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Hard yet self-lubricate TiAlN/DLC multilayered coating deposited by high energetic ion-assistant deposition

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Introduction: Diamond-like carbon (DLC) coatings, especially hydrogenated DLC coatings (α-C:H), are known for their excellent tribological properties such as small friction coefficients (0.05~0.2) and wear rates ($<10^{-15}$ $m^3/N \cdot m$) [1, 2]. However, the hardness of α-C:H films are typically less than 20 GPa. While TiAlN coatings are known for its high hardness, but the friction coefficient of TiAlN, especially under dry conditions, is quite large reaching 0.9-1.0 at room temperature and 1.5 at 400 ℃ [3]. Multi-layered coatings can combine the advantages of the constituent layers and are preferred to enhance integrated performance over single-layered coatings.

Materials and Methods: In this study, TiAlN/DLC multi-layered coatings were prepared by high energetic ion-assistant deposition which is plasma immersion ion implantation and deposition (PIIID) combines high power impulse magnetron sputtering (HiPIMS) for TiAlN and assisted by anode-layer ion source for DLC, respectively. The physical and chemical characteristics of the TiAlN/DLC multilayered coatings were studied by scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), nano-indentation, ball-on-disk wear test machine and scratch test, etc.

Results and Discussion: The results show that the TiAlN/DLC multilayered coating present an excellent adhesion in all interface with a high critical load of 63 N. A high hardness of 26 GPa and a low friction coefficient of 0.13 were achieved.

Conclusion: An excellent adhered TiAlN/DLC multilayered coating was obtained by high energetic ion-assistant deposition. The TiAlN/DLC multilayered coating exhibits both excellent hardness and self-lubricate effect.

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