Enhanced Diamond Film Adhesion on Cobalt-Cemented WC Substrates

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Cobalt-cemented tungsten carbide (WC-Co) is a widely used material for making cutting tools. Coating these tools with a protective diamond film should improve their lifetime and performance. However, the deposition and adhesion of diamond films on this material are hindered by the presence of the cobalt binder. To circumvent this problem, we have developed a substrate pretreatment method based essentially on carbon supersaturation of the metal surface through ion bombardment in the cathode fall of a pure methane dc discharge. Chemical analysis of the substrate by X-ray photoelectron spectroscopy (XPS) and secondary ion mass spectroscopy (SIMS) showed that our pretreatment method efficiently limits the cobalt migration from the bulk to the surface and, consequently, reduces the dissolution and diffusion of carbon atoms coming from the plasma. As a result, the adhesion strength of the deposited diamond films, evaluated by a scratch tester, is substantially enhanced. While adhesion is characterized by a critical load $F_C$ of 12 N following standard substrate pretreatment (acid etching), additional carbon supersaturation of the substrate surface yields $F_C$ values exceeding 30 N, the upper limit of our scratch tester.