Noritake Proposal

Featured Products and Technology

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Uniform Structure Vitrified wheel Enabling “Difficult to cut” materials and High Efficiency Grinding

When the abrasive grains are poorly dispersed and forming aggregates, significant frictional heat is generated at these aggregates, causing workpiece to form altered layer and loading, and shortening wheel life.
Noritake has developed homogeneous structure vitrified-bond grinding wheels “Super Uniform” and “NonClotty” with focus on abrasive grain dispersibility to suppress grinding heat and Loading, and improve grinding wheel shape retention.

Homogeneous structure vitrified-bond grinding wheel series

Super Uniform, NonClotty

[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	Improved workability
●	●	●		

Influence of Abrasive Grain Homogeneity on Grinding

Vitrified-bond grinding wheel requirements

Many of our customers require “grinding wheels with good cutting ability and long life”.

Normally, as grinding wheels lose their cutting ability and their shape, dressing is applied to restore their grinding performance.

One of the elements that determines grinding wheel life is the number of workpieces ground per one dressing cycle (dress interval), and customers require not only that cutting ability to be maintained, but also dressing interval and grinding wheel life to be extended.

Noritake developed a new bond system enables homogeneous dispersion of abrasive grains (grains) and pores, and employed this technology in "Super Uniform", a grinding wheel designed to offer better sharpness and longer life than conventional wheels.

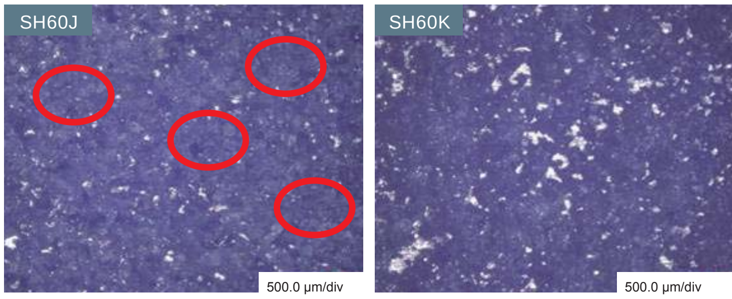
By dispersing grains homogenously, the grains cut workpieces at constant interval just like a saw, and maintain consistent cutting ability. Moreover, in response to demands for high-efficiency grinding and high quality in recent years, grinding wheels tend to be of porous structure, and so Noritake has developed “NonClotty”, a grinding wheel that achieves porous structure employing this same homogeneous concept.

Overcoming problems with homogeneous structure

One object that poses a challenge to grinding wheels is the turbine blades used in thermal power equipment and aircraft engines. Turbine blades are used at high temperatures in excess of 1000 °C, so they are made of heat-resistant steel. This type of steel tends to be strong and sticky, and so it is not only extremely difficult to grind, but generally have poor thermal conductivity, making it difficult to release grinding heat. This means that grinding heat tends to remain in the workpiece more than it does with normal steal grinding.

When grinding heat-resistant steel, problems such as grain wear and loading* occur due to the previously discussed features, and this leads to the excessive grinding wheel wear due to grain loss, and a work-hardened surface layer caused by grinding heat.

Fig. 1 shows grinding wheel observation photos after grinding when conducting an internal grinding test of heat-resistant steel. In this photo on the left, grain loss has occurred, and in the photo on the right, grain wear and loading have occurred. We were unable to solve this defect simply by adjusting grains, structure, and bonding strength.



Areas of breaking down (area ○ in photo: no white dotted areas) observed

Many areas of wear, adhesion (white dotted areas in photo)

Fig. 1 Grinding wheel surface observation photo after grinding

Observation results obtained from an internal grinding test revealed that with grinding wheels using the traditional bond system, the distances between neighboring grains varies as shown in Fig. 2, and that attrition wear of grains and loading progress at the areas where the grains are

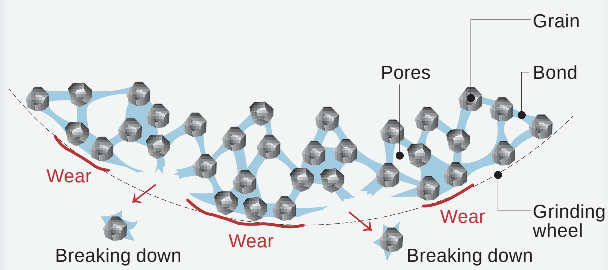


Fig. 2 Grinding wheel structure schematic diagram (traditional structure)

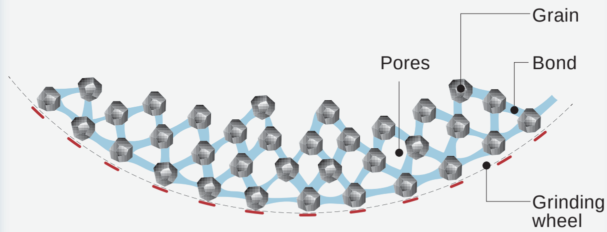


Fig. 3 Grinding wheel structure schematic diagram (homogeneous structure)

close together, and on the other hand wheel break down progress at the areas where grains are widely spaced.

To minimize such defects, controlling the distance between grains more than that of the traditional structure is believed to be effective.

We believe that grinding wheels with highly homogeneous structure as shown in Fig. 3 presents localized grain wear and grain loss, improving cutting ability and shape retention.

We aimed to develop a grinding wheel with structure in which grains are more homogenously dispersed.

Development points, quantification

We focused on the importance of controlling homogeneity, and developed technology that allowed us to understand how homogeneity can be controlled, and how it can be evaluated.

The evaluation method applied from this development is to analyse cross-sectional images of grinding wheels. The homogeneity is evaluated with grain density distribution standard deviation values (Fig. 4), and we set the optimum values for division size and number of samples.

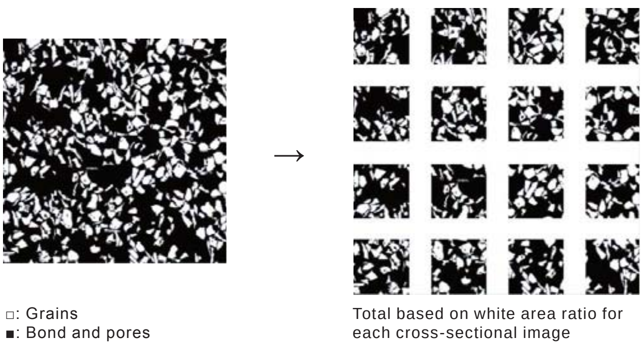


Fig. 4 Method used to evaluate grain dispersibility from cross-sectional image of grinding wheel

Dispersibility evaluation results for the grinding wheel surface after dressing of both the developed wheel with controlled homogeneity and a traditional wheel are shown in Fig. 5.

The grinding wheel with homogeneous structure exhibited few clumps of grains, as well as homogenous dispersion of grains on the grinding wheel, and there was little variation or standard deviation in grain area ratio.

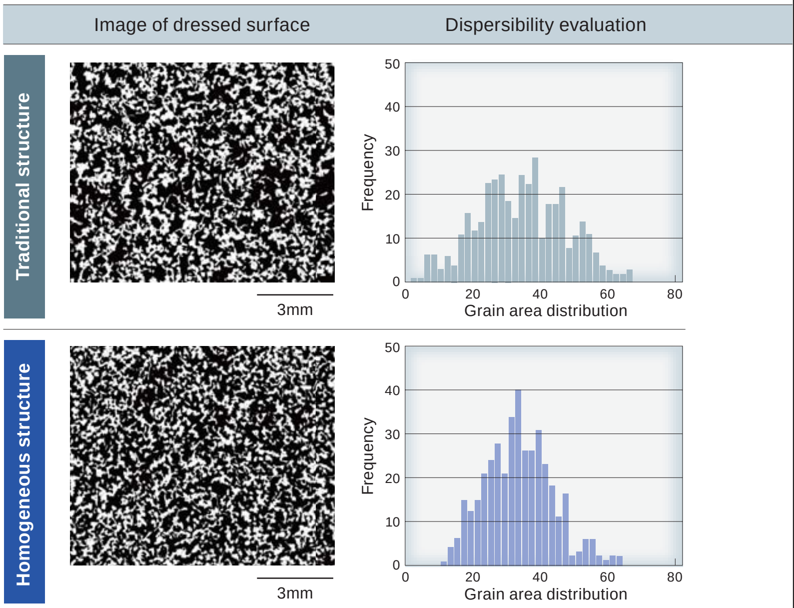


Fig. 5 Dispersibility evaluation results for traditional and homogeneous structure wheels

In order to compare newly developed homogeneous structure grinding wheel with traditional structure grinding wheel, we conducted a grinding test against heat-resistant steel, which is a difficult-to-cut material, under the conditions shown in Table 1, and obtained the results in Fig. 6.

Table 1 Test conditions

Grinding method	Surface Grinding (Wet)
Wheel dimensions	ϕ205 × t19 × ϕ76. 2
Grinding Wheel speed	33 m/s
Workpiece	Heat-resistant steel
Table feedrate	0.33 m/s
Infeed	10 μm/pass
Total stock	3 mm
Coolant	Water soluble

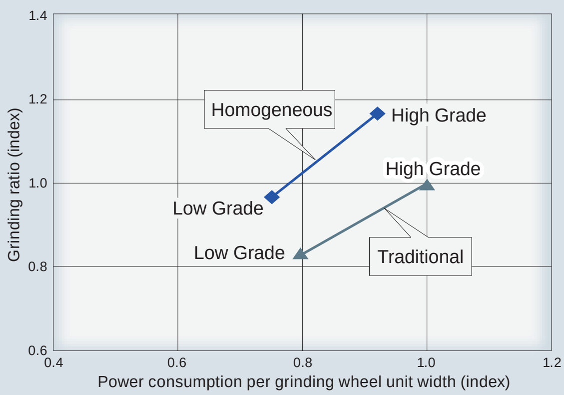


Fig. 6 Grinding test results

The X- axis shows the power consumption per grinding wheel unit width, and it tends to show that the smaller the value, the better the grinding wheel cutting ability. The Y-axis shows the grinding ratio* value, the amount of workpiece ground per unit amount of grinding wheel wear, and greater value generally means better tool life. The homogeneous structure (◆) has a lower power consumption and higher grinding ratio than the traditional structure (▲), in other words, the homogeneous structure offers both superior cutting ability and higher grinding wheel wear resistance.

Noritake developed a grinding wheel in which homogeneity was controlled, and employed this technology to bring our customers a product suited to their applications, and to their needs. If shape retention is the first priority, we recommend “Super Uniform”, a grinding wheel with dense structure, or if cutting ability is the first priority, in such to prevent burning, we recommend “NonClotty”, a grinding wheel with open structure (Fig. 7).

Use in various applications

Noritake’s homogeneous structure vitrified-bond grinding wheels “Super Uniform” and “NonClotty” are grinding wheels initially developed for heat-resistant steel with high efficiency, high accuracy, and high quality, however, the concept is also valid for other applications, and these products are now used in a variety of different fields such as automobile parts and bearings.

Noritake continues to research and develop ideal grinding wheels that may serve the needs of our valued customers.

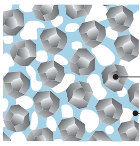
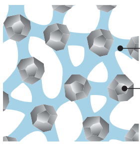
Homogeneous structure	Structure	Application / Requirement
Super Uniform	Dense structure 7, 8 	Shape retention
NonClotty	Open structure 9,10,11,12 	Cutting ability ex. eliminate grinding burn.

Fig. 7 Super Uniform and NonClotty

[Notes]

* Loading: State in which workpieces melt due to the temperature rise produced by grinding heat, etc., and adhere to the surface of abrasive grains, grinding wheels
* Grinding ratio: Value obtained by dividing the amount of workpiece stock that has been removed by the amount of grinding wheel wear

Q **Can these products be manufactured with CBN grains?**

A No. These products use only alumina grains (A type conventional grains).

Q **Does the maximum grinding wheel speed differ compared to traditional open structure grinding wheels (porous type)?**

A There is no difference. The speed is the same if the grit size, grade, and structure are the same.

Q&A