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Compositional gradient nanocrystalline Ni-W coatings by electrodeposition for superior wear resistance

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The hard nanocrystalline coatings are often deposited to improve the wear resistance. However, due to their poor toughness and strain hardening ability, nanocrystalline coatings suffer from the formation of delaminating tribo-layers and therefore high friction coefficients [1]. In recent studies, compositional and/or microstructural gradient nanocrystalline metals have demonstrated improved toughness while retaining their inherent high strength/hardness [2]. Therefore, the present study is aimed at extending the concept of compositional gradient to produce wear-resistant hard coatings. To demonstrate, (a) multi-layered and (b) continuous gradient nanocrystalline Ni-W coatings were developed by using the pulse electrodeposition technique. The Ni-W multilayer coatings comprising of alternate W-rich and W-poor layers were successfully deposited by manipulating the reverse current density. In contrast, the continuous gradient Ni-W coatings with linear increase in the W-content from the substrate-coating interface to the surface of the coating were deposited by tailoring the concentration of the W-precursor in the bath. Results have shown that the compositional gradient Ni-W coatings have substantially lower residual stresses compared to their homogenous counterparts. Furthermore, micro-scratch and sliding wear tests have demonstrated that the gradient coatings have superior contact damage resistance than the homogenous coatings. The improvement in the properties is rationalized by correlating with the microstructural stability, and strain hardening ability of the compositional gradient Ni-W coatings.

Keywords: Pulse electrodeposition; Ni-W alloys; multilayers; tribology

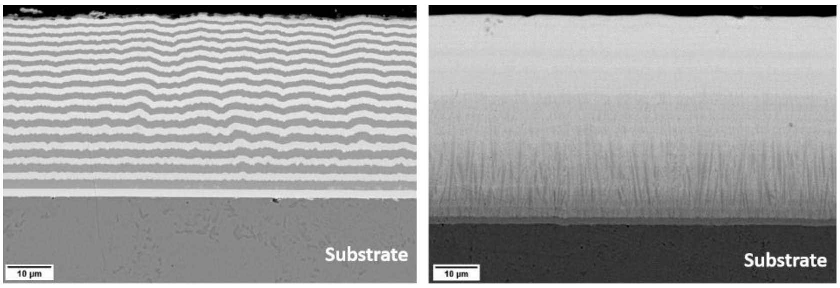

Figure 1. The developed compositional gradient Ni-W coatings

[1] X. Chen et al./ *ACS Appl. Mater. Interfaces,* 10 (16), 2018, 13829–13838
[2] Evan Ma and Ting Zhu / Materials Today, 20 (6), 2017, 323-331