FRAUNHOFER INSTITUTE FOR MATERIAL AND BEAM TECHNOLOGY IWS

PRESS RELEASE

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Save the date

IWS @formnext: »High entropy alloys for Additive Manufacturing«

11/21/2019
2:15 p.m.

@TCT Introducing Stage

High entropy alloys for hot turbines and tireless metal-forming presses

Symposium in Dresden focuses on a new class of materials

(Dresden, November 5, 2019) A new class of materials promises many innovations in aviation, turbine construction and other branches of industry: High entropy alloys (HEA) are metals in which five or more elements are atomically bonded in similar proportions. Properly designed, they are harder, more heat-resistant and lighter than steel, aluminum and other classic materials. For about 15 years, engineers around the world have been trying to make these innovative materials ready for series production. But high-entropy alloys are still too expensive and difficult to process. The Fraunhofer Institute for Material and Beam Technology IWS Dresden is therefore now inviting experts to a symposium in March 2020 to demonstrate how they can overcome these problems – for example through industrial 3D printing, in other words "Additive Manufacturing". Fraunhofer IWS will give a first insight with the lecture "High entropy alloys for Additive Manufacturing" on November 21, 2019, 2:15 p.m. at the "TCT Introducing Stage" during the "Formnext" trade fair in Frankfurt am Main, Germany.

The new conference format is called "1st HEA Symposium: Potentials for industrial application". Prof. Christoph Leyens, head of the Fraunhofer Institute for Material and Beam Technology IWS and director of the Institute for Materials Science at the Technical University of Dresden, explains: "We want to connect basic researchers and users. Because we keep noticing that many companies are not even aware of this new class of materials. High entropy alloys have great economic and technological potential." Classical alloys such as steel have been known since ancient times and produced industrially for over 150 years. In addition to iron, steel contains small amounts of carbon, manganese, nickel, vanadium and other elements. These tiny admixtures influence the hardness, elasticity, forgeability and other properties of steel.

Quintet of elements

High entropy alloys, on the other hand, have only been in the research and engineering focus since 2004. They consist of at least five different components, each in high proportions. These can be aluminium, titanium, iron, chromium or nickel, for example,

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but also completely different elements, also in combination with nitrogen or carbon – then ceramics are produced. “Some of these alloys, consisting of elements such as aluminum, titanium, niobium, hafnium and vanadium, are suitable high-temperature materials for turbines,” says organizer of HEA Symposium, Dr. Jörg Kaspar, who heads the research group for Materials and Failure Analysis at IWS. “This enables more efficient power plants and aircrafts to be designed that consume less gas or fuel. Other compounds are more suitable for lightweight construction”. Ceramic HEA coatings would also make the enormous sheet metal forming tools in the automotive industry more resistant to wear and heat.

Manual brewery would take thousands of years

However, there are still some technological problems to be solved before such alloys become suitable for mass production - and this is where the expertise of IWS researchers comes into play. “High entropy alloys are conceivable in many variations,” explains Jörg Kaspar. “Anyone who wanted to test them all individually would need several thousand years to do so.” The Dresden-based Fraunhofer analysts have therefore further developed methods to quickly produce samples from various HEA compositions and automatically determine hardness, strength and other properties. This is made possible by “additive production facilities” that transport their HEA ingredients from several containers with iron, chromium, nickel and other elementary powders. A laser melts these substances and carries the desired mixture onto a sample plate. The machine then takes, for example, less iron and more chromium for the next sample, tests the influence on the hardness of the new HEA, and subsequently varies the recipe again. The system changes the composition in the following steps until the test series is completed. IWS engineers draw on profound experience with these and other HEA technologies: They also master materials that are difficult to process, which otherwise become brittle and susceptible to cracking at room temperature and air influences, in high quality. In addition, they contribute their expertise in the use of various additive manufacturing processes: These include laser metal deposition systems that expect ingredients in form of powders or wire, but also metal printers or systems that shape metal alloys using polymer support structures. “Many institutes and companies around the world are working on high-temperature alloys. But in this technological depth like ours, not many can. Especially in HEA processing using additive manufacturing methods, I see ourselves ahead,” summarizes Jörg Kaspar.

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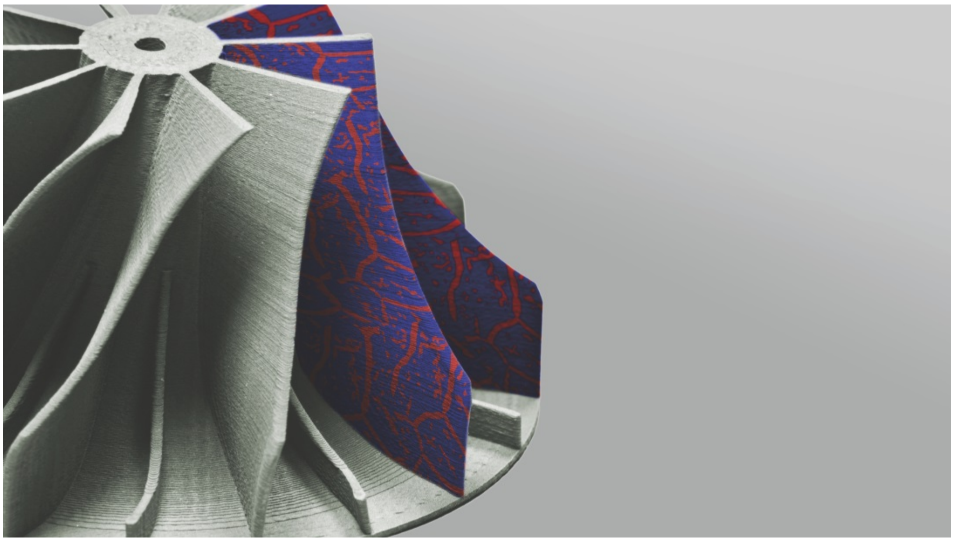
Save the date: HEA-SYMPOSIUM

Fraunhofer IWS organizes the **"1st HEA Symposium for High Entropy Alloys: Potentials for Industrial Application"** in Dresden on March 12 and 13, 2019.

More info: https://www.iws.fraunhofer.de/hel-symposium



For the first time, scientists at Fraunhofer IWS printed 3D high-entropy demonstrator structures made of the Cantor alloy "CrMnFeCoNi" using the Fused Filament Fabrication (FFF) process. On the surface, the illustration shows an example of a particularly high-strength microstructure consisting of two phases as a planned further alloy system development.
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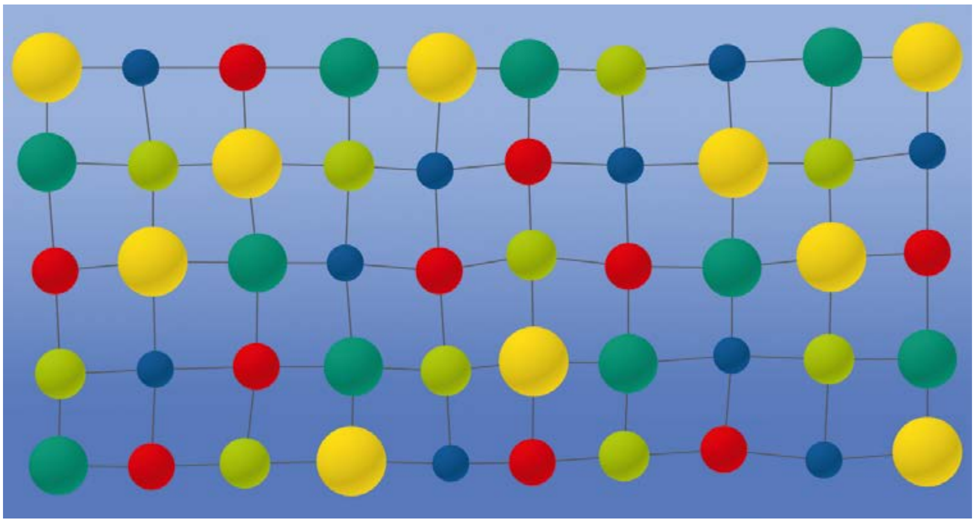

Schematic representation of the disordered atomic lattice structure of a HEA: Different sizes and colors represent different types of atoms. Their different sizes cause strong lattice distortions and thus allow both high strength and high thermal stability.
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The **Fraunhofer Institute for Material and Beam Technology IWS Dresden** stands for innovations in laser and surface technology. As an institute of the Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V., IWS offers one stop solutions ranging from the development of new processes to implementation into production up to application-oriented support. The fields of systems technology and process simulation complement the core competencies. The business fields of Fraunhofer IWS include PVD and nanotechnology, chemical surface technology, thermal surface technology, generation and printing, joining, laser ablation and separation as well as microtechnology. The competence field of material characterization and testing supports the research activities.
At Westsächsische Hochschule Zwickau, IWS runs the Fraunhofer Application Center for Optical Metrology and Surface Technologies AZOM. The Fraunhofer project group at the Dortmunder OberflächenCentrum DOC® is also integrated into the Dresden Institute. The main cooperation partners in the USA include the Center for Coatings and Diamond Technologies (CCD) at Michigan State University in East Lansing and the Center for Laser Applications (CLA) in Plymouth, Michigan. Fraunhofer IWS employs around 450 people at its headquarters in Dresden.