Noritake Proposal

Featured Products and Technology

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“Ultra” Long Life wheel enables both ‘Reducing wheel cost’ and ‘Improving productivity’

Vitrified-bond CBN wheel used in the grinding process in various industrial fields such as automobiles and bearings

As good cutting ability tends to result in shorter wheel life, Noritake has developed “MEGA-LIFE WHEEL” offering both “cutting ability” and “ultra” long life by focusing on homogeneous structure and high-strength bond.

Vitrified-bond CBN wheel

MEGA-LIFE WHEEL

[Scope of application and expected benefits]

Metallic material		Non-metallic material		Other
Ferrous material	Non-ferrous material (Al, etc.)	Inorganic material (glass, ceramics)	Organic material (rubber, plastic)	Advanced material
●				

Shorter cycle time	Improved tool life	Improved machining quality	Improved workability	Environmental consideration
●	●	●		

Aiming for Improved Grain Homogeneity and New High-strength Bond

Difficulty in meeting all targets

Vitrified-bond CBN wheels which use cubic boron nitride for the abrasive grains (grains) are particularly employed for high efficiency, long life, and automation. To be more specific, they are used in a variety of applications such as for the cylindrical grinding of crank shafts, centerless grinding of needle rollers for bearings, and inner surface grinding of injection nozzles. Cam profile grinding in particular involves machining material such as chilled cast iron or ductile cast iron, and tends to present problems when it comes to achieving the required quality (surface roughness, profile accuracy, chattering (Fig. 1), etc.) and surface condition (grinding burn (Fig. 2), cracks, residual stress, etc.)

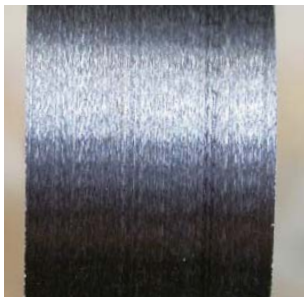


Fig. 1 Chattering

Fig. 2 Grinding burn

A wheel with good cutting ability may be chosen as a countermeasure for this, however, such wheels tend to have short wheel life, and problems such as (1) increased tool cost and (2) lower productivity (significantly more frequent dressing and tool change) occur.

The use of vitrified bond CBN wheel with harder grade and high concentration is the most effective way to extend wheel life. However, the traditional wheel tends to increase grinding force due to dull cutting edges. Consequently, there would be a high possibility to generate the cracks in some applications. [1] To overcome this situation, we developed "MEGA-LIFE WHEEL" which delivers both cutting ability and long life.

Benefits of MEGA-LIFE WHEEL

To evaluate the grinding performance of MEGA-LIFE WHEEL, we conducted a grinding test and compared the results with a traditional wheel under the test conditions in Table 1 for the cam profile grinding method mentioned earlier. The results showed that MEGA-LIFE WHEEL improves surface roughness maintainability, resulting in longer dressing interval by 90%, and reduces wheel wear by 34% (Fig. 3). The power consumption was high at approximately 40%, however, the surface ground by MEGA-LIFE WHEEL didn't indicate any cracks, compared to the traditional wheel shown as Fig.4. We believe that homogenous structure provided high power consumption. From these results, we can say that MEGA-LIFE WHEEL is a product with reduced tool cost and improved productivity, and which realizes ultra-long life, and it is currently in use by many of our customers.

Table 1 Test conditions

Grinding method	Cam profile grinding
Workpiece	Chilled cast iron material (FC250)
Grinding wheel speed	160 m/s
Grinding efficiency*	Z' = 176 mm³/mm•s
Dresser	Metal rotary type

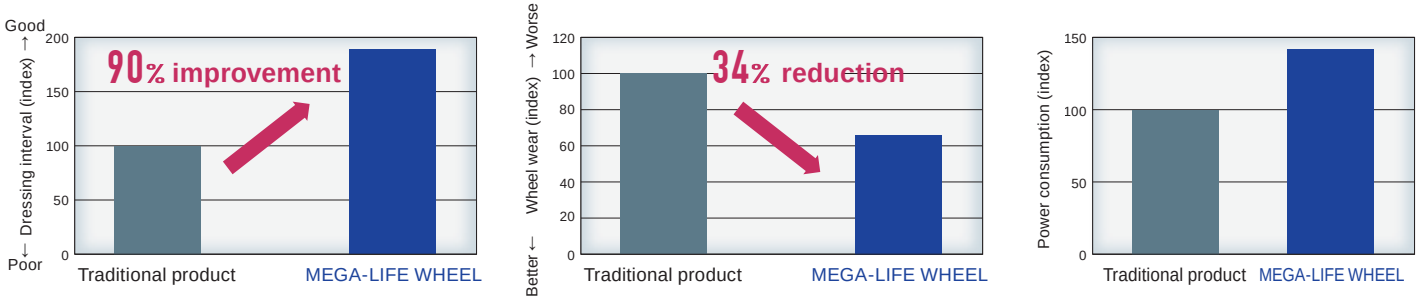


Fig. 3 Test results

Fig. 4 Grinding test results (cracking inspection)

Let's now take a look at the viewpoints and ingenuity behind the development of Noritake's MEGA-LIFE WHEEL, for which outstanding grinding performance has been verified.

Noritake ingenuity in extending wheel life

- Development of new bond VML1

As grinding progress, the surface roughness may gradually deteriorates due to a decrease in sharp cutting edge of the grain tips and break down. As it is necessary to regularly dress the wheel to be recovered, it is important to increase the number of workpiece per dressing cycle. The breakdown is the largest factor that determine surface quality of workpiece. Therefore, grain, grade, concentration and bond are optimized to avoid break down.

It is essential to improve the ability to hold CBN grains, which means that the development of a new bond is the most important. The VML1 bond shows higher grinding wheel strength than traditional one by 50% shown in Fig. 5.

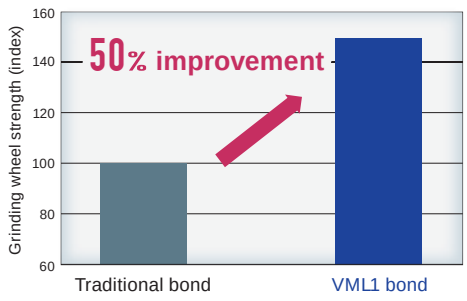


Fig. 5 Grinding wheel strength

Adoption of Noritake's homogeneous structure for high-accuracy, high-quality

When applying a vitrified-bond CBN wheel using high-strength bond for cam profile grinding during the MEGA-LIFE WHEEL development process, we found that grinding resistance increased and surface condition of workpiece deteriorated (grinding cracks, etc.) as grinding wheel strength increased. Figure 6 (a) illustrates a structure with low dispersibility of CBN grains. In this structure. grinding heat tends to occur at the area where grains are highly concentrated, and both cutting ability and coolability were insufficient. It is believed that this would be more notable in high-efficiency grinding such as cam profile grinding, and so a wheel with the homogenous structure shown in Fig. 6 (b) has been developed.

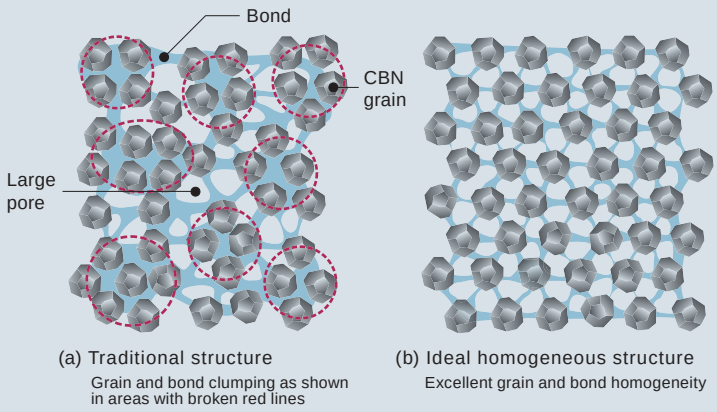
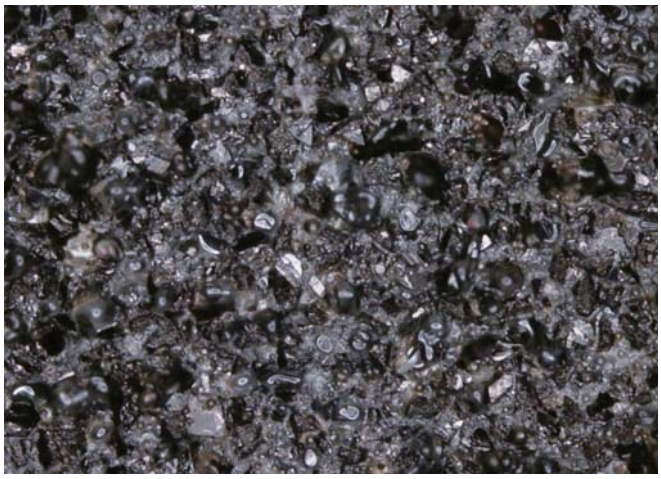
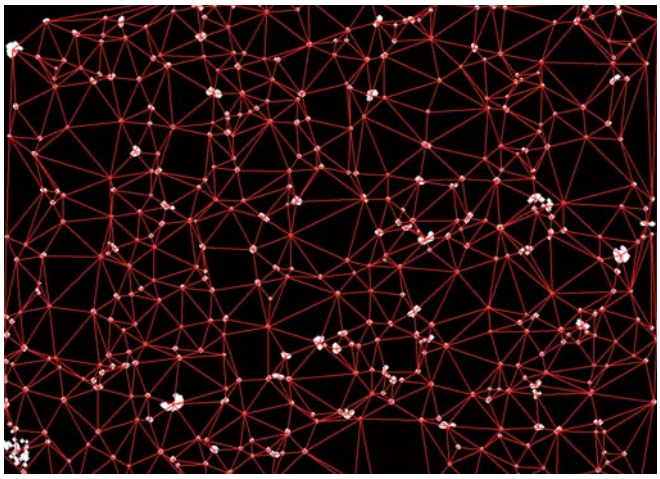


Fig. 6 Vitrified-bond CBN wheel structure

We also considered the best way to evaluate the dispersibility when developing the homogeneous structure. With the traditional structure shown in Fig. 6 (a), there are both areas with dense structure with grains highly concentrated, and areas with open structure with large pores, resulting in a great variation in distance between neighboring grains. With the homogeneous structure shown in Fig. 6 (b) on the other hand, there was little variation in distance between neighboring grains. We then decided to focus on this, and evaluated the dispersibility based on the standard deviation and the coefficient of variation of distance between neighboring grains. An image of actual vitrified-bond CBN wheel that was partially



(a) Grinding wheel surface photo



(b) Analysis result

Numerical analysis of the distribution of distance between grains (red lines)

Fig. 7 Method used to evaluate homogeneous structure

enlarged and observed is shown in Fig. 7 (a), and the result of image processing of this photo is shown in Fig. 7 (b). The white dots in Fig. 7 (b) indicate grains, and the length of the red lines joining neighboring grains is the distance between grains. We were able to confirm that structure with improved dispersibility in Fig. 6 (b) exhibits a 20% improvement in variation in distance between grains over the traditional structure in Fig. 6 (a) (Fig. 8) [2]. Noritake then released "MEGA-LIFE WHEEL", a vitrified-bond CBN combining technology used to improve the dsipersibility of CBN grains with high-strength VML1 bond.

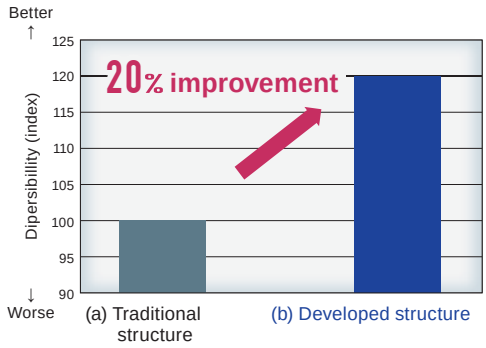


Fig. 8 The dispersibility of CBN gains in grinding wheels

Use in various applications

In addition to cam profile grinding, MEGA-LIFE WHEEL has been applied for centerless grinding contour grinding (Fig. 9, Fig. 10), and groove grinding, which particularly require wear resistance and shape retention. Here we'll introduce an example based on contour grinding. Contour grinding is a method which involves grinding workpieces to the desired shape by feeding a pre-shaped vitrified-bond CBN wheel (see Fig. 9 for example of shape) as shown in Fig. 10. As shape collapse occurs from the preshaped area as grinding prog, this grinding method requires shape retention.

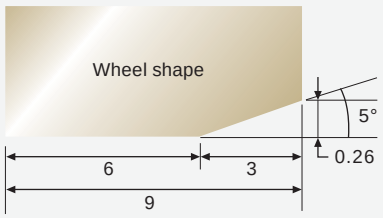


Fig. 9 Test vitrified-bond CBN wheel shape

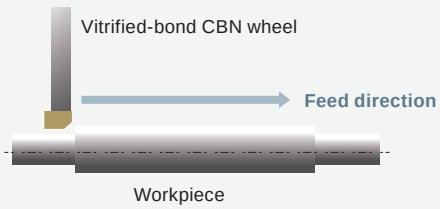


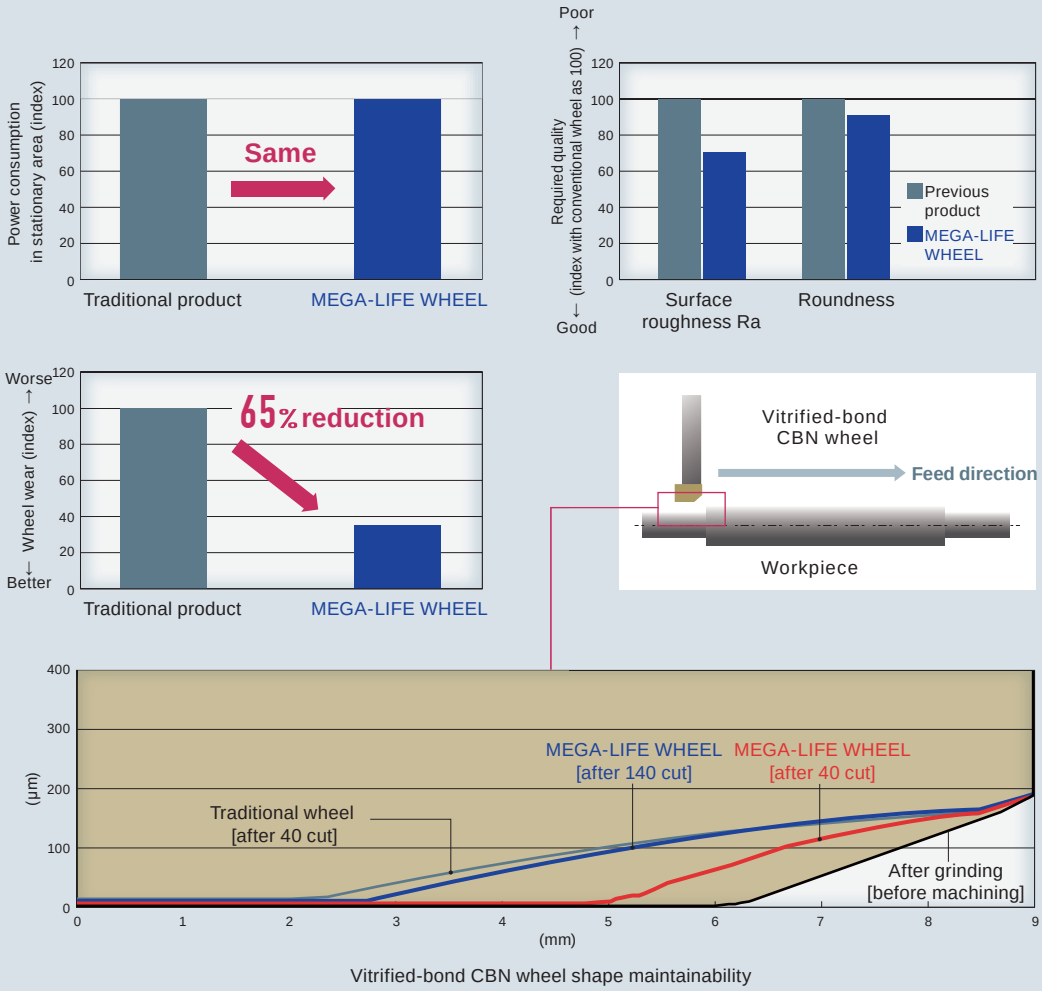
Fig. 10 Contour grinding test method

We conducted a grinding test under the test conditions in Table 2 for the purpose of verifying wear resistance and shape retention.

Power consumption, amount of wheel wear, required quality (surface roughness, roundness), and wheel shape are shown in Fig. 11. The power consumption during grinding is the same as that for the traditional wheel, the amount of wheel wear decreased by 65%, and better results were also obtained for the required quality such as roundness and surface roughness over the traditional wheel. MEGA-LIFE WHEEL has also been positively received in fields where importance is placed on shape retention.

Table 2 Test conditions

Grinding method	Cylindrical grinding (contour grinding)
Workpiece	SCM 435, hardened
Grinding wheel speed	120 m/s
Feedrate	580 mm/min



Vitrified-bond CBN wheel shape maintainability

Fig. 11 Test results

In addition to applications introduced here, we also expect even higher grinding process accuracy and higher quality, as well as even further process integration in the future. To achieve process integration, grinding wheels with predominantly higher performance than ever before will be required, and so we at Noritake are developing even higher performance grinding wheels based on the knowledge obtained here.

[Notes]

* Grinding efficiency: Volume of work stock removed per unit time

[Literature]

[1] Kouichi Yoshimura: Vitrified-bond CBN Wheel "MEGA-LIFE WHEEL" Realizing Machining Cost Reductions, Mechanical Engineering 63, 10 (2005) 70-72.

[2] Kouichi Yoshimura, Akihiro Mizuno, Takeshi Mishima, Kazumasa Yoshida, Hiroshi Hoshino, Fukuo Hashimoto: DEVELOPMENT OF NOVEL LONG-LIFE CBN GRINDING WHEEL AT HIGH EFFICIENCY CONDITION, MSEC2014, Detroit, Michigan, USA, 2014 Proceedings of the ASME 2014 International Manufacturing Science and Engineering Conference

Q Is there no suitable workpiece material other than castings?

A As mentioned earlier, we have results for SCM contour grinding, and SUJ2 centerless grinding. Moreover, application may be possible for other materials by lowering the concentration.

Q What applications do you have performance results for?

A We have many results for heavy-duty grinding such as cam profile grinding and contour grinding. We also have case studies for groove grinding which require shape retention, and centerless
grinding for which there is a particular need for long-term durability.

Q & A