Accepted Manuscript

High-pressure high-temperature tailoring of High Entropy Alloys for extreme environments

Kirill V. Yusenko, Sephira Riva, Wilson A. Crichton, Kristina Spektor, Elena Bykova, Anna Pakhomova, Adam Tudball, Ilya Kupenko, Arno Rohrbach, Stephan Klemme, Francesco Mazzali, Serena Margadonna, Nicholas P. Lavery, Stephen G.R. Brown

PII: S0925-8388(17)34412-2

DOI: 10.1016/j.jallcom.2017.12.216

Reference: JALCOM 44302

To appear in: *Journal of Alloys and Compounds*

Received Date: 23 September 2017

Revised Date: 6 December 2017

Accepted Date: 19 December 2017

Please cite this article as: K.V. Yusenko, S. Riva, W.A. Crichton, K. Spektor, E. Bykova, A. Pakhomova, A. Tudball, I. Kupenko, A. Rohrbach, S. Klemme, F. Mazzali, S. Margadonna, N.P. Lavery, S.G.R. Brown, High-pressure high-temperature tailoring of High Entropy Alloys for extreme environments, *Journal of Alloys and Compounds* (2018), doi: 10.1016/j.jallcom.2017.12.216.

High-Pressure High-Temperature tailoring of High Entropy Alloys for extreme environments

Kirill V. Yusenko,[1,2*] Sephira Riva,[1] Wilson A. Crichton,[3] Kristina Spektor,[3] Elena Bykova,[4] Anna Pakhomova,[4] Adam Tudball,[5] Ilya Kupenko,[6] Arno Rohrbach,[6] Stephan Klemme,[6] Francesco Mazzali,[1] Serena Margadonna,[1] Nicholas P. Lavery,[1] Stephen G.R. Brown[1]

[1]College of Engineering, Swansea University, Bay Campus, Swansea SA1 8EN, Wales, UK

[2]Institute of Solid State Chemistry, Pervomaiskaia str. 91, 620990 Ekaterinburg, Russia

[3]ESRF – The European Synchrotron, 71 Avenue des Martyrs, 38000, Grenoble, France

[4]Photon Sciences, Deutsches Elektronen-Synchrotron, Notkestrasse 85, D-22607 Hamburg, Germany

[5]Kennametal Manufacturing (UK) Ltd., Lake Road, Leeway Industrial Estate, Newport NP19 4SR, Wales, UK

[6]Institut für Mineralogie, Westfälische-Wilhelms-Universität Münster, Corrensstrasse 24, 48149 Münster, Germany

*E-mail address: k.yusenko@swansea.ac.uk

Abstract

The exceptional performance of some High Entropy Alloys (HEAs) under extreme conditions holds out the possibility of new and exciting materials for engineers to exploit in future applications. In this work, instead of focusing solely on the effects of high temperature on HEAs, the effects of combined high temperature and high pressure were observed. Phase transformations occurring in a pristine HEA, the as-cast *bcc*–Al_2CoCrFeNi, are heavily influenced by temperature, pressure, and by scandium additions. As-cast *bcc*–Al_2CoCrFeNi and *fcc*–$Al_{0.3}$CoCrFeNi HEAs are structurally stable below 60 GPa and do not undergo phase transitions. Addition of scandium to *bcc*–Al_2CoCrFeNi results in the precipitation of hexagonal AlSc*M* intermetallic (*W*-phase), which dissolves in the matrix after high-pressure high-temperature treatment. Addition of scandium and high-pressure sintering improve hardness and thermal stability of well-investigated *fcc*- and *bcc*-HEAs. The dissolution of the intermetallic in the main phase at high pressure suggests a new strategy in the design and optimization of HEAs.

Keywords: High-Entropy Alloys; Scandium; High-pressure high-temperature sintering; Spark plasma sintering; *In situ* X-ray diffraction