1.1 as depicted in Fig. 2(d). Figs. 2(e) and 2(f) show the formation of profuse mechanical twins near the inserted tip in the hat-shaped specimen, indicating twinning-induced continuous strain-hardening, which suppresses shear localization in competition with the thermal softening effect.

The combination of excellent strain-hardening ability and modest thermal softening gives rise to remarkable resistance to shear localization, which makes fcc HEAs an excellent candidate for impact resistance applications.

Acknowledgements

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

Impact resistance of high-entropy alloys

Zezhou Li, Shiteng Zhao, Senhat Alotaibi, Marc Meyers
Bingfeng Wang, Yong Liu, Haoyan Diao, Peter Liaw
University of California, San Diego
Central South University
The University of Tennessee, Knoxville

Impact resistance of the Al_{0.3}CoCrFeNi high-entropy alloy

Dislocation Generation (10^{4} s^{-1})

Entangled dislocations and deformation twins (1800 s^{-1})

The combination of multiple strengthening mechanisms such as solid-solution hardening, forest dislocation hardening (Figs. 2(a) and 2(b)), as well as mechanical twinning (Figs. 2(c)) leads to a high work-hardening rate in this alloy. No adiabatic shear band could be observed at a shear strain ~1.1 as depicted in Fig. 2(d). Figs. 2(e) and 2(f) show the formation of profuse mechanical twins near the inserted tip in the hat-shaped specimen, indicating twinning-induced continuous strain-hardening, which suppresses shear localization in competition with the thermal softening effect.

Dislocations Generation (10^{4} s^{-1})

Entangled dislocations and deformation twins (1800 s^{-1})

The combination of multiple strengthening mechanisms such as solid-solution hardening, forest dislocation hardening (Figs. 2(a) and 2(b)), as well as mechanical twinning (Figs. 2(c)) leads to a high work-hardening rate in this alloy. No adiabatic shear band could be observed at a shear strain ~1.1 as depicted in Fig. 2(d). Figs. 2(e) and 2(f) show the formation of profuse mechanical twins near the inserted tip in the hat-shaped specimen, indicating twinning-induced continuous strain-hardening, which suppresses shear localization in competition with the thermal softening effect.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

Acknowledgements

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.

We thank the Department of Energy NNSA/SSAP (DE-NA0002080) for partial support and a UC Research Laboratories Grant (09-LR-06-118456-MEYM). Support of Zezhou Li by China-Scholarship-Council (201508020004) was greatly acknowledged.