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Deposition of CVD diamond films on WC-Co-TiC inserts for machining

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Abstract - A boron thermo-reactive interlayer (CoW_2B_2) has been used to avoid Co migration and to stabilize cobalt in WC-Co-TiC tools. The diamond films grown on boride interface presented good adherence. Machining tests showed that the boride/ CVD diamond film interlayer was effective to improve tool life.

The technology of CVD diamond film deposition has many industrial applications [1]. Among these applications there is the coating of machining cutting tools in order to increase its useful life. These tools are mainly made of sintered WC-Co with other addictives, mainly TiC. Cobalt is the most used binder in cemented carbides, due to its high wettability to WC. However, cobalt has some specific interactions with carbon that are deleterious for CVD diamond deposition [2]. Co migrates to the growth surface and hinders diamond deposition.

The boronising process [3] has been used as a pre-treatment for diamond film deposition on WC-Co. It consists of a boron thermodiffusion from heated powders, mixed according to pre-established mass proportions. After boronising the sample is submitted to chemical etching, first with an acid solution (H_2SO_4 + H_2O_2) to remove free Co from boride surface, followed by an alkaline etching using Murakami's solution [4] to improve surface roughness and therefore improving diamond film adherence. The boronising technique has shown to be effective as a barrier for Co diffusion to the surface at the diamond deposition temperature. However, it sometimes presents negative effects due to brittlening of substrate surface (Fig. 1), mainly for very fine grain WC-Co substrates. In this paper we show that brittlening is due to cobalt diffusion out of the substrate during the heating of the boronising mixture, up to the ideal boronising temperature. The boride layer formed (CoW_2B_2) stabilizes the surface cobalt (Fig. 2) and works as a barrier for Co diffusion to the surface at the diamond deposition temperature. The diamond films grown on boride interface were evaluated by indentation tests using diamond cone Rockwell C indenter and also by machining tests. It was also characterized by Raman spectroscopy (Fig. 3), X-ray diffraction, and Scanning Electron Microscopy (SEM).

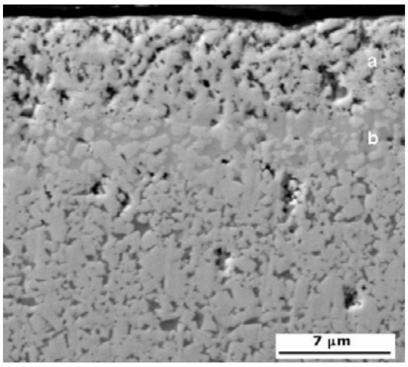

Figure 1: SEM image of the transversal section of WC-Co substrate after boronising process. Detail (a) shows the brittle region and (b) the boride interlayer that blocks Co diffusion to surface.

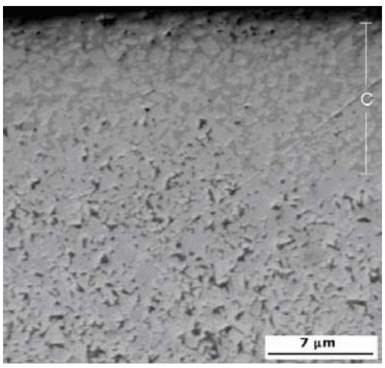

Figure 2:SEM image of the transversal section of WC-Co substrate after boronising process with brittleness control technique. Detail (c) shows the boride interlayer without the brittle region.

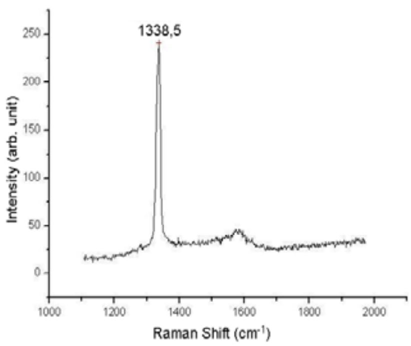

Figure 2:SEM Raman spectrum of diamond film on WC-Co with boride interlayer.

References

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