

## RVG® WS60 Diamond Demonstrates Superior Performance in Resin Bond Grinding of Silicon Nitride Ceramics

Grinding tests were performed at Diamond Innovations® Application Development Center to determine the most suitable abrasive crystal for surface grinding hot pressed Silicon Nitride (Si<sub>3</sub>N<sub>4</sub>) ceramics. These tests were performed at the request of a job shop who had experienced rapid wheel wear and frequent dress intervals in grinding ceramic components. A friable nickel coated diamond crystal (RVG 880 Diamond) and a spiked nickel coated diamond crystal (RVG WS60 Diamond) were evaluated against an uncoated diamond crystal which had been used in the manufacturer's resin bond grinding wheels. The grinding test conditions and grinding wheel specifications are shown in Table 1.

**Table 1**

Test Conditions	Grade
Grind mode	Surface grinding (upcut)
Wheel speed	(v <sub>s</sub> ) 6,000 SFPM (30 m/sec)
Depth of cut	(a <sub>e</sub> ) 0.0020" (0.051 mm)
Table speed	(v <sub>t</sub> ) 500 ipm (12.7 m/min)
Width of cut	(b <sub>d</sub> ) 0.153" (3.9 mm)
Material removal rate	(Q' <sub>w</sub> ) 1.0 in <sup>3</sup> /in/min (10.8 mm <sup>3</sup> /mm/sec)
Workpiece material	Si <sub>3</sub> N <sub>4</sub>
Coolant	Water soluble oil (5%)
<b>Wheel Specifications</b>	
Wheel type	1A1
Wheel diameter	7.0" (178 mm)
Mesh size	200/230
Concentration	100
Bond type	Phenolic resin

**Figure 1**



### Benefit

Increased friability of an abrasive grain will result in lower normal forces per crystal and reduce the tendency of the crystal to be pulled out of the bond.

### Risk

The benefits of a friable diamond can only be realized if the crystal is *retained* in the grinding wheel bond system.

### Solution

Nickel (Ni) alloy is typically applied to diamond abrasives to improve mechanical retention of crystals in resin bond grinding wheels. RVG WS60 diamond contains a Ni-spiked coating that further enhances the irregularity of the crystal shape.

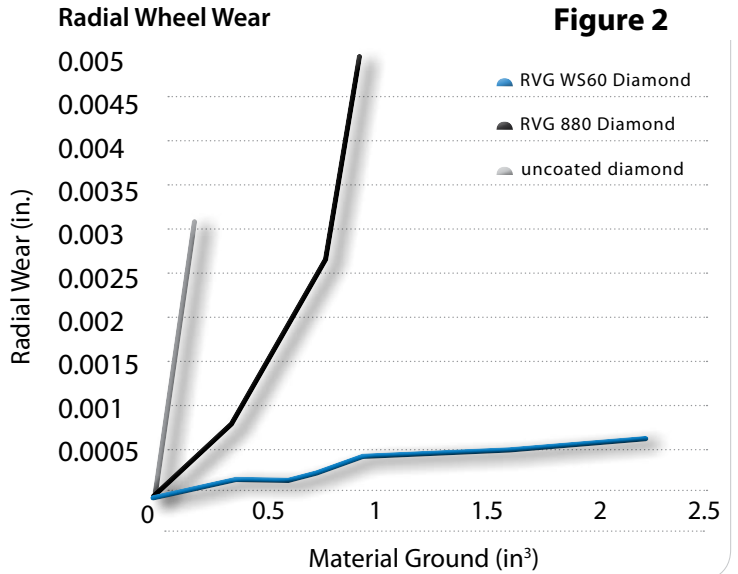
### Test Result

The crystal/bond interface of the grinding wheel is strengthened by the Ni-based coating, maximizing crystal retention in the grinding wheel enabling longer wheel life and maintaining part quality. SEM photographs shown in Figure 1 illustrate the change in texture that occurs to a crystal as Ni coating is applied.

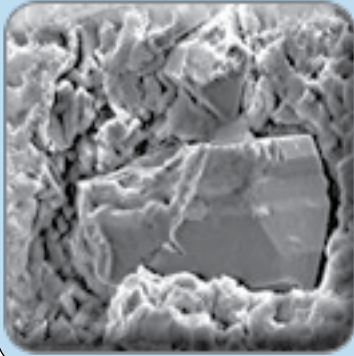
The grinding test results indicate that the wheel containing RVG WS60 product outperformed the wheel which contained RVG 880 product by a factor of 24x in terms of grinding ratio (G).

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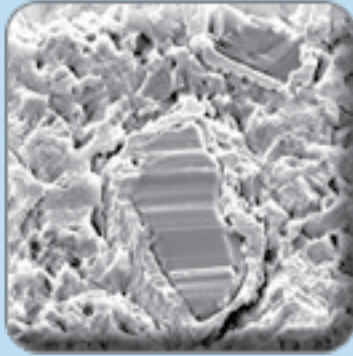
The x-y chart in Figure 2 shows radial wheel wear for the uncoated diamond compared to RVG 880 and RVG WS60 diamonds. Immediate failure is seen with the grinding wheel containing the uncoated diamond, as these crystals are stripped from the bond. RVG 880 product did demonstrate a 50x increase in G compared to the uncoated diamond product but shows a rapid increase in wheel wear over time due to crystal pullout. RVG WS60 diamond shows very consistent performance in a steady state grinding condition.



**Figure 3** RVG 880 diamond



**Figure 4** RVG WS60 diamond

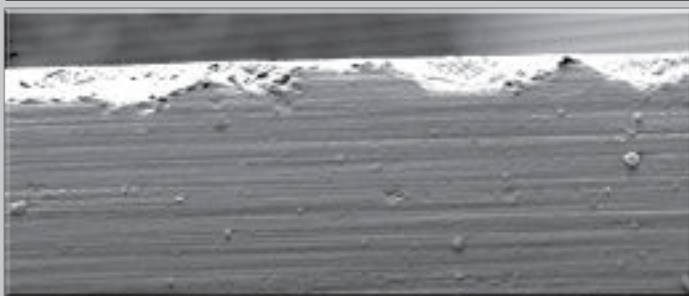


### improved retention

The superior performance seen with RVG WS60 diamond compared to RVG 880 diamond is due to an increased number of crystals retained in the bond. SEM photographs in Figures 3 and 4 illustrate the improved mechanical retention of RVG WS60 diamond crystal compared to the friable RVG 880 diamond crystal. The benefit of the friable RVG 880 diamond crystal is not realized due to the weak bond/coating interface which is responsible for premature crystal pullout.

Maximizing the number of crystals in the bond of the grinding wheel helps keep the theoretical chip thickness and normal force of each individual grain at low levels. This reduces the wear rate of the grinding wheel which promotes longer wheel life.

**Figure 5** Si<sub>3</sub>N<sub>4</sub> Ceramic Ground with RVG 880 Diamond



**Figure 6** Si<sub>3</sub>N<sub>4</sub> Ceramic Ground with RVG WS60 Diamond



This very same principle is also responsible for improvements seen in the edge quality of the silicon nitride ceramic workpieces ground with RVG WS60 diamond. SEM photographs in Figures 5 and 6 show a significant reduction in edge fracturing of the ceramic component that was ground with the wheel containing RVG WS60 diamond compared to RVG 880 diamond.

### summary

These test results show that crystal retention is the single most important factor in maximizing productivity and quality in the grinding of ceramics with resin bond grinding wheels. The enhanced coating characteristics of RVG-WS60 diamond demonstrate huge cost savings in grinding technical ceramics and bring real value to the ceramic grinding industry.