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TRIB / Plasma - deposited protective and tribological coatings

Enhanced tribomechanical performance of metal-doped DLC coatings deposited by HiPIMS with positive pulse technology

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Abstract content

Diamond-like Carbon (DLC) coatings have been recognized as one of the most valuable engineering materials for various industrial applications including manufacturing, transportation, biomedical and microelectronics. Among its many properties, DLC stands out for a good frictional behaviour combined with high surface hardness, offering an elevated protection against abrasive wear. Nevertheless, a factor limiting the widespread application of DLC coatings is their thermal stability. DLC is very temperature-sensitive since its sp3-sp2 structure undergoes a graphitization process at high temperatures that deteriorates both hardness and coefficient of friction. In order to overcome this limitation, new ways to modify DLC coatings for acceptable high temperature performance have been explored. In this work, we investigated the deposition of hard DLC coatings doped with various elements (W, Cr and Si) using HiPIMS technique with the novel incorporation of positive pulses. Highly ionized plasma discharges were obtained during HiPIMS deposition. The high ion energy bombardment allowed reaching higher sp3 bonding levels. EELS spectroscopy was used to evaluate sp3 content and Raman was used for sp2 structural characterization of the films. Enhanced mechanical properties (hardness up to 35 GPa) were observed with nanoindentation for doped DLC coatings. High temperature nanoindentation tests were also performed from room temperature to 500ºC in order to evaluate the evolution of hardness and Young Modulus with temperature. The results shows that the mechanical properties at high temperature mainly depend on the sp3 content. Pin-on-disk tests were carried out in order to assess the tribological performance of the coatings both at room and high temperature. The increased toughness and reduced compressive stress that doping provides to the carbon matrix together with a high sp3 bonding structure obtained with HiPIMS deposition improves the stability of DLC coatings for high temperature tribological applications. The application of metal-doped DLC coatings has proven highly effective in machining high silicon content aluminium alloys.

References

[1] J.A. Santiago et al., Surface and Coatings Technology 358 (2019) 43-49
[2] J.A. Santiago et al., Surface and Coatings Technology 382 (2020) 124899