HiPIMS deposition of AlCoCrFeNi high entropy alloy thin films for marine environment applications.

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Operating in corrosive environments such as those exposed to seawater is a major challenge for structural materials: traditional alloy materials, such as aluminum and/or titanium alloys and stainless steels, have excellent corrosion resistance, but their reduced wear behavior limits their use.

Among innovative materials, High Entropy Alloys (HEA) represent promising candidates for severe environment applications due to their high mechanical strength, good thermal stability, wear, and corrosion resistance [1]. HEAs are multicomponent alloys where each element varies in the range from 5 at% to 35 at%, with microstructures characterized by simple solid solution phases [2]. Due to their attractive properties, HEAs are potential solutions not only in bulk form but also as coating materials for enhancing surface properties in different harsh environments and operating conditions.

In this work, AlCoCrFeNi HEA coatings were deposited via High Power Impulse Magnetron sputtering (HiPIMS) PVD technique using two commercial targets, i.e., CoCrFeNi alloy and pure Al. The effects of the applied bias potential (V_{bias}) and the target/substrate distance on the structure and properties of the coatings were investigated: HEA thin films morphology, chemical composition, microstructure, residual stress state, mechanical properties and corrosion resistance were analyzed by SEM, X-EDS, XRD, nanoindentation and potentiodynamic polarization in 3.5% NaCl solution.

It was found that the Al content in deposited HEA coatings is almost constant up to an applied substrate bias voltage of -70 V (Fig. 1(a)). Above this value, the Al content decreases, probably due to re-sputtering phenomena. Furthermore, the target-substrate distance was modified to maintain a similar Al percentage, even when changing V_{bias}. Regarding mechanical properties and residual stress state of deposited films, hardness remains almost constant at about 9 GPa as the applied bias voltage increases, while the stress state is tensile up to V_{bias} = -70 V and compressive beyond this value.

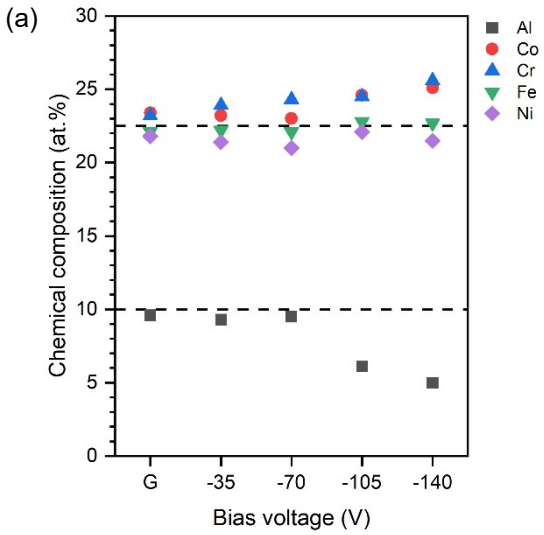

Fig. 1: (a) Chemical composition of HiPIMS-deposited AlCoCrFeNi HEA thin films as a function of the substrate bias voltage.

[1] J.W. Yeh, S.K. Chen, S.J. Lin, J.Y. Gan, T.S. Chin, et al. *Adv. Eng. Mater.* 6 (2004) 299-303

[2] Y.F. Ye, Q. Wang, J. Lu, C.T. Liu, Y. Yang, *Mater. Today* 19 (2016) 349-362