Boron Doping Effects on Mechanical Properties of Ultrananocrystalline Diamond/Amorphous Carbon Composite Films Deposited on Cemented Carbide Substrates by Coaxial Arc Plasma Deposition

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Ultrananocrystalline diamond/amorphous carbon composite (UNCD/a-C) film, wherein a significant number of diamond grains (diameters <10 nm) are embedded in an amorphous carbon matrix, is a new hard coating material for cemented carbide (WC-Co) cutting tools. In our previous study, we have realized the formation of UNCD/a-C films having the hardness of 50 GPa. It has been reported that boron doping facilitates the growth of diamond grains. In this study, to enhance the hardness further, boron doping effects on the structural and mechanical properties of UNCD/a-C films were investigated.

In this work, boron-doped ultrananocrystalline diamond/amorphous carbon composite films were deposited on cemented carbide (WC-Co) substrates by using coaxial arc plasma deposition with boron-blended graphite targets. The doping of boron degrades the hardness and modulus. From energy-dispersive X-ray spectroscopic measurements, the diffusion of Co atoms from the substrates into the films were observed for the films. Since the Co diffusion induce the graphitization due to the catalytic effects, the degraded hardness and modulus should be attributable to the catalytic effects of Co.

Boron-doped films were deposited on a thin undoped UNCD/a-C buffer layers deposited on WC-Co substrates. It was found that the undoped UNCD/a-C layer prevent from the Co diffusion, which results in an enhancement in the hardness to 60 GPa. The details will be reported at the conference.

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