The Effect of Pretreatment for Cemented Carbide Substrate Using Wet Blasting

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Abstract

The pretreatment for substrate was carried out in change of gun pressure of 0.5 ~ 3.5 bar using wet blasting. The size of Al_2O_3 powder was about 50 ~ 150 µm. As the results, the surface roughness of cemented carbide substrate was improved with increment of gun pressure of wet blasting. A new surface layer was formed and Co particles were uniformly distributed over the entire surface after pretreatment. The adhesion of the pretreated substrate in same PVD-TiAlN film was improved and in approximately Ra=90~120 nm shown the best adhesion value.

Keywords : Cemented Carbide, Cutting Tool, PVD, Surface Roughness, Blasting

1. Introduction

The quality of cemented carbide cutting tool coated with PVD films depends on the adhesion between the cemented carbide substrate and film. The cemented carbide in conventional PVD has been directly coated on surface of the sintered and grinded (1-2). The surface of cemented carbide has many defects such as surface contaminations, poor surface roughness, and Co leaching, which resulted from sintering and grinding process. As the results, the adhesion between the substrate and PVD films is not good, and tool life is decreased. So, the surface of cemented carbide should be clean and smooth (3-4).

In order to obtain good adhesion, the surface of cemented carbide has been treated with physical and/or chemical methods, such as metal etching and/or ion bombardment using a plasma, and acid and/or alkali solution before PVD coating. However, these methods are not improved the adhesion between the substrate and PVD films.

In this study, the effect of pretreatment for the cemented carbide substrate using wet blasting with Al_2O_3 powder to improve the adhesion was investigated.

2. Experimental and Results

A milling RH insert was used as the cemented carbide substrate of ISO P30 grade. The size of insert was 12.7mm×12.7mm×3.24mm. The composition of the cemented carbide substrate was WC-9wt%Co. The substrate was ground insert of posi type shape.

The pretreatment for the substrate was carried out for 20 sec in change of gun pressure of 0.5 ~ 3.5 bar in wet blasting. The size of Al_2O_3 powder was about 50 ~ 150 µm. The distance between the substrate and gun was about 5 cm, and the powder was used with water.

The surface of pretreated substrates was evaluated with SEM, AFM, residual stress, scratch tester and cutting test.

Figure 1 shows SEM images of the substrate untreated and pretreated. As shown in Fig. 1, a grinding line was observed on the surface of untreated substrate, and surface roughness was not good. On the other hand, the surface of the substrate pretreated using wet blasting of 1.5 bar was flat, and surface roughness was found to be better than the untreated substrate.

Figure 2 shows the surface roughness and residual stress of the pretreated substrates. The residual stress of the pretreated substrate was calculated by $\sin^2\psi$ method with XRD. The compressive residual stress of untreated substrate was about -0.2 GPa, and was increased with the increment of gun pressure. This may be due to the increment of atom deformation in outer surface layer. The residual stress of substrate, having the best surface roughness, was about -0.6 GPa, and was reached 3 times of substrate of untreated. The surface roughness of cemented carbide substrate was improved with increment of gun pressure of wet blasting, but was not good at gun pressure of over 2.5 bar. This may be due to the over removal of outer surface layer of substrate by strong gun pressure.

After wet blasting, the existence of Al_2O_3 powder on the pretreated substrate was analyzed with XPS. From the Al2p and O1s spectra, Al atoms were finely combined with O atoms on the substrate pretreated, and ultrafine Al_2O_3 particles were found to exist in Co binder of surface of the substrate pretreated at a gun pressure of 1.5 bar. Furthermore, from EPMA images of Co distridution, Co particles were uniformly distributed over the entire surface of pretreated substrate. As the result, a new surface layer was supposed to form by wet blasting.

Figure 3 shows the adhesion result of scratch test. All the pretreated substrates were coated as about 3 μm thickness with PVD-TiAlN film. As the result, the pretreated substrate in 1.5 bar was shown the good adhesion of approximately 90 N, in comparison to 63 N of the untreated substrate. It was found that the adhesion of pretreated substrate in same PVD-TiAlN film was good in the range of approximately Ra=90~120 nm. This may be due to the formation of new surface layer, good surface roughness, and removal of contamination by the pretreatment of the blasting.

Using the above PVD-TiAlN film, the cutting test was carried out at 271 m/min using a workpiece of SCM440.

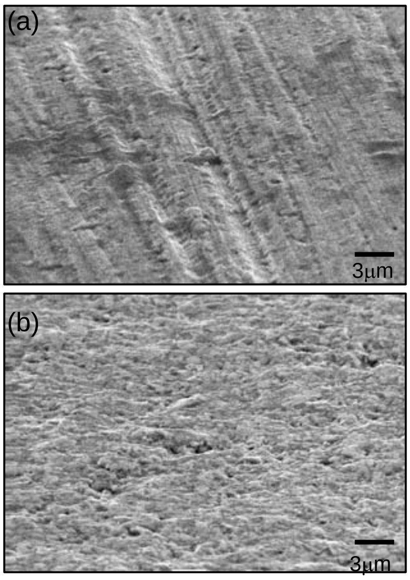

Fig. 1. SEM images of the substrates (a)untreated and (b)pretreated.

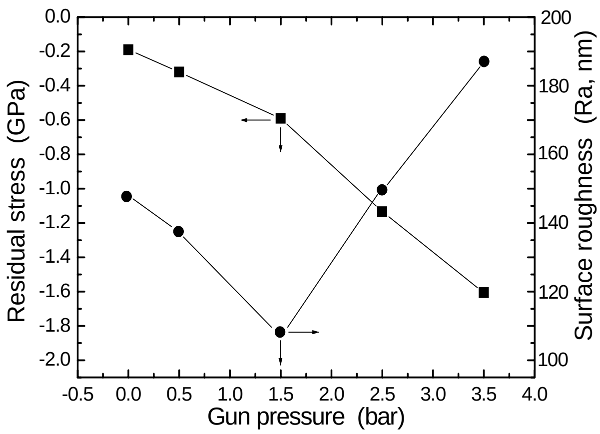

Fig. 2. Residual stress and surface roughness of the substrates pretreated at various gun pressure.

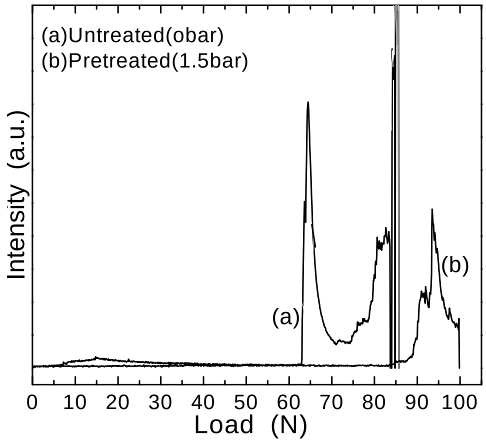

Fig. 3. Scratch test of the substrates (a)untreated and (b)pretreated.

The initial frank wear was low, and good cutting performance was shown at 1.5 bar. This is corresponded to the substrate having the good surface roughness and adhesion.

3. Summary

The effect of pretreatment for the cemented carbide substrate using wet blasting with Al_2O_3 powder to improve the above defects was investigated by change of gun pressure of 0.5 ~ 3.5 bar. The surface roughness of the cemented carbide substrate was improved with increment of gun pressure. A new surface layer was formed, and Co particles were uniformly distributed over the entire surface after pretreatment. The adhesion of the pretreated substrate in same PVD-TiAlN film was improved, and in approximately Ra=90~120 nm shown the best adhesion value and good cutting performance. This may be due to the formation of new surface layer and having good surface roughness by the pretreatment of the blasting.

Acknowledgements

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4. References

1. K.-D. Bouzakis et. al: Surf. Coat. Technol. 174-175, p.393(2003).
2. C. Ducros, V. Benevent and F. Sanchette: Surf. Coat. Technol. 163-164, p.681(2003).
3. K.-D. Bouzakis et. al: Surf. Coat. Technol. 163-164, p. 625(2003).
4. H.K. Tonshoff et. al: Surf. Coat. Technol. 116-119, p. 440(1999).