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Mechanical and tribological characterization of CrN-Bi films

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Chromium nitride is one of the most commonly used protective coatings by industry because of its capacity to combine notable tribological properties with high resistance to corrosion and oxidation. One of the main drawbacks of CrN is its high friction coefficient at elevated temperatures. The addition of Al to CrN to form a solid solution allows improving the friction coefficient as well as other mechanical properties. An alternative approach is to combine CrN with a solid lubricant, such as Ag, to produce nanocomposite coatings that can display superior tribological properties.
In this work CrN has been combined with Bi as a solid lubricant, in order to produce self-lubricant films. The coatings were obtained by sequential sputtering of two individual high purity (99.99 at %) targets of Cr and Bi onto Si and steel substrates, in a mixed Ar and N2 discharge. As a result, nanocomposite coatings consisting of thicker CrN layers separated by Bi nanolayers were produced. The thickness of the Bi nanolayers was varied by varying the Bi deposition time from 10 to 60 s while the CrN layers deposition time was kept constant at 10 min.
The chemical compositions of the resulting films were investigated by means of Electron Probe Microanalysis, while the crystal structure was evaluated by X-ray diffraction using glancing incidence geometry with a 2º incident angle. The Bi content in the films varied between 1.7 and 8.1 at. %, depending on the deposition time used for the Bi nanolayers. Broad CrN diffraction peaks were obtained by XRD on the samples with lower Bi content while the Bi phase was detected along with CrN on the films deposited with higher Bi content. Hardness and Young’s modulus of each sample were measured by nanoindentation. Tribological tests were conducted using a pin-on-disk tribotester.

Keywords
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