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Co-deposition of Bi and hard protective nitride phases by r.f. and d.c. sputtering

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The incorporation of additional alloying elements in nitride protective coatings to produce nanocomposite coatings is a promising approach to improve their tribological properties. For example, Ag has been successfully added to CrN films to form self-lubricating films. Silver is extremely mobile and diffuses out of the matrix onto the surface and allows maintaining a low friction coefficient even at high operating temperature (600 ºC). In this work co-deposition of Bi as a solid lubricant and several hard nitride phases (CrN, CrAlN and AlN) both by r.f. and d.c. sputtering. The main objective was to take advantage of the low Bi melting temperature (270 ºC) to decrease the friction coefficient of the nitride coatings at elevated temperature.
The chemical composition of the resulting deposits was measured by means of Electron Probe Microanalysis (EPMA). The Bi content varied between 0.2 and 36.4 at. %, depending on the power ratio of the targets and the N to Cr, Al or Al+Cr atomic ratio was close to unity indicating the formation of the hard nitride phase. The structure of the deposits was analised by X-ray diffraction (XRD) at glancing incidence. Bi diffraction peaks along with low intensity nitride phase peaks were detected in most films. The morphology of the deposits was characterized by Scanning Electron Microscopy (SEM). The hardness and Young’s modulus were measured by nanoindentation. Compact coatings were only obtained at low discharge power in the Bi target. However, decreasing the Bi target power leaded to poisoning by residual oxygen and to the incorporation of high oxygen amounts in the coatings. The depositions at high Bi target power resulted in the formation of mixed nitride and Bi powders with different morphologies depending on the Bi to nitride phase ratio in the deposits.

Keywords
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