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Study of morphology of Cr/CrN nanometric multilayers grown at different periods

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Abstract – Cr/CrN multilayers of 200 nm, 1 μm, 3 μm total thickness and a period (Λ) of 200 nm, 100 nm, and 20 nm have been produced at room temperature on silicon (100) and stainless steel AISI 304 by means of the Unbalanced Magnetron Sputtering (UBM) technique in order to study roughness and grain size. Results show a dependence of these parameters as a function of the multilayer period and total thickness.

Chromium/chromium nitride nano-multilayers have shown to have a number of advantages in comparison to their monolayer counterparts such as improved hardness, wear and corrosion resistance [1,2]. In addition, the period (Λ), which is the thickness where the multilayer composition is repeated, has also shown to have effect in multilayer properties [3]. To produce high quality multilayer coatings, Physical Vapor Deposition (PVD) techniques can be used especially the technique of Unbalanced Magnetron Sputtering (UBM). This technique has been used lately due to its superior performance as compared to conventional balanced magnetron.

In this research the effect of period and thickness in morphology of Cr/CrN coatings grown by UBM was determined. Coatings were deposited at room temperature and 400 mA discharge current. Flow rates were maintained at 9 sccm for Ar and 3 sccm for N_2, and multilayers with 200 nm, 1 μm and 3 μm total thickness and a period (Λ) of 200 nm, 100 nm and 20 nm were obtained. For microstructural study the Atomic Force Microscope (AFM) mode was used. Parameters used for morphology study were grain size and roughness, and dependence in these parameters is shown as a function of film thickness. (111) and (200) planes were obtained for CrN as shown in figure 1. In figure 2 an AFM image is shown for the multilayers grown at 3 μm total thickness. Rms roughness values were taken in areas of 2 μm^2 and results show no significant variation with bilayer period for multilayers grown at 200 nm and 1 μm total thickness, presenting values of 3.3 ± 1.5 Å (Λ=200 nm), 4.6 ± 0.6 Å (Λ=100 nm) and 5.7 ± 1.4 Å (Λ= 20 nm) for multilayers grown at 200 nm total thickness and 23.6 ± 3.1 Å (Λ=200 nm), 21.2 ± 3.6 Å (Λ=100 nm) and 21.1 ±1.7 Å (Λ= 20 nm) for multilayers grown at 1 μm total thickness. For the multilayers grown at 3 μm total thickness an increase in roughness was obtained from 35.3 ± 1.9 (Å) for Λ = 200 nm to 54.5 ± 8.5 (Å) for Λ = 20 nm. However, from the values presented it is clear an increase in roughness with total thickness. This could indicate a decrease in grain size with multilayer period which is common for this kind of structures.

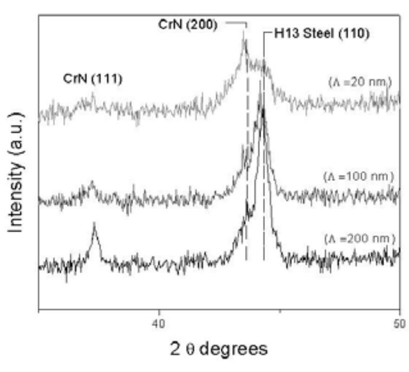

Figure 1: XRD spectra for the multilayers grown with 1 μm total thickness

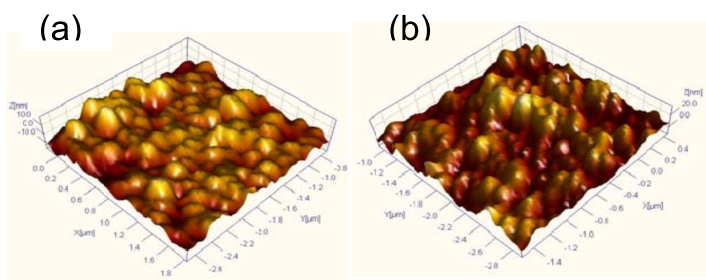

Figure 2: AFM images for the multilayers grown at 3 μm total thickness and (a) Λ = 200 nm and (b) Λ = 20 nm

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