Research Background

Processing efficiency improvement of the **grooving process** is difficult

factors

- Maximum cutting depth in radial axis
- The contact surface between the peripheral flute and the workpiece is large

- The blade is restrained
- It is difficult to discharge chips

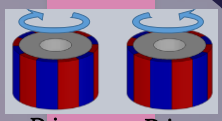
short tool life

Research purpose

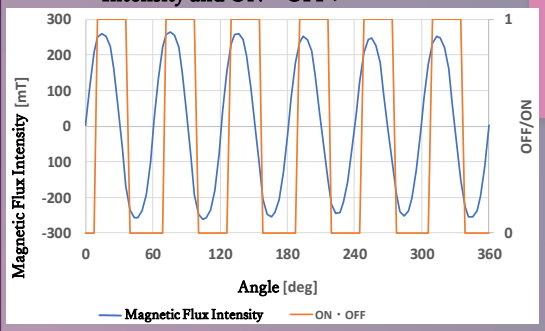
Deployment of an end milling machine with early prediction of tool failure and breakage prevention using cutting force

With magnetic gear

- S and N poles are alternately magnetized
- Rotary power transmission by meshing of magnetic force



<Relationship between Magnetic Flux Intensity and ON・OFF>

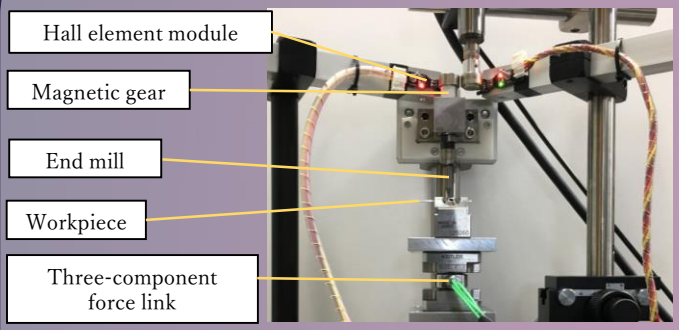


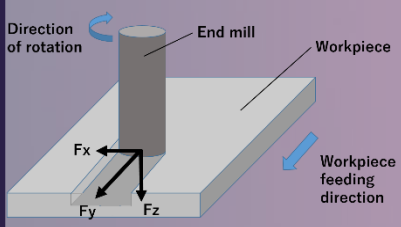
Output signal by Hall element module

Switching ON / OFF with **225 [mT]** as a threshold

Application to Break Avoidance Using Magnetic Gear Characteristics

Experimental device

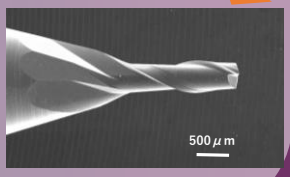




Fx：Principal force
Fy：Feed force
Fz：Thrust force

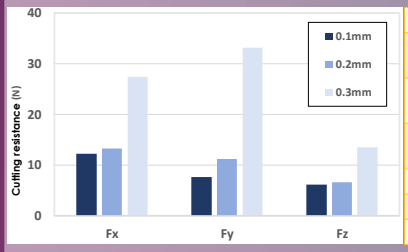
<Tool specification>

Cutting tool	CSS 2005-0150(Union Tool)
Material	Cemented carbide
Cutting diameter[mm]	0.5
Blade length[mm]	1.5



Cutting resistance in grooving

<Processing conditions>



Workpiece	Aluminium alloy		
Thickness[mm]	1		
Feeding speed[mm/min]	30		
Scan distance[mm]	5		
Rotational speed[min^{-1}]	15000		
Axial depth of cut[mm]	0.1	0.2	0.3
Coolant	none		

Depth of cut affects 3 component forces

Increase in cutting resistance causes deterioration in machining accuracy and breakage of tools

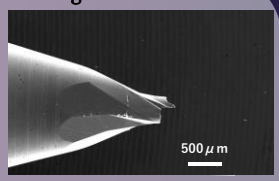
→ Tool breaks in the middle of processing of cutting depth 0.3 [mm]

Thrust resistance

<SEM image of fracture side>

Cemented carbide end mill: 267.4~271.5 [N]

High-speed steel drill: 58~79 [N]



Bending breakage

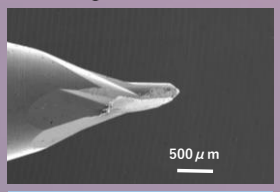
Approximately 3.5 times the strength in the axial direction

Maximum torsional torque

<Processing conditions>

Workpiece	Aluminium alloy
Thickness[mm]	1
Feeding speed[mm/min]	120
Rotational speed[min^{-1}]	5000
Cutting speed [m/min]	7.9
Coolant	none

<SEM image of fracture side>



Cemented carbid end mill：1.8~3.13[N・cm]

High-speed steel drill：1.9~3.4[N・cm]

Torsional breakage

There is no difference in strength against twisting

Consideration

It is thought that machining can be stopped and breakage can be avoided by utilizing the shift of the magnetic gear that occurs when the tool is subjected to excessive cutting resistance.

Conclusion

- The cemented carbide end mill has almost the same maximum torsional torque as high-speed steel drills, but has about 3.5 times the thrust resistance.
- The depth of cut in the Z-axis direction affects the cutting resistance in groove processing.