Microstructure and tribology of nitrided heterogenious eutectic high entropy alloys

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Many mechanical moving components are operating in extremely harsh environments such as, nuclear energy, aerospace industries, bioapplications or advanced cutting tools. Due to the surface friction and wear at high temperatures, in a corrosive environment and/or under significant radiation the service life and reliability of these components are still suffering serious technical challenges. Hence, there is an urgent need to develop new materials, which can provide this reliability, and much recent research has focused on this topic. For example, high-entropy alloys (HEAs) are presently of great research interest in materials science and engineering.

In this paper we propose is to increase the mechanical and tribological properties of heterogenous-structural eutectic high entropy alloys (EHEA) by nitriding or nitrogen ion implantation. Nitrogen atom radius is small compared to typical elements in HEAs what lead to increase of lattice distortion and creation of its own sublattice. Sluggish diffusion can be held accountable for significant inhibition of nitrogen atoms diffusion into bulk material thus increasing differences between bulk and surface layer properties.

We have studied ion implantation and plasma nitriding on bulk eutectic AlCoCrFeNiTi0.2 high-entropy alloy. Ion implantation was proven to cause σ-to-BCC phase transformation, thus leading to increase in nano-hardness (Fig. 1a and b) [1]. On the other hand, in the case of plasma nitriding structural changes were more severe. In both cases X-ray diffraction experiment was performed to reveal the crystalline phases present in the sample surface and their volume contribution. Next the mechanical properties were studied with the use of nanoindentation (Fig. 1c and d) and micropillars compression. Finally, friction coefficient was determined with the use of AFM.

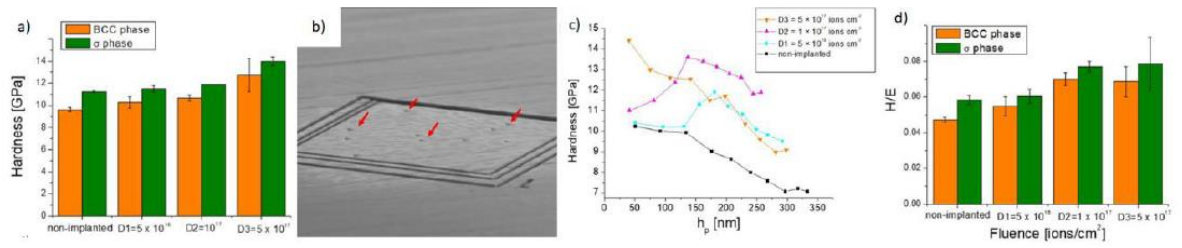

Figure 1. Studies of nitrogen ion implanted AlCoCrFeNiTi0.2

References

[1] Jenczyk P., Jarząbek D.M., Lu Z., Gadalińska E., Levintant-Zayonts N., Zhang Y., Unexpected crystallographic structure, phase transformation, and hardening behavior in the AlCoCrFeNiTi0.2 high-entropy alloy after high-dose nitrogen ion implantation, Materials & Design, **2022**, Vol.216, pp.110568-1-11