Multilayer structure of WC-CrN and nanocrystalline diamond coatings

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Nanocrystalline diamond (NCD) films show high hardness and toughness with low surface roughness. In addition, they have low coefficients of friction against many metals and ceramics. However, NCD films are very difficult to deposit onto many technological substrates. Typically, significant surface modification in the form of chemical etching, and/or physical seeding with diamond nanoparticles, is required for reasonable growth rates of uniform and smooth NCD layers with sufficient adhesion. These additional steps may weaken the substrate material, can be costly, and may lead to inconsistencies in the final product. Another approach is the use of transition thin-film layers between the substrate and the NCD film. An ideal transition layer would provide high nucleation rate (>10\textsuperscript{10} cm\textsuperscript{-2}) and support the growth of smooth NCD films without additional treatment steps. In addition, such layer should be hard to allow for practical application of NCD layer.

Here, we report on the preparation and test of WC-Cr-N-based coatings as a transition layer for NCD growth. WC-Cr-N coatings (~ 500 nm thick) were grown on Si substrates via reactive RF magnetron sputtering (Ar/N\textsubscript{2} gas mixture) at the substrate temperatures varied from 100 °C to 400 °C, and with the Cr:W ratio varied between 0.5:1 and 3:1. After that, a 2-3 µm thick nanocrystalline diamond layer was deposited by microwave PACVD. Both WC-Cr-N and WC-Cr-N/NCD composite layers were characterized by HR-SEM, EDS/WDS, XPS, XRD, AFM, Raman spectroscopy, and nanoindentation. The results show that NCD forms in the range from random NCD grain clusters to a continuous layer depending on the WC-Cr-N layer composition and deposition parameters.

\textbf{Keywords}

tungsten carbide
chromium
nanocomposite
nanocrystalline diamond