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# Enhancement of electrochemical and tribological properties by using a [BCN/h-BN]$_n$/c-BN multilayer system

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**Abstract** – [BCN/h-BN]n/c-BN non-isostructural multilayered systems with various periods (λ) have been synthesized by reactive magnetron sputtering and deposited on AISI 4140 steel. Six [BCN/h-BN]n/c-BN systems with n=1, 5, 10, 15, 20 and 25 bilayers were made. The minimum period reached was deposited for (25 bilayers). All the systems were evaluated in terms of corrosion resistance and tribological properties. Tribological results are shown in Fig. 1. The multilayer system with 25 bilayers revealed the lowest corrosion rate (022 mpy) and lowest friction coefficient (0.32), corresponding to 29.6 and 1.7 times better than those values for the coating with n =1, respectively.

Boron nitride (BN) is a synthetic ceramic compound, which crystallizes in crystallographic structures similar to the allotropic forms of carbon. Two most important crystalline forms are hexagonal (h-BN) and cubic (c-BN) one, which are similar to graphite and diamond respectively. Therefore c-BN thin films and h-BN/c-BN multilayer films can be applied as super-hard wear-resistant corrosion resistant coatings for cutting tools, optical and electronic devices etc. The most important advantages of PVD are high stoichiometry control in deposition films, high possibility to deposition without substrate heating and easy preparation of multilayer coatings [1]. We study the Enhancement of electrochemical and tribological properties by using a [BCN/h-BN]n/c-BN multilayer system with various periods (n) on silicon (100) and steel AISI 4140 substrates of through a multi-target r.f. was studied in this work. The coatings were characterized in terms of chemical, electrochemical and tribological properties by Fourier transform infrared spectroscopy (FTIR), Tafel polarization curves, impedance spectroscopy methods (EIS), pin-on-disc and scratch test. Results from FTIR analysis showed the chemical nature based on vibrations modes of BCN and c-BN, from Tafel and EIS test we analyzed reduction on corrosion rate in 96 percent with period increasing, finally enhancement of tribological properties was determinate via pin-on-disc and scratch test results. The best behavior was obtained with (25 bilayers), giving lowest friction coefficient (0.32) and highest critical load (61 N), these values are 1.7, and 3 times better than coating with n =1, respectively. The enhancement tribology effects in multilayer coatings could be attributed to different mechanisms, for layer formation with nanometric thickness due to Hall Petch effect; because this effect, originally used to explain the increase in hardness with decreasing grain size in bulk polycrystalline metals, has also been used to explain the tribological enhancements in multilayer take into account thickness decreasing at single layer.

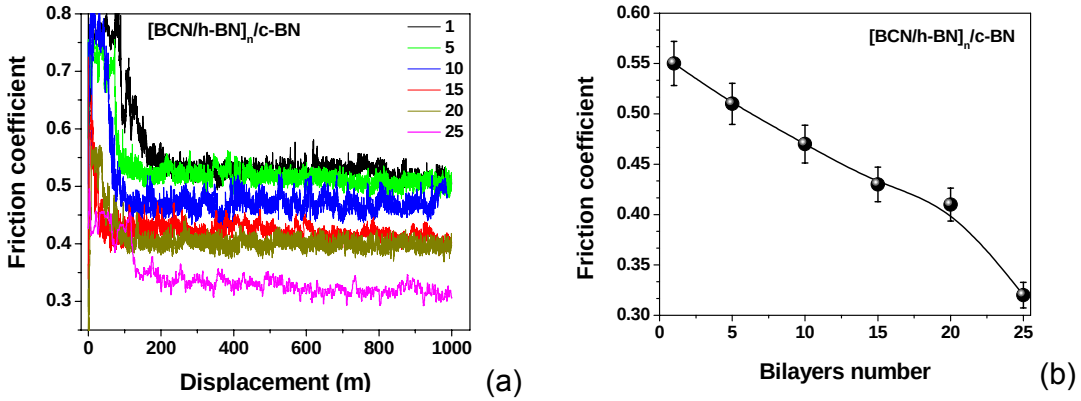


**Figure 1:** Tribological result (a) Friction coefficient for [BCN/h-BN]n/c-BN as function of displacement for multilayers (b) Friction coefficient as function of bilayers number.

[1] T. Sugino, H. Hieda, Diamond Relat. Mater. 9 (2000) 1233