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The Microstructure and Corrosion Behavior of High Entropy Metallic Layers Electrodeposited by Low and High-Temperature Methods

Authors : Zbigniew Szklarz, Aldona Garbacz-Klempka, Magdalena Bisztyga-Szklarz

Abstract : Typical metallic alloys bases on one major alloying component, where the addition of other elements is intended to improve or modify certain properties, most of all the mechanical properties. However, in 1995 a new concept of metallic alloys was described and defined. High Entropy Alloys (HEA) contains at least five alloying elements in an amount from 5 to 20 at.%. A common feature this type of alloys is an absence of intermetallic phases, high homogeneity of the microstructure and unique chemical composition, what leads to obtaining materials with very high strength indicators, stable structures (also at high temperatures) and excellent corrosion resistance. Hence, HEA can be successfully used as a substitutes for typical metallic alloys in various applications where a sufficiently high properties are desirable. For fabricating HEA, a few ways are applied: 1/ from liquid phase i.e. casting (usually arc melting); 2/ from solid phase i.e. powder metallurgy (sintering methods preceded by mechanical synthesis) and 3/ from gas phase e.g. sputtering or 4/ other deposition methods like electrodeposition from liquids. Application of different production methods creates different microstructures of HEA, which can entail differences in their properties. The last two methods also allows to obtain coatings with HEA structures, hereinafter referred to as High Entropy Films (HEF). With reference to above, the crucial aim of this work was the optimization of the manufacturing process of the multi-component metallic layers (HEF) by the low- and high temperature electrochemical deposition (ED). The low-temperature deposition process was crried out at ambient or elevated temperature (up to 100 °C) in organic electrolyte. The high-temperature electrodeposition (several hundred Celcius degrees), in turn, allowed to form the HEF layer by electrochemical reduction of metals from molten salts. The basic chemical composition of the coatings was CoCrFeMnNi (known as Cantor's alloy). However, it was modified by other, selected elements like Al or Cu. The optimization of the parameters that allow to obtain as far as it possible homogeneous and equimolar composition of HEF is the main result of presented studies. In order to analyse and compare the microstructure, SEM/EBSD, TEM and XRD techniques were employed. Morover, the determination of corrosion resistance of the CoCrFeMnNi(Cu or Al) layers in selected electrolytes (i.e. organic and non-organic liquids) was no less important than the above mentioned objectives.

Keywords : high entropy alloys, electrodeposition, corrosion behavior, microstructure
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