doi:10.1017/S143192762100146X
Microsc. Microanal. 27 (Suppl 1), 2021

In-Situ TEM Studies of High Entropy Alloy Nanoparticles Under Gas/Liquid Environment

Reza Shahbazian-Yassar

University of Illinois at Chicago, Chicago, Illinois, United States

High entropy materials are emerging materials with significant increase in their configurational entropy making them very stable in extreme service conditions. In spite of such tremendous potential, it is not clear how these materials behave under reactive gaseous or liquid environment and/or at elevated temperatures. This presentation will summarize the recent efforts of this PI and the team of his collaborators on nanoscale dynamic imaging of high entropy nanoparticles under high temperatures, oxidative, and reductive gases.

Initially, we studied the behavior of $Fe_{0.28}Co_{0.21}Ni_{0.20}Cu_{0.08}Pt_{0.23}$HEA nanoparticles (NPs) in air environment by *in situ* gas-cell TEM. We found that the oxidation of HEA NPs is governed by Kirkendall effects where the oxidation rate is significantly lower than monometallic or binary alloys. Interestingly, oxidation drives surface segregation of Fe, Co, Ni, and Cu, while Pt stays in the core region.

In another in-situ gas-cell TEM study, we investigated the behavior of high entropy alloy nanoparticles under hydrogen (H_2) environment. It was noticed that the reduction reaction front was at the external surface of the oxide layer that was present on the surface of high entropy nanoparticles. During reduction, the oxide layer enlarged and transitioned into porous structures. Interestingly, the oxidized Cu was completely reduced to Cu nanoparticles while Fe, Co, and Ni remained in the oxidized state. *In situ* EELS analysis showed that the expansion of oxide layer resulted from the outward diffusion of Fe, Co, Ni and Cu elements.

Revealing the oxidative and reductive behavior of HEA NPs facilitates the development of advanced multicomponent alloys for applications targeting structural alloys, high temperature materials, corrosion-resistive materials, hydrogen embrittlement protection, and catalytic oxidation or hydrogenation. These studies are utmost importance for the promising applications of high entropy materials in catalysis, electronics, structural mechanics, and energy storage.

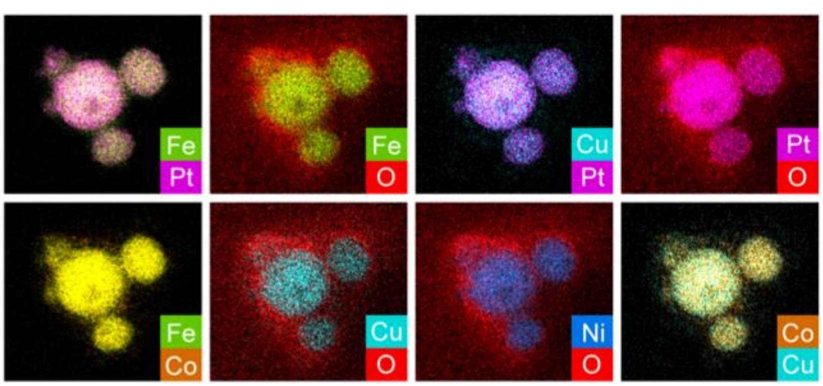

Figure 2. The STEM-EDS maps showing the oxidation of high entropy alloy nanoparticles.

References

The author acknowledges the financial support from National Science Foundation DMR-1809439.

https://doi.org/10.1017/S143192762100146X Published online by Cambridge University Press