Enhancement of Tribological Properties in Steel by Using a $[TiCN/TiNbCN]_n$ Multilayer Nanostructured System

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$[TiCN/TiNbCN]_n$ multilayers were grown onto silicon and steel substrates by reactive r.f. magnetron sputtering technique using two targets (TiC and Nb) and alternating deposition conditions. The multilayer period (λ) was varied from the micrometric to the nanometric range, maintaining the total thickness of the coatings in the range of a few microns by depositing a suitable number of bilayers (n). The coatings were characterized by x-ray diffraction (XRD), optical reflectance spectroscopy, and scanning electron microscopy (SEM). The tribological properties were determinate via dynamic contact test using a Microtest MT 4001–98 tribometer and Scratch Test Microtest MTR2 system; from them we measure friction coefficient and critical load for the different samples. The stress was calculated by measuring the curvature of the films onto Si substrates with a profilometer. An enhancement of both hardness and elastic modulus was observed as the number of bilayers (n) in the coating was increased. Sample with length period (λ) of 15 nm (n=200 bilayers) showed the lowest friction coefficient (~0.1) and the highest critical load (80 N), corresponding to 2.2, and 1.6 times better than those values for the coating with n=1, respectively. The enhancement effects in this $[TiCN/TiNbCN]_n$ multilayer coatings can be attributed to the Hall Petch effect in multilayered coatings, in which the interfaces act as a barrier against the movement of the dislocations and the bilayers of materials having different mechanical properties generate an inhomogeneous system prohibiting the advancement of potential micro-cracks.