Factors Affecting Surface Finish When Using CBN

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A key issue since the introduction of cubic boron nitride (CBN) has been achieving good surface finish in precision grinding applications. Although CBN provides an acceptable finish for most requirements, it may not be good enough for certain applications.

In order to meet specific surface finish requirements, a number of factors in the grinding wheel's design and in its utilization should be considered. They include:

- o CBN type
- o CBN mesh size
- o CBN concentration
- o Grinding wheel bond type
- o Grinding wheel speed
- o Wheel conditioning parameters
- o Grinding fluid type and delivery methods
- o Grinding machine condition
- o Grinding parameters

Clearly, there are many factors that can affect the surface finish generated in a grinding operation. Because of the difference in wear mechanisms and the long life of CBN wheels, their factors can be different or have a significantly greater impact than when using conventional abrasive wheels.

CBN Type. Microcrystalline CBN products tend to generate better surface finishes than typical monocrystalline CBN. Because of their attritious wear characteristics, these products tend to be less sharp, creating shallower scratches in the workpiece surface. See Figure 1.

CBN Mesh Size. Generally speaking, finer sizes of CBN will produce finer surface finishes. Finer sizes of CBN contain smaller, more numerous particles. Each of these more numerous particles creates a smaller chip and, consequently, a smaller scratch on the ground surface.

CBN Concentration. Higher concentration means a larger number of CBN particles in the abrasive matrix. As with mesh size, the more numerous the number of working particles on the surface of the grinding wheel, the smaller the produced chip and resultant scratch will be.

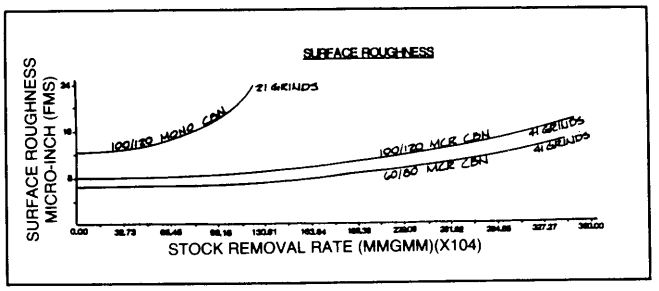

Figure 1

Grinding Wheel Bond Type. CBN wheels made with impregnated bond systems (resin, metal and vitrified) tend to produce better finishes than do electroplated or single-layered wheels. Vitrified CBN wheels, because of their higher abrasive concentration and superior abrasive retention capabilities generally produce the best surface finish within the impregnated bond systems.

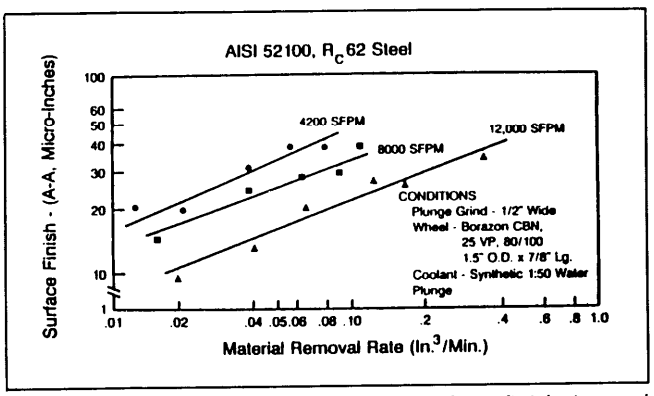

Figure 2. Effect of wheel speed on surface finish internal grinding.

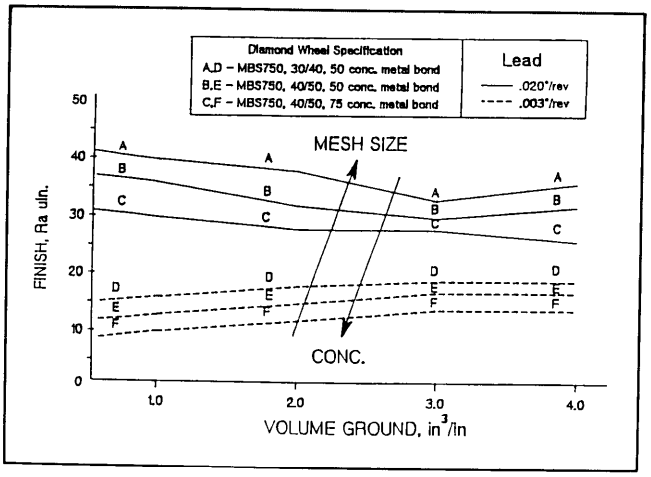

Figure 3

Grinding Wheel Speed. Higher wheel speeds tends to produce a better surface finish — regardless of bond type. This is due to the fact that, at higher speeds, each working crystal produces a smaller chip and, therefore, a shallower scratch. See Figure 2.

Wheel Conditioning Parameters. The design of the truing tool as well as the parameters of the process can dictate, to a large extent, the quality of surface finish generated with a CBN wheel. This is especially true when considering porous vitrified bond wheels. By varying the lead and infeed of the truing operation, the wheel can be made to be very aggressive or to produce a fine surface finish. The mesh size and concentration of the diamond truer as well as the shape and size of the truer itself can also have an effect on the performance of the grinding wheel. See Figure 3.

Grinding Fluid Type and Delivery Methods. As the grinding fluid acts as a lubricant in the grinding operation, its quality can have a major influence on the surface finish generated by the grinding wheel. Fluids with greater lubricity tend to produce a better surface finish — especially when applied to the grinding zone correctly. The use of secondary, high-pressure coolant delivery has also proven to be an effective aid in obtaining improved surface finish. See Figure 4.

TABLE 1
FINISH vs. MESH SIZE VITRIFIED BOND

O.D. Grind SKD11 (D-2) Steel
(HRC 60)
305 × 16 m (12" × 5/8") wheel
1700 m/min (5575 SFPM)

Abrasive	Condition A Monocrystalline CBN (Borazon* CBN Type I)	Condition B Microcrystalline CBN (Borazon CBN 550*)
Mesh Size	140/170	80/100
Concentration	100	200
Average Infeed	.02 mm	.04 mm
G Ratio	52	122
Power (.04 infeed)	1.43 KW	1.78 KW
Finish	18 RMS	4 RMS

* Trademark General Electric Co.,. USA

Grinding Machine Condition. The condition of the grinding machine, particularly with respect to rigidity and lack of vibration, will have a dramatic effect on the surface finish produced. Lower removal rates, especially as a result of lower infeed rates will improve surface finish characteristics.

As surface finish and geometric tolerance becomes more critical in today's manufacturing processes, we must be aware of the factors that affect our ability to meet these criteria. CBN, when understood and properly used, can help meet these requirements while reducing process time and overall manufacturing costs.

Table 1 shows just how dramatic an impact changing a number of these factors can have on surface finish. In this case, CBN could not be qualified to make a part under Condition A because it did not meet the surface finish requirements. Under Condition B, however, CBN was qualified for the production grinding operation.

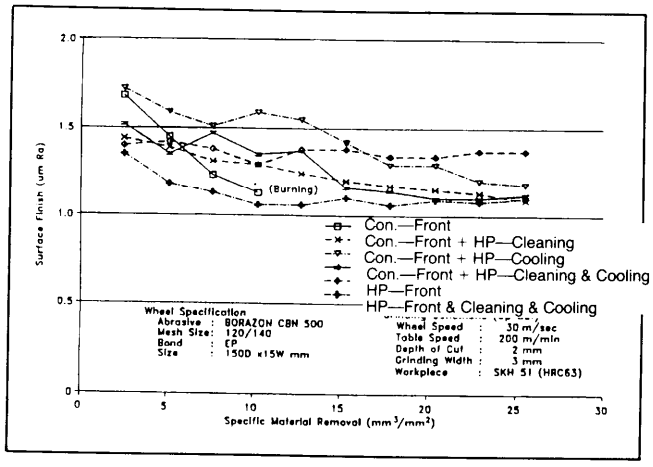

Figure 4. High pressure fluid; surface finish.