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TSP-1 Enhanced Hardening and Damage-tolerance Nanotwinned Medium Entropy Alloy CoCrNi Coatings Deposited by Magnetron Sputtering, ***Fuyang Cao**, P Munroe,* University of New South Wales, Australia*; Z Zhou,* City University of Hong Kong, China, Hong Kong*; Z Xie,* University of Adelaide, Australia

High entropy alloys (HEA) are defined as alloys consisting of at least five or more equiatomic elements, such as FeNiCoCrMn, commonly with a single FCC (or BCC) crystal structure. HEAs are reported to have promising mechanical properties, high thermodynamic stability, as well as excellent fracture toughness at cryogenic temperature. Herein we have investigated a series of equiatomic medium entropy alloy coatings, containing only three elements, Co, Cr, Ni. These coatings were deposited onto M2 steel substrates using a DC magnetron sputtering system with a CoCrNi alloy target (1:1:1 at.%). The microstructure and mechanical properties were examined by a number of techniques, including transmission electron microscopy (TEM) and nanoindentation. TEM results showed that the coatings were composed of elongated grains containing fcc {111} nanotwins. Such coatings exhibited a very high hardness, ~10 GPa as well as exceptional damage-tolerance under contact loading. It is believed that the nanotwinned structure is responsible for the high hardness and damage tolerance in these coatings.

TSP-4 Hvof Coatings Modified With Polymers To Reduce Ice Accretion For Use In Aerostructures Components, ***Raúl Muelas Gamo**, A Agüero Bruna, J Mora Nogues, P García Gallego,* Instituto Nacional de Técnica Aeroespacial (INTA), Spain

Accretion of ice on aerostructures affects airplanes as well as rotorcraft as it constitutes a severe security issue and requires certified anti-icing technologies. Moreover, icing increases the aerodynamic drag on an aircraft and thus increase fuel burn. Most ice protection technologies presently in use have inherent negative effects such as high energy consumption, increased weight, a negative environmental impact, and the need for frequent reapplication among others.

Surface engineering can contribute to reduce ice accumulation in a durable manner. An attractive approach to this issue is the development of hard icephobic coatings applied by thermal spray in particular High Velocity Oxyfuel (HVOF), using highly resistant coatings to the different atmospheric aggressions and doping them with polymers particles, which can provide the icephobic properties necessary to complete the demanded functionality.

The inclusion of the polymer in the high resistance coating improves the hydrophobicity and the ice accretion behavior without affecting its structural properties. This polymer-doped cermet coating has been tested on an ice wind tunnel and compared with an anti-icing commercial paint, and has improved the properties in terms of ice accretion behavior.

The proposed solution is environment-friendly, will contribute to the reduction of energy consumption, and will help eliminate the need for frequent on-ground de-icing procedures. This in turn will contribute to the reduction of cost, pollution and flight delay.

TSP-5 The Electro-Mechanical Properties of Cathodic Arc Deposited High Entropy Alloy Thin Films on Polymer Substrates, *A Xia,* Montanuniversität Leoben, Austria*; O Glushko, M Cordill,* Erich Schmid Institute of Materials Science, Austria*;* ***Robert Franz**,* Montanuniversität Leoben, Austria

In recent years a new class of materials has emerged in the field of metallurgy: high entropy alloys (HEAs). These metallic alloys consist of 5 to 13 metallic elements in an approximately equimolar ratio. Studies conducted on HEA bulk materials revealed promising combinations of properties, such as strength, ductility, corrosion resistance, wear resistance, hardness, diffusion and thermal conductivity. While research on bulk high entropy alloys has seen quite a boost over the past years, investigations on thin films are still a relatively unexplored area.

The focus of this report lies on the cathodic arc deposition (CAD) of two different HEA thin films and the characterization of their electro-mechanical properties, in particular their fracture behavior. The MoNbTaVW and AlCuCrTaTi thin films were synthesized by CAD with an Ar pressure of 4.9 Pa and a current of 120 A to a thickness of 200 nm on polyimide foils and silicon substrates. While the MoNbTaVW film revealed a smooth surface with columnar microstructure, the AlCuCrTaTi film showed a high number of droplets on the surface and a coarse microstructure. In-situ characterization techniques were used to examine the mechanical and electrical properties of the films, while the adhesion energies were calculated using the geometry of buckles formed due to the presence of compressive stresses. The films were exposed to uniaxial tensile straining, while simultaneously measuring the change in electrical resistance. Additionally, the crack formation during straining was investigated with optical microscopy. The results showed that both films remained electrically conductive up to 3% strain. At higher strains MoNbTaVW revealed brittle behavior as seen by straight through thickness cracks and an abrupt increase in resistivity, whereas AlCuCrTaTi showed a more ductile fracture and a less steep resistivity increase.

TSP-6 Synthesis and Characterization of Multicomponent Nitrides in the Al-Cr-Nb-Y-Zr System, ***Kristina Johansson**,* Uppsala University, Sweden*; P Soucek,* Masaryk University, Czech Republic*; A Srinath, D Rehnlund, E Lewin,* Uppsala University, Sweden

Nitride based thin films are commonly used as protective coatings for e.g. cutting tool applications due to their excellent properties regarding high hardness, thermal stability as well as corrosion and oxidation resistance. Recently, multicomponent nitrides with five or more principal elements have attracted a lot of attention due to their interesting material properties. In this regard they can outperform their respective binary nitrides. Multicomponent nitrides are based on the high entropy concept, where the high entropy of mixing caused by including at least five elements will favor the formation of a solid solution. Whereas binary nitride materials, such as Cr-N, Nb-N, Zr-N and Cr-Al-N, have been widely studied for their high hardness and corrosion resistance, multicomponent nitrides have not been studied to the same extent. Also, by addition of yttrium corrosion and oxidation resistance can be improved as previously studied for the Cr-Al-Y-N and Ti-Cr-Al-Y-N systems [1-2]. In this study, multicomponent nitride thin films of the Al-Cr-Nb-Y-Zr system were deposited in order to study their mechanical and electrochemical properties. The films were synthesized by dc magnetron reactive sputtering using elemental targets of the respective elements and a gas flow of Ar and reactive N_2. Both the substrate temperature and the target powers were varied to study their effect on the structure and the material properties.

All films were found to have a nitrogen content of about 40 at.%, indicating substoichiometric films with respect to N. From XRD it was found that all coatings were of single solid solution phase with NaCl-type structure. The lattice parameter ranged between 4.29 to 4.38 Å depending on both the composition and the substrate temperature, where is it was found that the unit cell size decreased with increased temperature and also increased with increased Nb and Zr content. SEM cross section images revealed a columnar microstructure, which became finer with increased temperature and with decreased Al and Cr content. The hardness increased from 17 GPa up to 27 GPa with increased substrate temperature and with decreased Al and Cr content. Corrosion resistance, studied by polarization measurements between -0.2 V to +1.5 V in a 1.0 M HCl aqueous electrolyte, showed improved corrosion resistance for all the studied samples, i.e. increased corrosion potential and lower current densities, compared to an industrial stainless steel reference sample. Thus, this material system shows a potential for the use as hard and corrosion resistant coating.

References

1. F. Rovere et al., Surf. Coat. Technol. 202 (2008)

2. L.A. Donohue et al., Vacuum, 55 (1999)

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