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Plasma vapor boriding of cemented tungsten carbide (WC-Co) for improved nanostructured diamond adhesion and cemented carbide tool performance

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The objective of this research is to explore the use of Chemical Vapor-Deposition (CVD) boronizing to improve nanostructured diamond (NSD) growth on cemented tungsten carbide (WC-Co) by fabricating a cobalt boride interlayer; preventing cobalt triggered graphitic formation and improving NSD adhesion for increased tool life. We show that interfacial cobalt boride (CoB) is formed during plasma boriding, creating a functional barrier against cobalt diffusion during NSD growth and leading to improved nanodiamond adhesion. Glancing angle x-ray diffraction indicates that the boronized WC-Co interfacial layer consists heavily of tungsten carbide with a distinct presence of cobalt boride (CoB) and no detectable elemental cobalt. Unlike pack boriding or acid etching techniques that tend to leech cobalt from cemented carbides, the effect of plasma chemical vapor deposition boriding is not well known. Early results indicate that CVD boriding creates an interlayer that improves NSD adhesion without damaging the cemented carbide substrate. Nanostructured diamond and amorphous carbon of sp3 and sp2 bonding composes the well adhered diamond thin film. Initial field testing of diamond coated cemented carbides shows a 300% average increase in tool lifetime over traditional cemented carbides. Comparison of diamond coated boronized carbides to diamond coated raw carbides shows improved surface adhesion when the cobalt boride interlayer is present. The applications of this research are as broad as the applications of cemented tungsten carbide. Carbides are the primary mining, drilling, and material reclamation tool in use today. Improved performance through well adhered diamond coatings could potential impact every industry currently using these tools.

Biography

Jamin Johnston received his Master's degree in physics from The University of Alabama at Birmingham in 2013 where he is continuing pursuit of his PhD in applied physics. His research experience began with the exploration of CdSe quantum dot fabrication and electrophoretic deposition into thin-films, and has shifted focus to nanostructured diamond thin-film growth and deposition. Accomplishments include joint research partnerships with industrial collaborators to bridge the gap between scientific research and industrial application.

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