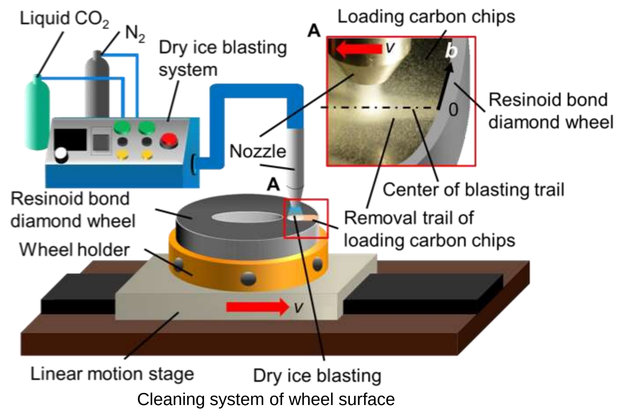
Okayama university　Manufacturing engineering laboratory

Development of advanced and optimized technology in cutting, grinding, and abrasive machining

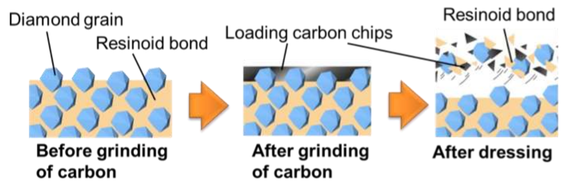
High efficiency cleaning of wheel surface

The high efficiently cleaning technology using dry ice blasting is developed for recovering grinding performance after loading by dry grinding of carbon parts.

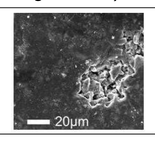
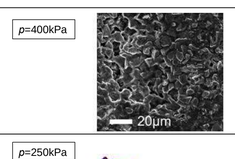
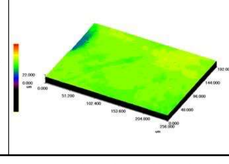
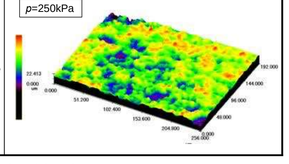


Cleaning system of wheel surface

Cleaning mechanism by dry ice



Problems in conventional dressing

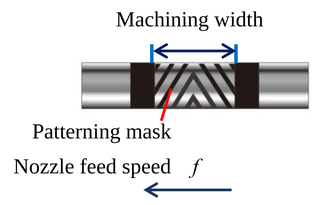
	Before dry ice blasting (loading surface)	**After dry ice blasting** (l =0.167g/s, v =0.02m/s, s =1mm)
SEM image		
Profile image		

Cleaning effect by dry ice blasting

Loading that occurs during dry grinding of carbon, etc. can be efficiently removed by dry ice blasting. As a result, the total wheel life is extended, and it is possible to stably obtain a high-quality ground surface with high efficiency.

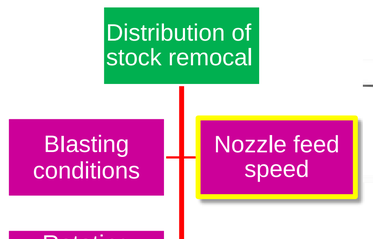
Abrasive jet micromachining

The abrasive jet machining technology for micro profiles with high efficiency and high accuracy is developed. Specifically, advanced micro-abrasive machining such as controlled three-dimensional precision patterning is developed.



Patterning using abrasive jet machining

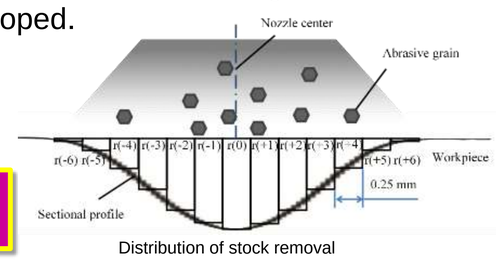
Herringbone grooves by abrasive jet micromachining
(Shaft diameter: ϕ4mm)



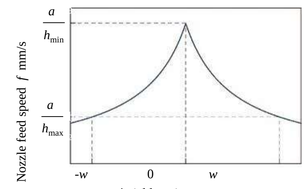
Simulation of machining profiles

Control of nozzle feed speed for target profiles

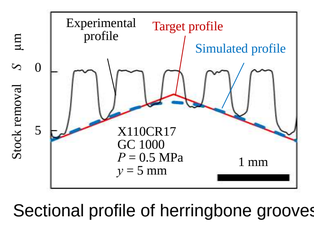
The machining of micro-profiles with high efficiency by controlling machining conditions such as the nozzle feed speed according to the target profile.



Distribution of stock removal



Calculation of nozzle feed speed

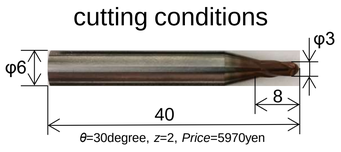


Sectional profile of herringbone grooves

Decision support system for skillful engineer

Skillful engineer

Unknown recommended cutting conditions



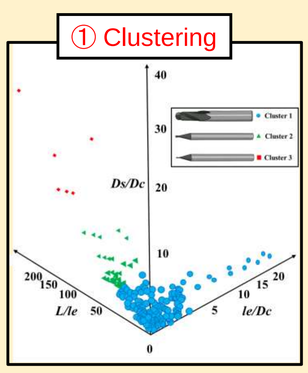
Cutting conditions
- Cutting speed
- Feed rate
- Depth of cut
- MRR

Data-mining process

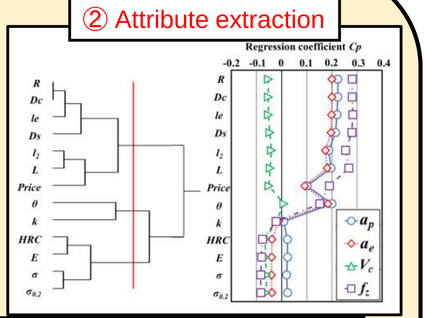
Support system

Catalog database

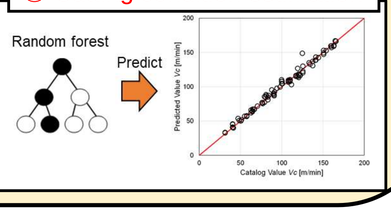
① Clustering



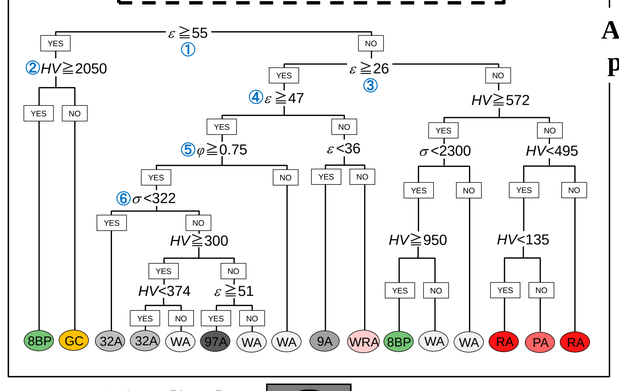
② Attribute extraction



③ Cutting condition estimation

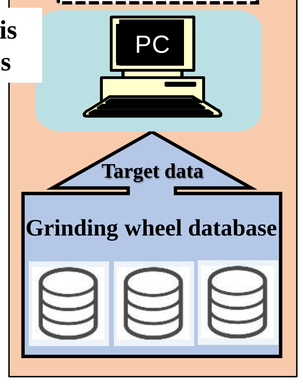


Output example of decision tree



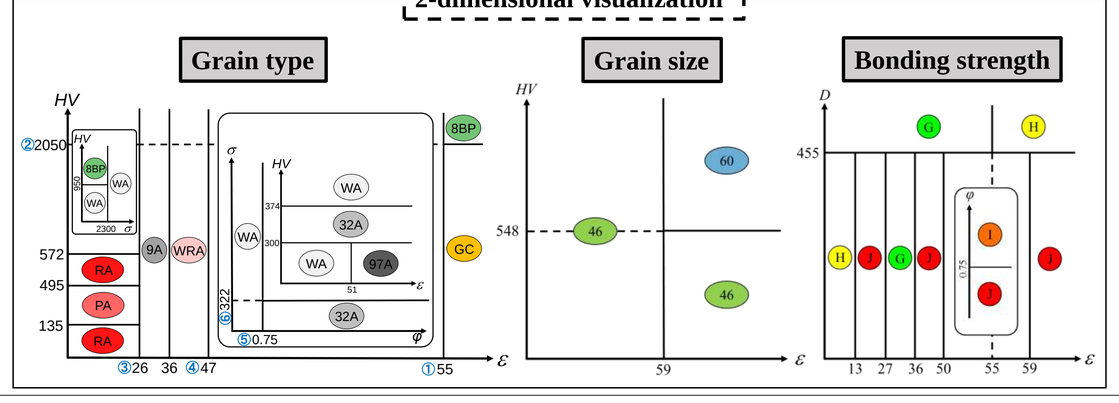
Analysis process

Support system



Visualized process

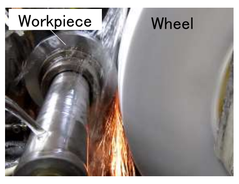
2-dimensional visualization

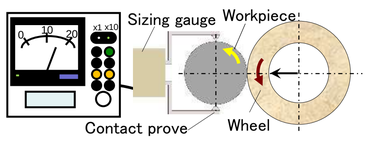


Intelligent grinding system improving dimentional accuracy

To improve the dimensional accuracy, the intelligent grinding system is developed. This system can reduce the effect of the thermal deformation of the workpiece by considering the analyzed thermal deformation.

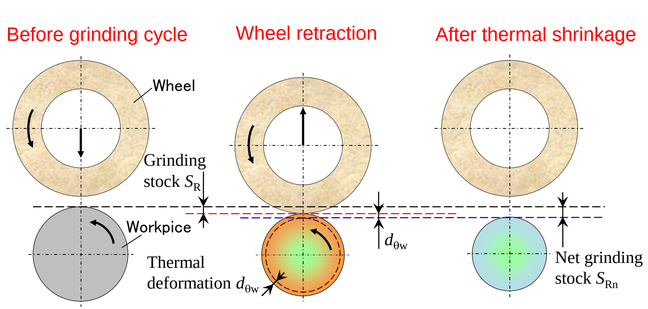
Sparks emitted at grinding point　Sizing gauge



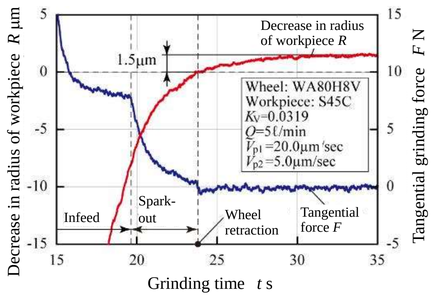


During the grinding cycle, the grinding heat is conducted into the workpiece. The thermal deformation of the workpiece causes the dimension error.

Net grinding stock

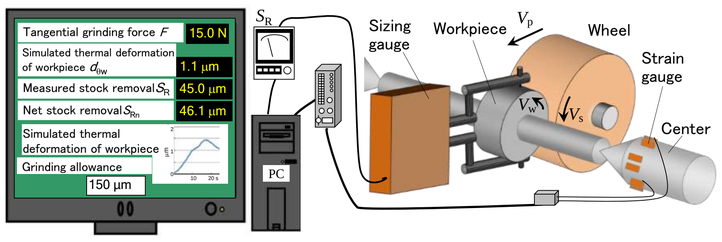


Themal shurinkag of workpiece after grinding cycle

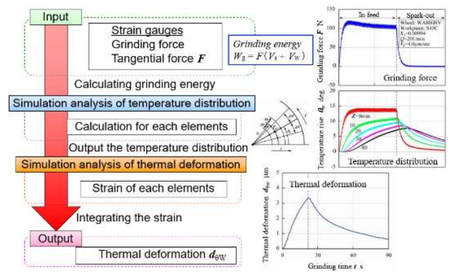


In the left figure, the workpiece shrinks 1.5μm in radius after the wheel retraction. This shrinkage causes the dimension error. To reduce the effect of the thermal deformation of the workpiece, the developed system can estimate the net grinding stick during the grinding process.
Net grinding stock : The grinding stock (Decrease in diameter of the workpiece) after the thermal deformation of the workpiece is converged.
The net stock removal is calculated by adding the measured grinding stock and the simulated thermal deformation of the workpiece. The thermal deformation is analyzed based on the tangential grinding force measured by the strain gauges.

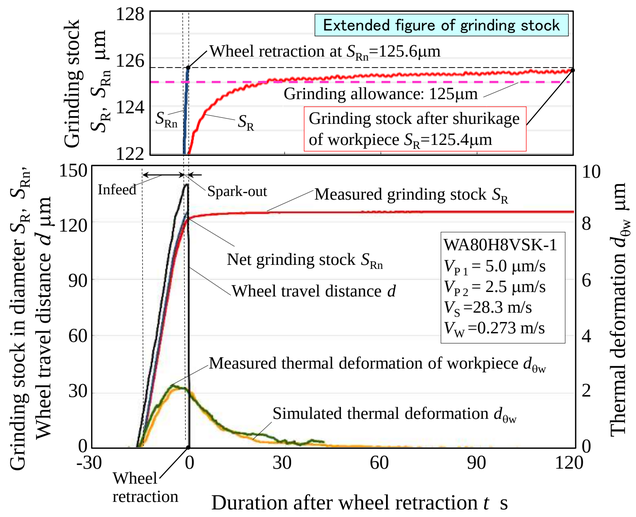
Intelligent grinding system to estimate net stock removal



Simulation analysis of thermal deformation



Result of grinding experiment with developed system（Grinding allowance in diameter :125μm）



The simulated thermal deformation agreed well with the experimental one as shown in the left figure. The grinding stock after the shrinkage of the workpiece was converged within 0.6 μm of grinding allowance.

Other research subjects involved in grinding
- Fabrication of tapered profile in internal grinding
- Improvement of form accuracy in cylindrical traverse grinding

The accuracy and the efficiency are improved by adjusting the grinding conditions that was determined based on the results of monitoring the grinding phenomenon.

Researches shown above are expected to use：High-precision high-efficiency machining for automobile and aviation industries, In-process evaluation technology of machining accuracy, Optimization system of machining conditions

Research collaboration：Research Training and information provision about sustainable manufacturing technologies for the next generation, Researches under academic-industrial partnerships, Recurrent education in doctoral program

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