Noritake Proposal

Featured Products and Technology 04

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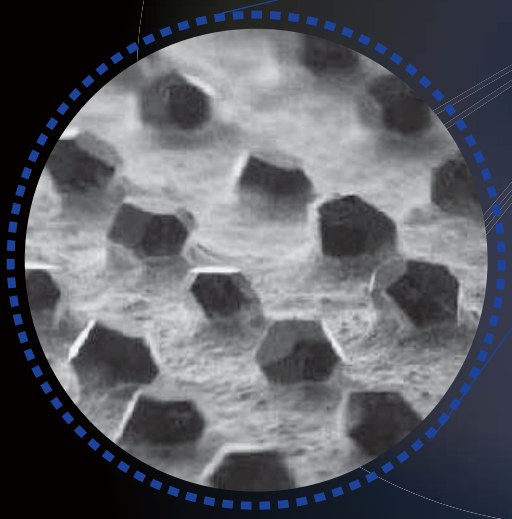

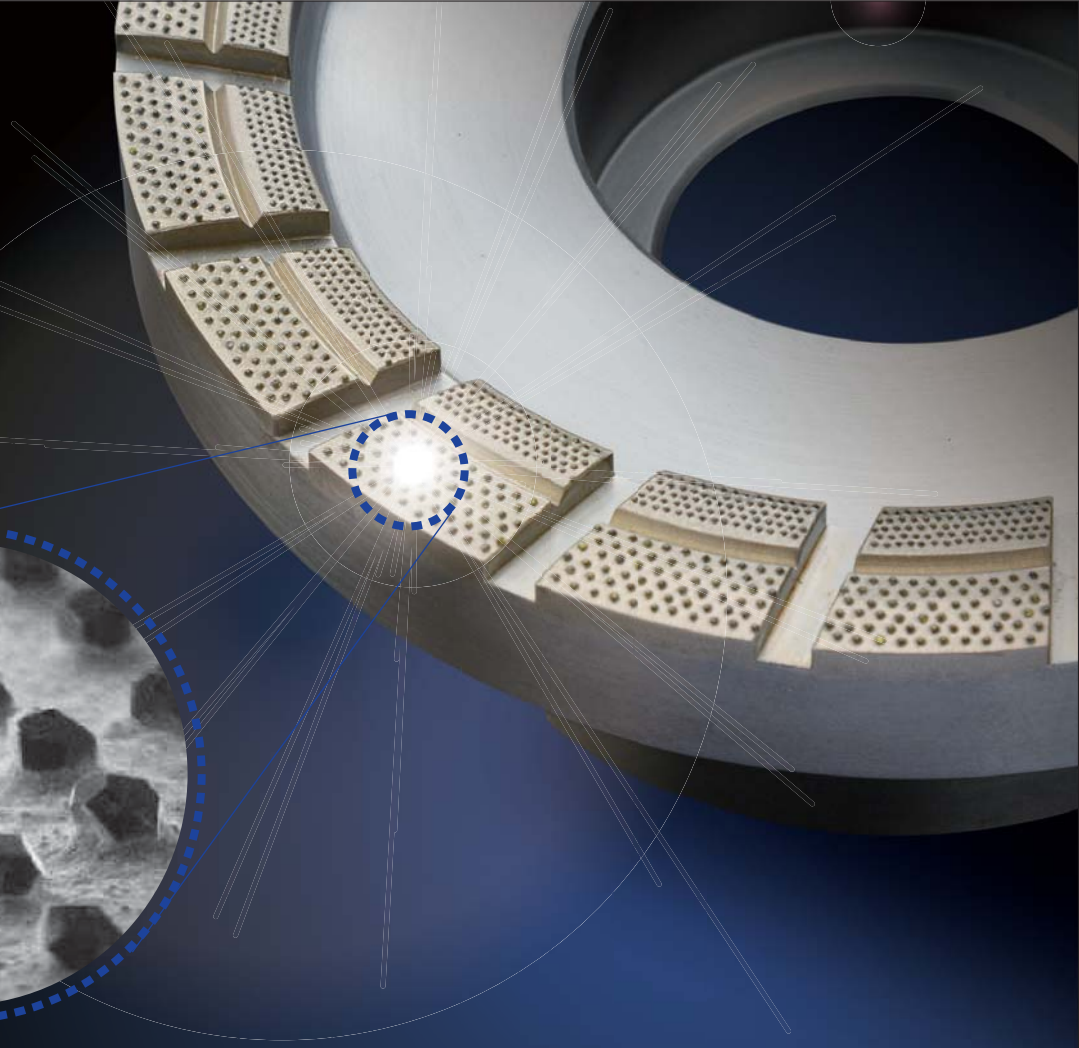

New concept of grinding tool achieving both ‘High efficiency’ and ‘surface finish in grinding field’

Realizing both machining efficiency and machining accuracy is a difficult issue on the shop floor. Tools generally require sharpness, long life, and machining accuracy. However, it is not easy to develop wheels that can deliver on all fronts. By thinking out of the box, Noritake has developed “Grit Ace”, with grains fixed in single layer, offering sharpness, long life, and machining accuracy through the adoption of unique new technology.

Wheel with grains fixed in single layer

Grit Ace

[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
●	●	●		

Featuring Technology Used to Control Abrasive Grain's "Ordered Arrangement, "Protrusion", "Arrangement Interval", and "Tip Height"

Going beyond the grinding capability, making a milling/grinding wheel into reality

Machining tools capable of responding to demands such as varying production volume, lead time reduction, and cost reduction are in huge demands. At the same time machine and tool manufacturers must continue to innovate technologies and products to meet the demands. The general machining theory is that heavy stock removal is done with rough cutting process, while precision machining requiring high accuracy finish is done with grinding.

As a grinding and polishing equipment manufacturer, we have received many inquiries in the past for tools to replace cutting process with grinding.

We approached such requests by making improvements realizing you can only do so much in modifying the wheel, this lead us in the direction in developing a totally different tool. So, we developed "Grit Ace", a new type of grinding tool employing Noritake's collective technological strengths.

Grit Ace is positioned as a grinding tool that offers both the machining efficiency of milling, and the surface roughness of grinding as shown in Fig. 1. It also is an original Noritake tool using 16 patented technologies.

Grit Ace capabilities

We compared the performance of Grit Ace with a PCD milling cutter on an aluminum alloy workpiece. Test conditions are shown in Table 1, and the Grit Ace appearance is shown in Fig. 2.

Fig. 2 Grit Ace

We used a PCD milling cutter with effective diameter of 100 mm, and 6 cutters.

Table 1 Test conditions

Grit Ace specs	SD 40
Wheel dimensions	ϕ100 × 30T × 31.75H mm
Grinding wheel speed	21 m/s
Feedrate	800 mm/min
Cut depth	1 mm /pass

Wheel spindle load factor is shown in Fig. 3, and surface roughness after machining is shown in Fig. 4. While the wheel spindle load of Grit Ace is the same as that of a PCD milling cutter, the surface roughness value is approximately 1/17, meaning that Grit Ace offers much better surface roughness.

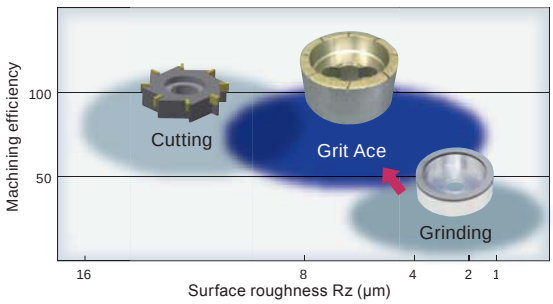

Fig. 1 Grit Ace positioning

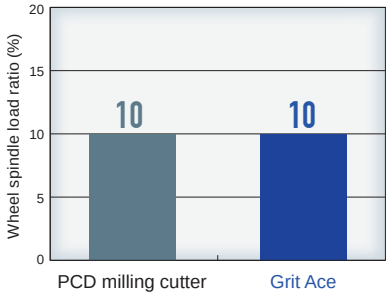

Fig. 3 Wheel spindle load ratio

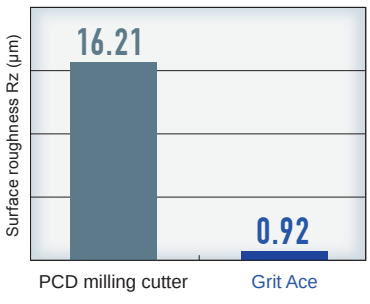

Fig. 4 Surface roughness

Another example is aluminum alloy machine parts. When a PCD milling cutter was used to machine such parts in the past, defects often occurred due to cough surface roughness caused by the cutter. Grit Ace can be used with almost the same machining efficiency as that of a PCD milling cutter, but with significant defect reductions due to smooth surface roughness. We also conducted a verification test of surface roughness and tool life. The test conditions are shown in Table 2, and the results are shown in Fig. 5.

Table 2 Test conditions

Conventional tool	PCD milling cutter
Grit Ace specs	SD40
Wheel dimensions	ϕ200 × 50T × 47.6H mm
Machine used	Vertical spindle machining center
Workpiece	Machine parts (aluminum alloy)
Grinding wheel speed	58 m/s
Cutting stock	0.5 mm/pass

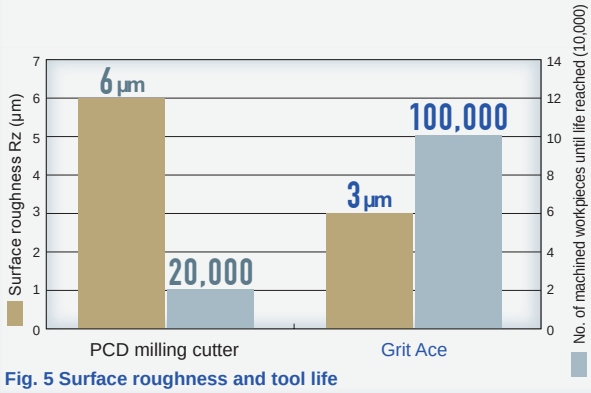

Fig. 5 Surface roughness and tool life

The test results revealed that the Grit Ace surface roughness was finer than that of the PCD milling cutter, and it was able to reduce the initiate defect rate issue. Moreover, results showed that the number of workpieces machined before the end of tool life was greater for Grit Ace, allowing tools to be replaced less frequently. Conventionally, there was the cutting process using a PCD milling cutter, and this was followed by the grinding process. However, the use of Grit Ace allows the cutting process to be omitted, and with an extended tool life, facilitating significant productivity improvements and reduction in workload. So what kind of grinding tool is Grit Ace? Let's take a look at the secret to its versatility.

Secret 01 Enabling Machining with High Efficiency [Ordered Grain Arrangement]

One of the secrets behind high machining efficiency is having ordered grain arrangement. Fig. 6 shows the surface of Grit Ace enlarged, allowing us to see the ordered grain arrangement.

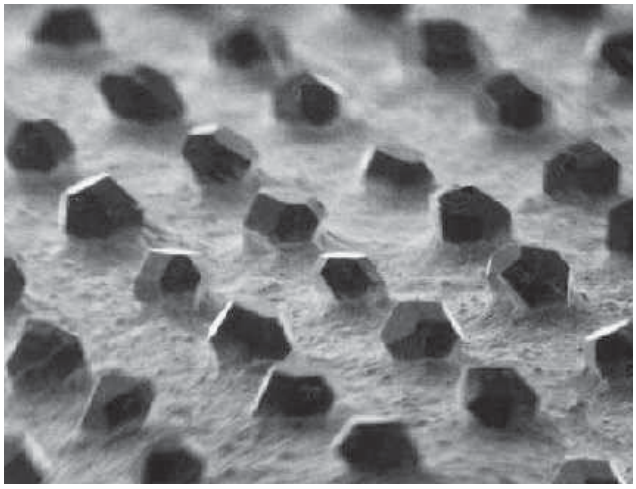

Fig. 6 Ordered grain arrangement

Noritake has been forging ahead with the development of grinding wheels with homogeneously dispersed abrasive grain (grain) structure. The process to have equal and ordered arrangement of grains is difficult to do. But, it is also a very important element in improving grinding efficiency and surface quality.

So why is it difficult to achieve machining efficiency with conventional grinding wheels to that required with cutting process. The reason lies in the chips discharged when machining, and the grinding wheel structure. Generally speaking, the chips discharged from the contact point are larger when machining with high efficiency. As those experienced in cutting knows, chips become larger when the tool infeed, or the tool workpiece feedrate is increased. This phenomenon is very similar with grinding wheels. Grinding wheels are made up of countless grains, however, when the interval between neighboring grains is not uniform, or if there are locations with narrow gaps between grains, these locations are prone to glazing

loading* or loading*. This results in a drop in wheel sharpness, which in turn reduces grinding efficiency.

With Grit Ace, we realized the importance of the ordered grain arrangement and developed the technology into reality. What's more, the grinding heat produced at the machining point is easily dissipated into the atmosphere with an ordered grain arrangement, allowing adverse effects on workpiece quality, such as grinding burn or residual stress, to be reduced.

Secret 02 Enabling Machining with High Efficiency [Grain protrusion]

Another secret behind realizing high machining efficiency lies in high grain protrusion. Conventionally, electro plated wheels have mainly been used when placing importance on machining efficiency. Electro plated wheels have the structure shown in Fig. 7, and grains are secured by plating them onto metal known as base metal*.

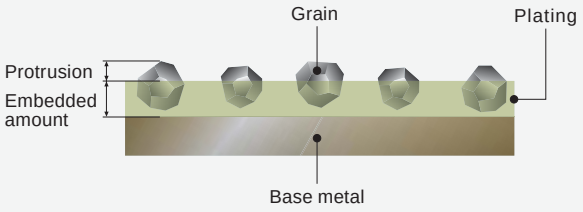

Fig. 7 Electro plated wheel structure

Electro plated wheel sharpness tends to be better the more the grains protrude from the plating. Higher grain protrusion makes it easier for grains to eat into the workpiece, improving chip discharge, in result achives a high machining efficiency.

Fig. 8 compares grain protrusion in Grit Ace with an electro plated wheel. Grit Ace exhibits protrusion of around 70%, which is greater than even that of the electro plated wheel.

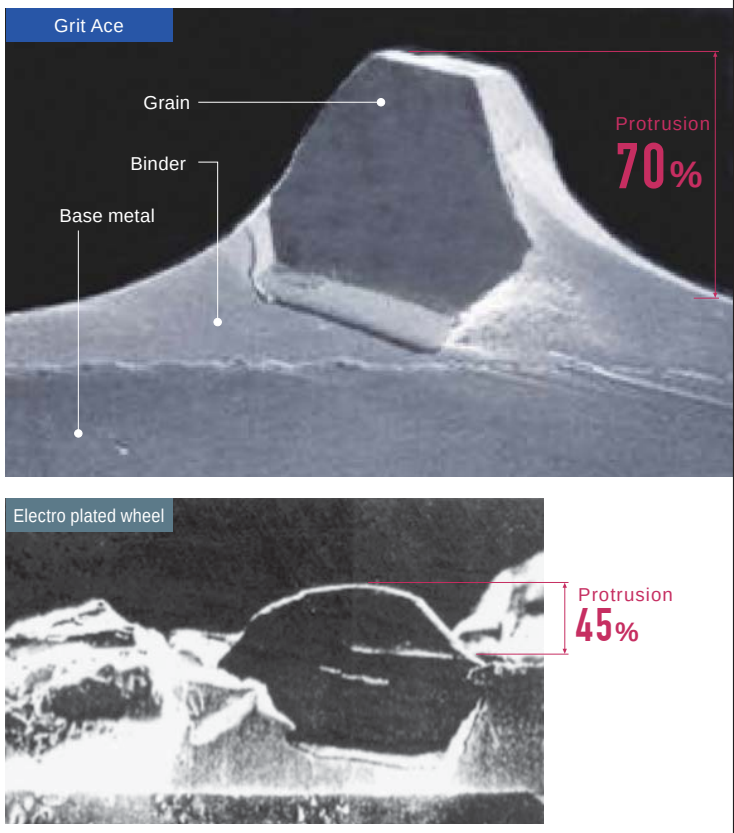

Fig. 8 Grain protrusion and retention state

There are also demerits, however, if the protrusion is too great. Breaking bown occurs if the force holding the grains is too weak, and this results in a drop in tool life. Grit Ace offers high retention using a powerful binding method different from that used in electro plated wheels, suppressing grain loss even when performing high-efficiency machining.

Secret 03 Achieving Good Surface Roughness [Ordered grain interval]

Normally, when the tool is sharp enough to achieve such high cycle time, the surface finish of the part tends to be very rough. Provided that the cycle time lies within the permissible range, the surface roughness becomes finer by changing machining conditions such as by lowering the workpiece feedrate or (cutting speed), or by using grinding

tools with grains with finer grain size. Incorporating the idea to freely change the grain arrangement interval, the Grit Ace gives us the ability to achieve the target surface roughness (Fig. 9). Overzealousness in our pursuit of surface roughness, however, can lead to a drop in sharpness sacrificing the machining efficiency.

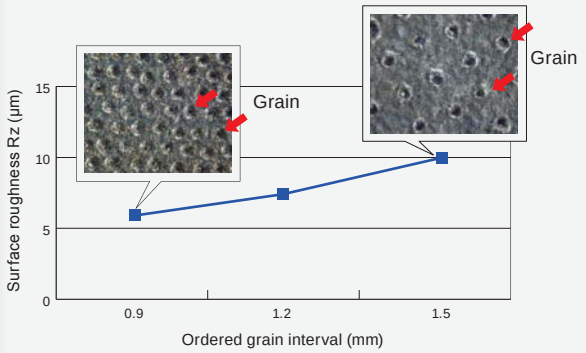

Fig. 9 Changes in grain arrangement interval and surface roughness

Secret 04 Achieving Good Surface Roughness [Grain tip height]

One other key element in ensuring stable high-accuracy finished surfaces is the grain tip height. An uneven tip height will result in uneven depth-of-cut and load on the workpiece. To ensure the tips are ever, a procedure called trueing*, which involves aligning the grain tips as shown in Fig. 10 (a), is performed on Grit Ace. Photos of grains before and after trueing are shown in Fig. 10 (b).

Before trueing, there are some particularly high grains such as that indicated by the arrow. Performing trueing here allows us to align the grain tips without cracking them. However, too much truing max lead to a drop in sharpness and the sacrifice of machining efficiency.

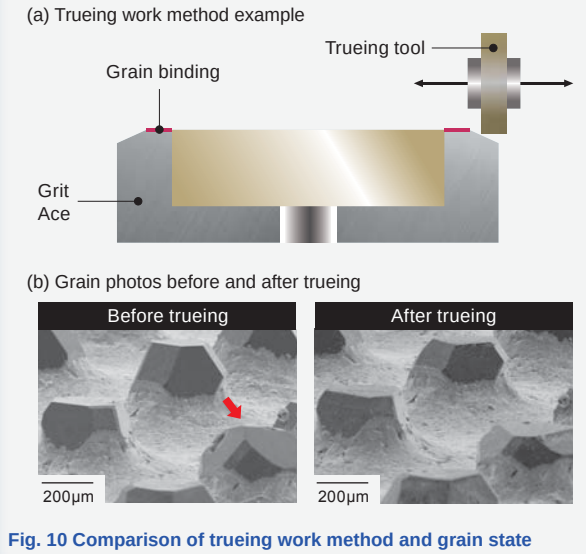

Fig. 10 Comparison of trueing work method and grain state

Introducing to burgeoning markets

Grit Ace can be used for a wide range of applications which demand high-accuracy, high-quality machining in the field of non-ferrous materials machined with high-efficiency cutting. Here are some examples.

- **Aluminum engine blocks**
- **Alloy brake pads**
- **Cast iron compressor parts**
- **Plastic lenses**

In addition to the previously mentioned applications, we believe that Grit Ace is also the ideal solution for applications requiring improved workpiece surface roughness and surface quality without sacrificing the machining efficiency of cutting. We hope that Grit Ace will continue to contribute to the productivity improvements our customers demand.

[Notes]

* Base metal: Metal on which binds grains
* Glazing: State in which workpieces melt due to the temperature rise produced by grinding heat, etc., and adhere to the surface of grains, grinding wheels
* Loading: State in which the grinding wheel pores are blocked with chips
* Trueing: Grinding wheel shape correction work

[Literature]

[1] Naoki Toge, Tetsuya Nonoshita, Yasuaki Inoue: Milling Cutter Tools, unexamined patent application 2002-263937, patent 3485544
[2] Yasuaki Inoue, Naoki Toge: Precision Cutting with Single Diamond Layer Bound Wheels, Japan Soc. of Mechanical Engineers Kyushu Branch, papers from regional lecture (2001) 7.

Q Can base metal be re-used?

A No, they cannot be re-used.

Q Can intricate shapes (forms) be manufactured?

A It is not possible in all cases. Please contact your sales representative for details.

Q Is Grit Ace suitable for machining soft, difficult-to-grind materials?

A Grain protrusion is high, and chips are efficiently discharged, and so it is ideally suited for soft material such as aluminum, plastic, or rubber, which is difficult to grind.

Q & A