The Metallization of Diamond Grits

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Abstract

A revolutionary "Active Braze Coated Diamond" (ABCD) has been developed for bonding diamond grits firmly in the metal matrix. The molten braze is wetted and reacted with diamond to form strong chemical bond at the interface so that the diamond does not become knocked out of tools. The ABC is a nickel alloy that can form metallurgical diffusion bondswith the metal matrix. In essence, ABCD turns diamond into a metal grain so that the diamond tools can be made by conventional powder metallurgical process without being concerned about the poor bonding between matrix metal powder and the diamond as before.

Keywords: diamond brazing, saw diamond, bonding strength

Active Braze Coated Diamond (ABCD)

In a conventional diamond saw, diamond grits, in most cases, are knocked off, and hence causing the blade to perform way below its potential. The industry has tried to cope with this problem by coating diamond with Ti, Cr, or Si (e.g. by CVD). Unfortunately, the coating is so thin (e.g. 1 micron) that it may be dissolved in the matrix metal itself. Moreover, the metal coating is easily oxidized, hence making it difficult to for a metallurgical bond with the matrix metal. Consequently, the diamond adherence in the matrix becomes so weak that the performance improvement is marginal.

A revolutionary technology has been developed to resolve the above problem. The diamond is surrounded by a molten braze, making the coating to be much thicker. Not

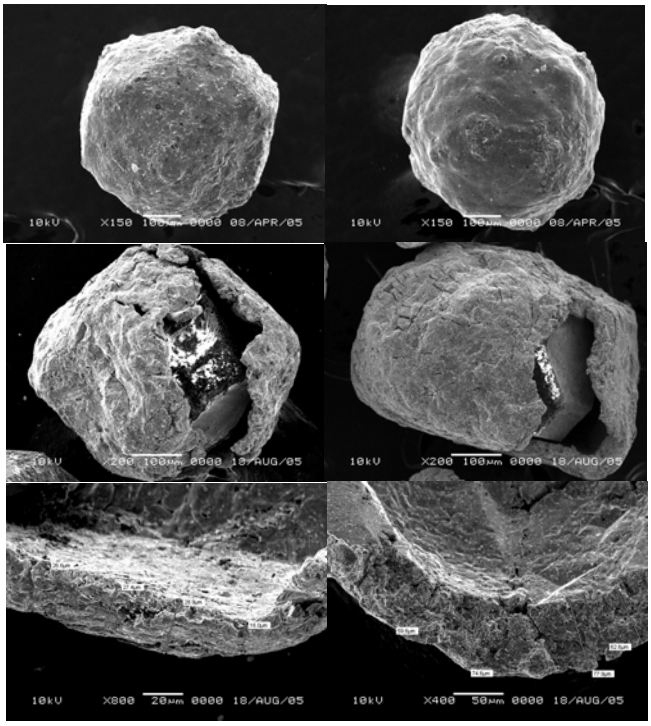

Fig. 1. The outer appearance of ABCD (top diagram), its fractured shell of nickel braze (middle diagram), and the thickness of the braze coating.

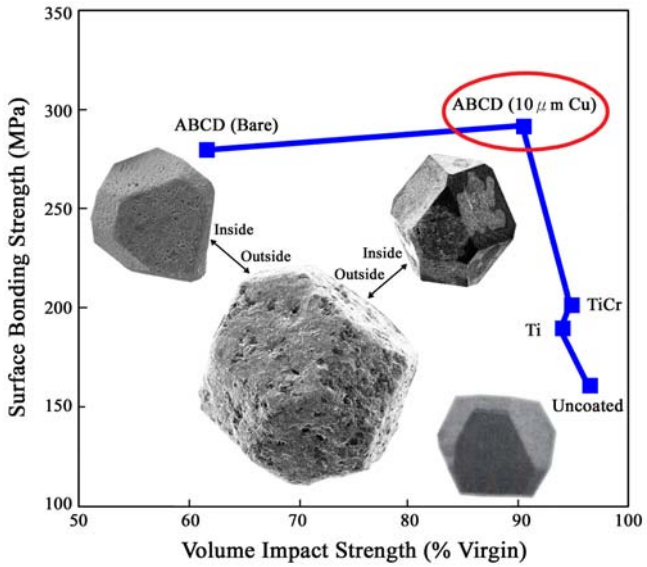

Fig. 2: The trade-off between the surface bonding strength and body impact strength of coated diamond. Note that ABCD can increase diamond adherence significantly, but it is vulnerable to impact. However, diamond's fracture strength is dramatically increased by pre-coating diamond with a thin layer of copper before over-coating it again with a molten braze.

only can the braze wet the diamond to form a strong bond, but it can join matrix metal with diffusion bond. As a result, there is no weak link from diamond to matrix.

Although molten braze facilitates bonding diamond and matrix, the diamond still becomes thermally degraded at high temperature during the coating process due to the severe reaction at the interface. In order to cope with this problem, a copper was used as the reaction moderator. This caused the ABCD to be held firm in the matrix

Molten braze can not only wet diamond to form strong chemical bonding, but it can also join seamlessly with surrounding matrix along it enlarged surface. The result is a full integration of the entire saw segment with no weak plane.

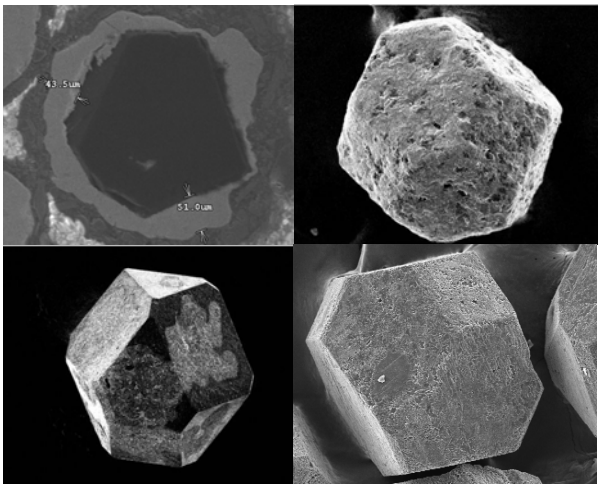

Fig. 3. The outer appearance of ABCD (top right), the polished section of ABCD in the saw segment matrix (top left), acid removed braze showed diamond with carbide still cling to the surface (bottom left), and the diamond surface showed pitting of reaction after the removal of carbide by a strong acid (bottom right).

The advantage of using molten braze coating versus conventional metal coating is immediately obvious by fracturing a saw segment and observe the fractured surface. When the coated diamond is held in a sintered matrix, the fracture surface deflects around diamond. The fracture propagates either between diamond and coating or between coating and matrix. However, the fracture may penetrate through diamond bonded by molten braze coating due to the thermal weakening of the diamond. Furthermore, as the copper moderated ABCD does not have any weak interfaces between diamond and coating, and between coating and matrix, the fracture surface may occur within the coating itself.

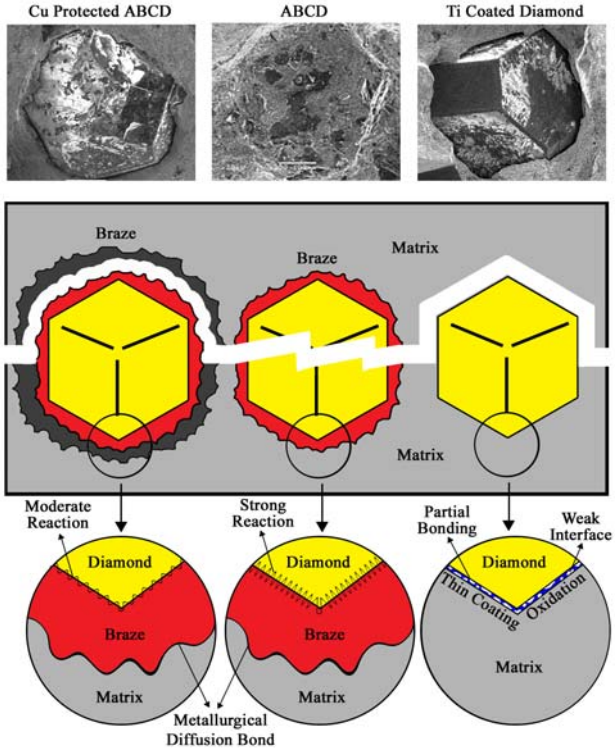

Fig. 4. The fracture plane went around Ti coated diamond held in cobalt matrix (right diagram). The fracture passed through the diamond of ABCD (middle diagram). The molten braze was torn apart for a copper moderated ABCD (left diagram).

Conclusion

Active braze coated diamond can dramatically increase the bonding strength of diamond in metal matrix. Hence ABCD can effectively increase the cutting speed of a diamond tool at the same time it will increase the survice life of the tool.

References

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