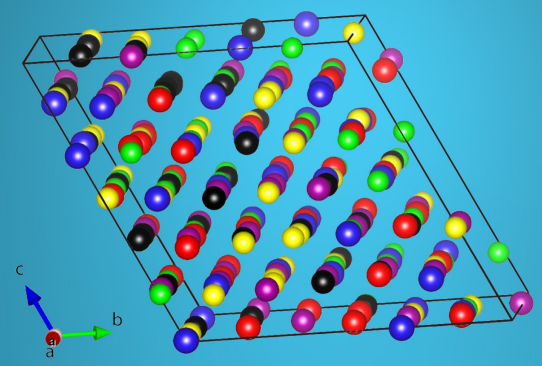
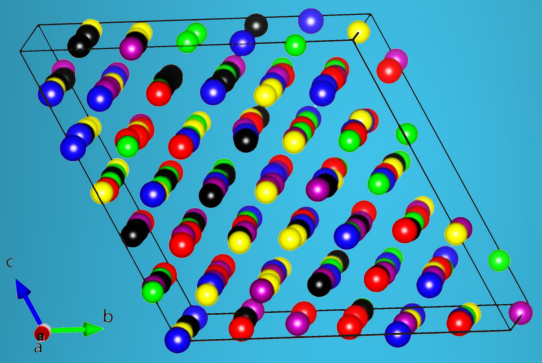
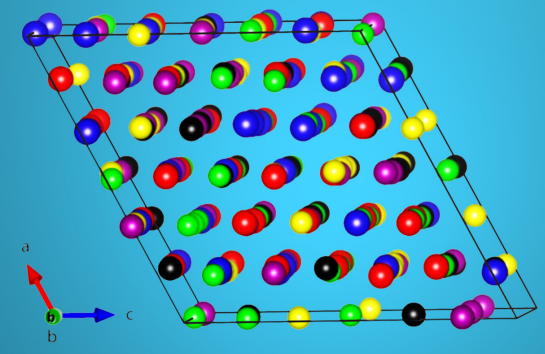
Technology Transfer

Success Story







Atomic Structure of AlCrFeMnTiV

Novel High-Entropy Alloys for High Temperature Applications

Opportunity

Research is currently active on the patent pending technology titled, "High Performance Light-Weight High-Entropy Alloys." This technology is available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.

Overview

Conventional alloys are based on one principal element with different kinds of alloys added to optimize functional characteristics. Existing alloy families are vulnerable to degradation in high temperature and pressure environments. There is an urgent need to develop cost effective materials with significantly improved mechanical and thermal properties.

High-entropy alloys (HEA) are defined as alloys with five or more principle elements in equal or near equal atomic percent. Due to their unique multi-principal element makeup, HEAs exhibit unique and different properties when compared to traditional alloys, including, and depending upon the alloy element constituents, increased strength, wear-resistance, and corrosion- and oxidation-resistance.

This invention describes the design of new lighter-weight, high-entropy alloy formulations in body-centered cubic structure. The densities of the new alloys have been specifically optimized for use in a variety of applications. The design is based on quantum mechanics simulations and CALPHAD methods for formulations composed of the multi-principal elements of Al, Cr, Fe, Mn, Ti and V in equi-atomic or slightly non-equi-atomic ratios, with and without other strength producing secondary phases. The new alloy formulations are lower in density but higher strength than Fe-containing alloys while maintaining similar intrinsic ductility. These alloys have better mechanical properties as well as superior oxidation resistance as compared to conventional lighter weight commercial alloys.

(continued)

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Significance

- Superior performance relative to conventional alloys including toughness, strength, and oxidative resistance.
- Slow diffusion and low thermal conductivity make the alloys suitable for a variety of heat resistant applications.
- Chemistry can be tailored for enhancement of specific alloy properties, including density.
- Fabrication does not require special processing techniques or equipment.

Applications

- Elevated temperature structural materials.
- Diffusion barrier and thermal barrier coatings.
- Other applications where heat and oxidative-resistant alloys are required.

Related Patents

A U.S. Provisional Patent Application **No. 62/108,566** filed January 9, 2015 titled "High Performance Light-Weight High-Entropy Alloys." Inventors: Jeffrey Hawk, David E. Alman, and Michael C. Gao

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