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A high-entropy alloy with ultrahigh ductility breaks strength-ductility paradox

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For thousands of years, human beings have been searching and preparing strong and ductile materials. However, strength and ductility of a material are generally mutually exclusive. This is the well-known strength-ductility paradox, which exists for centuries. The underlying mechanism for the strength-ductility paradox of metals and alloys is dislocation-slip dominated plastic deformation, which could be traced back to 1930's. Here, by means of alloying designation, we developed a new face-centered cubic (FCC) high entropy alloy (HEA) NiCoFeVMo with unique {111}<110> slip features including short slip distance, low mobile dislocation exhaustion rate, dynamic nucleation, homogeneous distribution of high-density dislocations and nano-scale planar slip lamella. These unique deformation mechanisms break the strength-ductility paradox by a super combination of an ultra-high tensile ductility of 90% (36% for coarse-grained Ni) and an ultimate tensile strength of 980 MPa (346 MPa for Ni). First principles calculation revealed that the unstable stacking fault energy, i.e. {111}<110> slip potential barrier of the HEA varies continuously from 830 to 1200 mJ/m^2, different from the unique value of 977 mJ/m^2 for Ni. The variable slip potential barriers result in the above unique HEA slip features. Our work explores a new concept for designing both strong and ductile alloys by actuating new slip features.

Biography

Yonghao Zhao has completed his PhD from Institute of Metal Research, Chinese Academy of Sciences. He did research at Max Planck Institute for Metal Research, Germany, Los Alamos National Lab and University of California at Davis. After that, he became the Deputy Director of Nanostructural Materials Reseach Center, School of Materials Science and Engineering, Nanjing University of Science and Technology. He has published more than 100 papers in reputed journals and his papers have been cited over 5000 times.

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