Atomic-scale observation of oxidation and decomposition processes in nanocrystalline alloys via in-situ heating

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Nanocrystalline metals are drawing considerable attention nowadays because of their superior performance, and the efficient approaches for generating applicable bulk alloys by severe plastic deformation. Nevertheless, thermal instability is the main drawback which restricts their applications at elevated temperatures. In addition, oxygen contamination is an issue which inevitably occurs during severe plastic deformation of metallic powders by exposure to air. This contamination can change the morphology and properties of the consolidated materials. However, a detailed information about the thermal behavior of oxygen in nanocrystalline alloys is still lacking. In this study, we employ the aberration-corrected high-resolution transmission electron microscopy, electron diffraction and associated techniques to investigate the thermal stability during *in-situ* heating of highly-strained Cu-Fe alloys, which are generated from blended powders. Contrary to expectations, some oxides are observed to form inside the grains prior to the decomposition of the metastable Cu-Fe solid solution. This oxide formation commences at relatively low temperatures, generating nano-sized clusters of firstly CuO and later Fe_2O_3. The orientation relationship between these clusters and the matrix is different from that observed in conventional steels. These findings provide a direct observation of oxide formation in single-phase Cu-Fe composites and pose a pathway for the design of nanocrystalline materials strengthened by oxide dispersions.

Reference

J. Guo, G. Haberfehlner, J. Rosalie, L. Li, M.J. Duarte, G. Dehm, G. Kothleitner, Y. He, R. Pippan, Z. Zhang, *In-situ atomic-scale observation of oxidation and decomposition processes in nanocrystalline alloys*, Nature Communications, accepted, in press.