WC-Co SUBSTRATE PREPARATION AND DEPOSITION CONDITIONS FOR HIGH ADHESION OF CVD DIAMOND COATING

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1. Introduction

Coating of hard metal cutting tools with CVD diamond films has been the focus of much research in academia as well as industry. Such coatings can significantly prolong the durability of coated tools and therefore they are of key importance in the fields of high speed cutting, dry machining or machining of special materials [1]. Apart from the advantages, however, a problem is the poor adhesion of diamond coatings on hard metals, like WC-Co, due to the Co-binder that catalyzes the formation of graphite. Some methods have been developed to overcome this problem, two can be highlighted: (i) application of intermediate layers to act as a cobalt barrier and (ii) chemical pre-treatment of the hard metal substrate in order to reduce the cobalt concentration on the surface to be coated [2]. In this work, pre-treatment of WC-9%Co substrates by two etching steps (Murakami solution and aqua regia) followed by seeding with diamond nanoparticles was used to enable the study of CVD diamond nucleation and growth.

2. Experimental

WC–Co disks (91% WC and 9% Co composition, 0.9 mm in diameter and 3 mm thick) commercially available were used as substrates. After the surface polishing procedures, these substrates were chemically pre-treated by two etching steps. First, it was used a Murakami solution ($K_3[Fe(CN)_6]$ + KOH + H_20) for 10 minutes in an ultrasonic bath to etch the WC phase of the cemented carbide. The second etching step was performed using solution of aqua regia (HNO_3 + HCl) for 5 minutes to remove the cobalt from the surface. After each etching steps the substrates were rinsed with pure water. Before of CVD diamond deposition, the substrates were characterized by SEM with integrated EDS analysis in order to detect the cobalt concentration on the surface. Subsequently, the substrates were seeded with diamond nanoparticles following the process described in ref [3]. The deposition of diamond films was carried out in a hot-filament CVD reactor using a mixture of 2.0% CH_4 and 98%H_2 or 6.0% CH_4 and 94%H_2. The diamond samples were investigated by Raman spectroscopy, AFM and 1500 N Rockwell indentation in order to evaluate the adhesion.

3. Results and Discussions

The Co content was determined using EDS. The results obtained before and after chemical pre-treatment are shown in Table 1. After etching procedures, the Co concentration has been reduced from around 9 % on the untreated substrate surface to 0.96 % on treated surface. Figure 1 shows the SEM image of the treated substrate.

Table 1. EDS analysis of the substrate

Composition	WC-Co substrate	
	Untreated	Treated
W [at.%]	22.09	36.57
C [at.%]	69.12	62.47
Co [at.%]	8.78	0.96

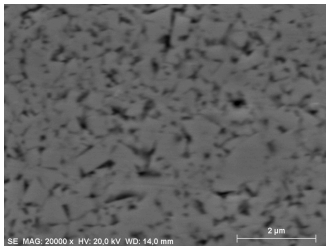

Fig. 1. SEM image of the surface of the WC-9%Co substrate after etching treatments

4. References

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