Mechanical characterization of a-C/Cu nanocomposite films obtained by high-power DC magnetron sputtering

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In recent years much attention has been paid to nanocomposite films for tribological and related applications, which are comprised of amorphous and nanocrystalline components in binar or more complex combination [1]. In the present contribution we have studied mechanical behavior of copper-carbon nanocomposite films produced by a high-power DC magnetron sputtering [2]. Copper is selected as a metal which is inactive to carbon and also is immiscible with it. Thick (8-10 μm) nanocomposite films with a carbon content 7-22 at.% were deposited onto bearing steel, silicon and glass substrates. Transmission electron microscopy demonstrates that films consist of copper nanocrystallites (~20 nm) embedded in the matrix of amorphous carbon. Nanoindentation tests show hardness of films 2.5-4 GPa and Young's modulus of about 80 GPa. The main peculiarity of copper-rich copper-carbon nanocomposite films, deposited by DC magnetron sputtering, is their comparatively high micro-plasticity at the room temperature. The ratio of plastic work to total work of indentation is in the range of 76-85%. The plasticity is facilitated by interfacial sliding between components of the composite, appearance of which in our study is confirmed by scanning electron microscopy. Deposited films exhibit a comparatively low residual stress (around 0.25- 0.3 GPa) reduced due to creep and stress relaxation processes. The obtained results characterize copper-carbon nanocomposite films as a promising solid lubricant or as a plastic component in complex tribological nanocomposites.

References

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