USUKI LAB.

[Extending cutting tool life using ultra-high pressure coolant]

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Advanced Machining

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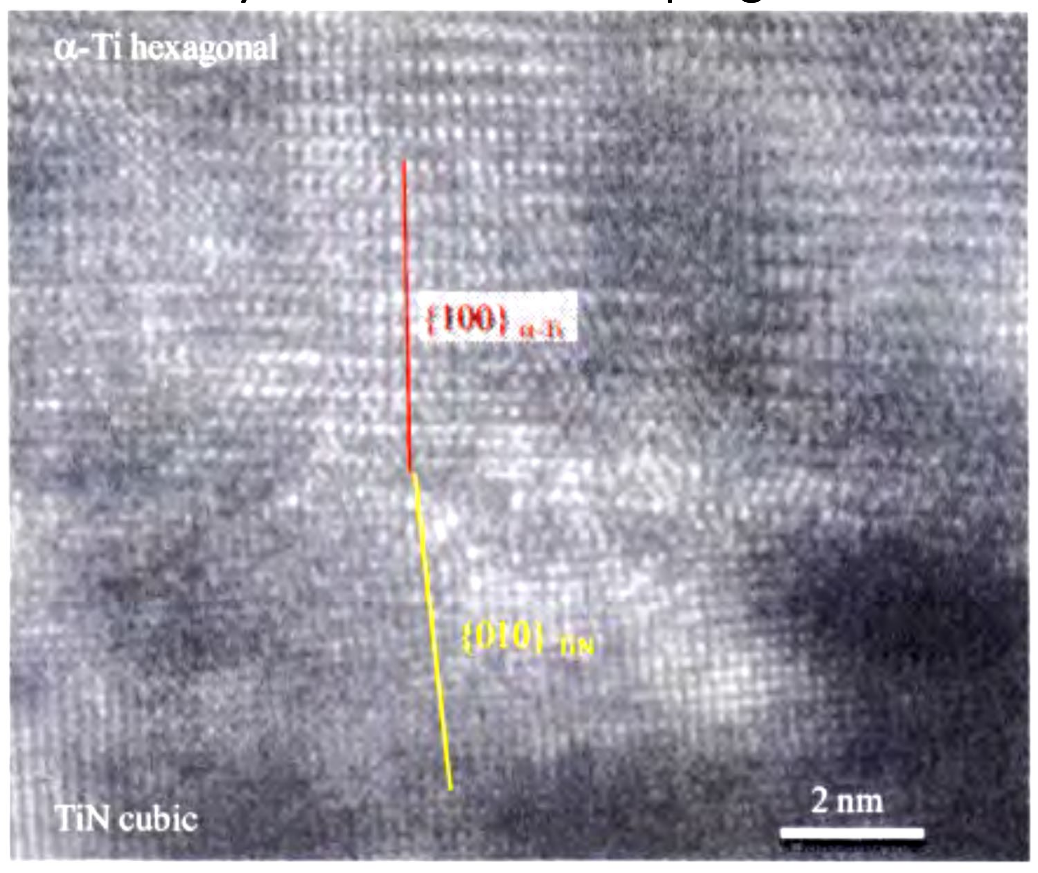
https://usukilab.iis.u-tokyo.ac.jp/

Research assignment of cutting titanium alloy and superalloy

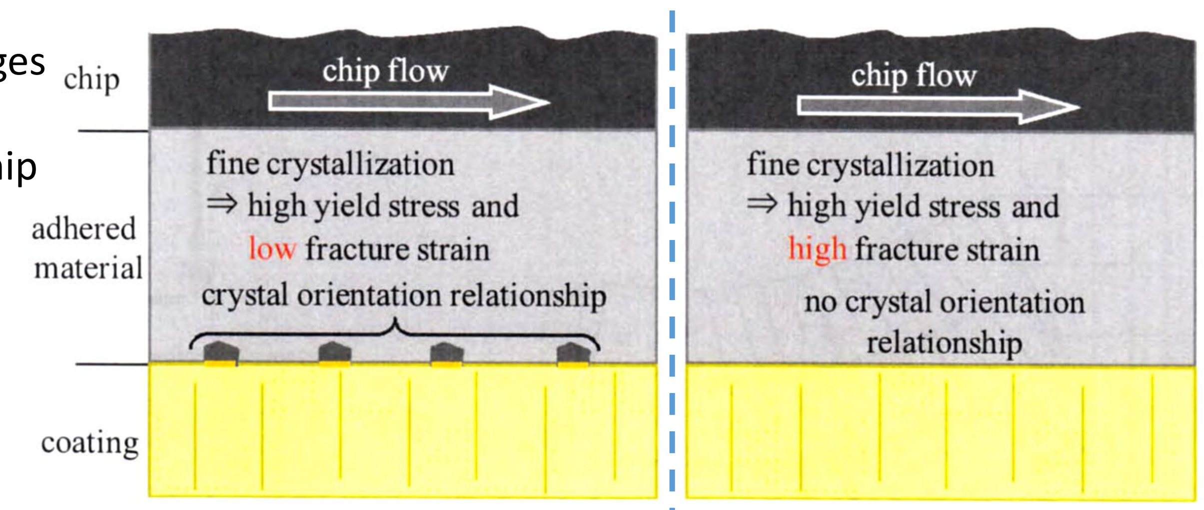
First step of adhesion between work material and tool is fine crystallization of adhered material

Adhesion by interatomic force progresses tool wear



TEM image of interface between adhered material and TiN coating

Surface of chip changes fine crystallization at interface between chip and coating
⇒~10 nm
・Crystal orientation relationship
・High adhesive strength

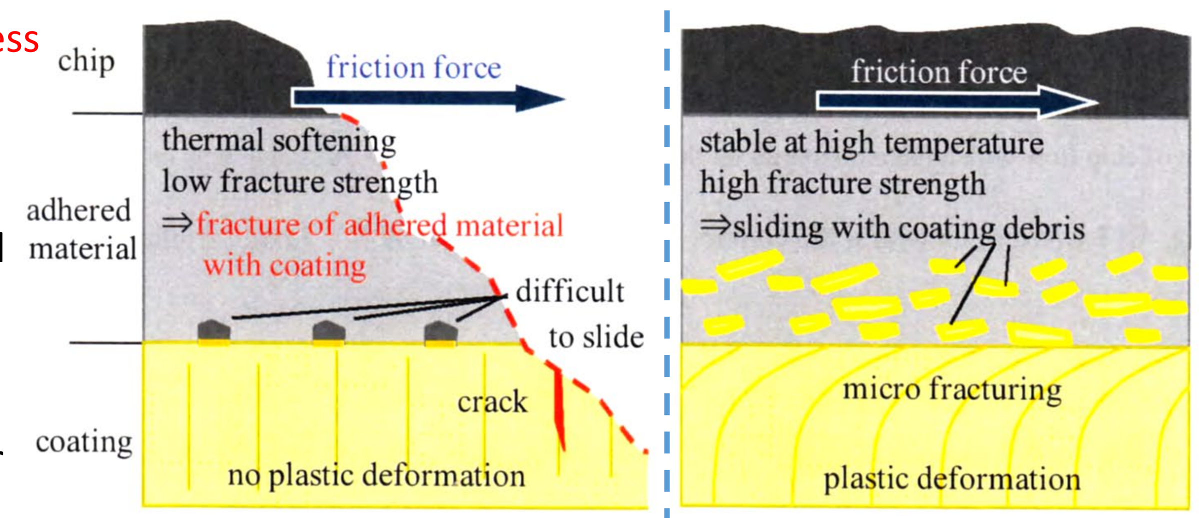


Surface of chip changes fine crystallization at interface between chip and coating
⇒~100 nm
・No crystal orientation relationship
・Low adhesive strength

Initial adhered condition on coating surface

High temperature Low stress
Plastic deformation of coating does not occur

1. Crack occurs on adgered material by shear stress
2.Crack spreads to coating layer
3. Fracture of coating layer



High temperature High stress
Surface of coating deforms and fractures

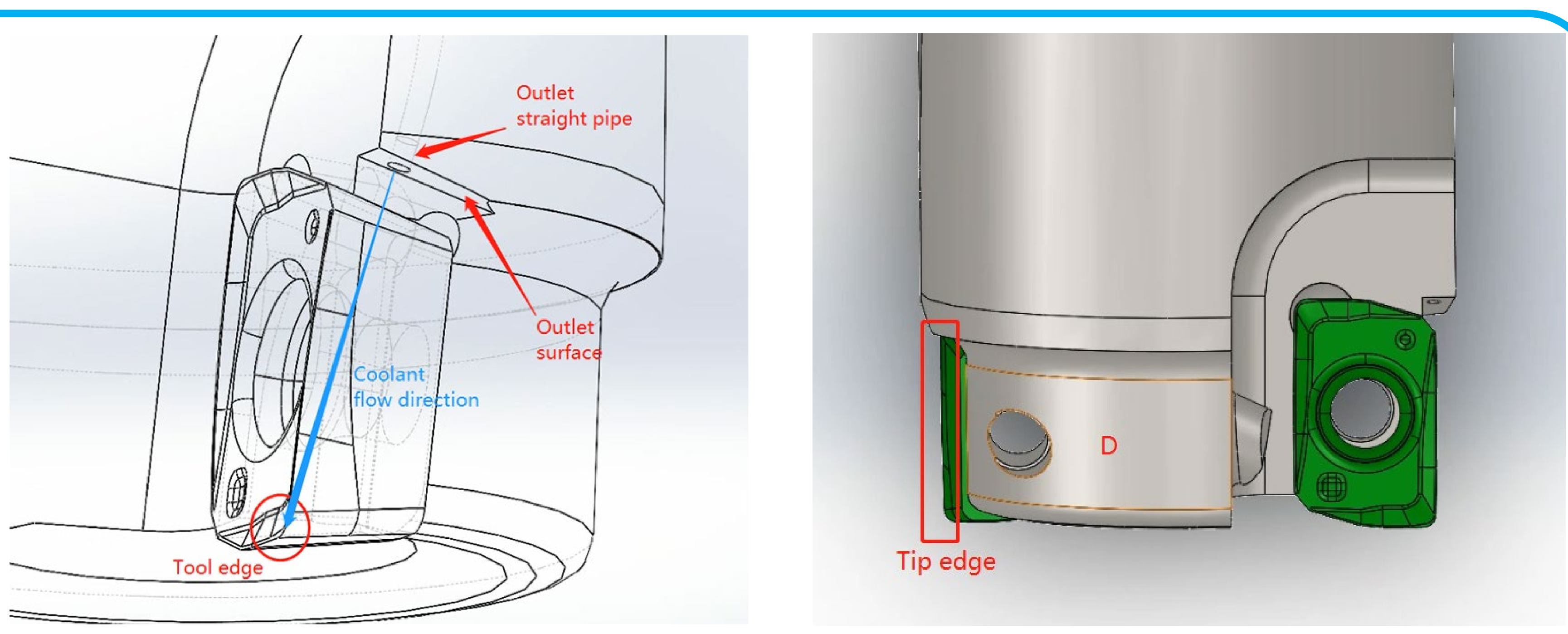
Titanium alloy Superalloy

Progression of coating damage

Wear processes of TiN coated tool when cutting Ti-6Al-4V and Alloy 718

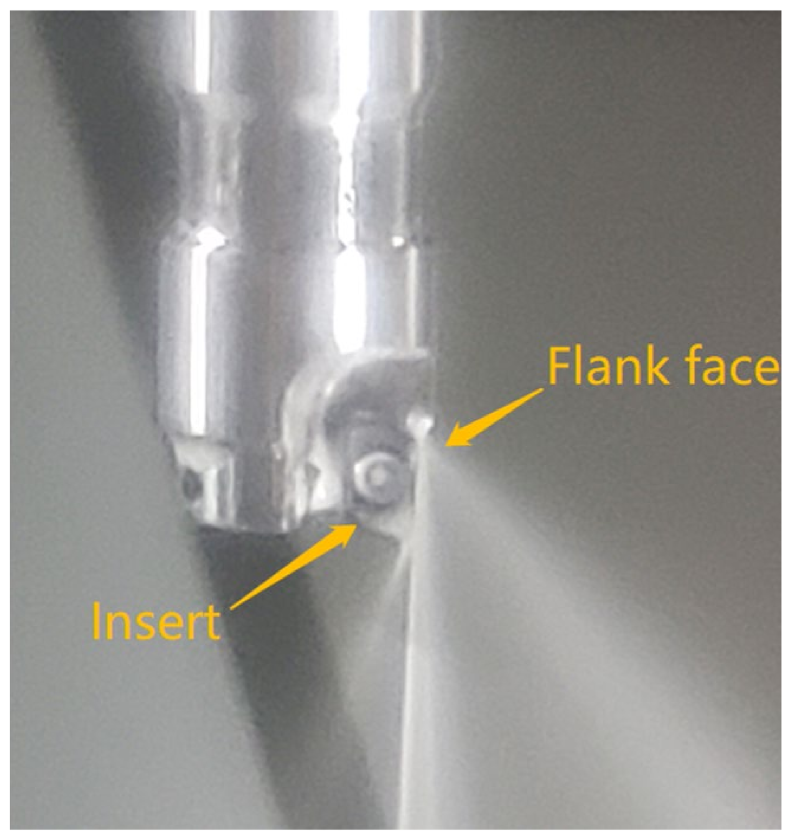
Fabrication of prototype end mill for ultra-high pressure coolant supplying from flank surface

Key point are decrease cooling velocity of work material and cutting heat at edge of tool, to prevent fine crystallization
⇒As one solution, we prototype a tool that can be supplying ultra-high pressure coolant from the flank side and verify its effect.

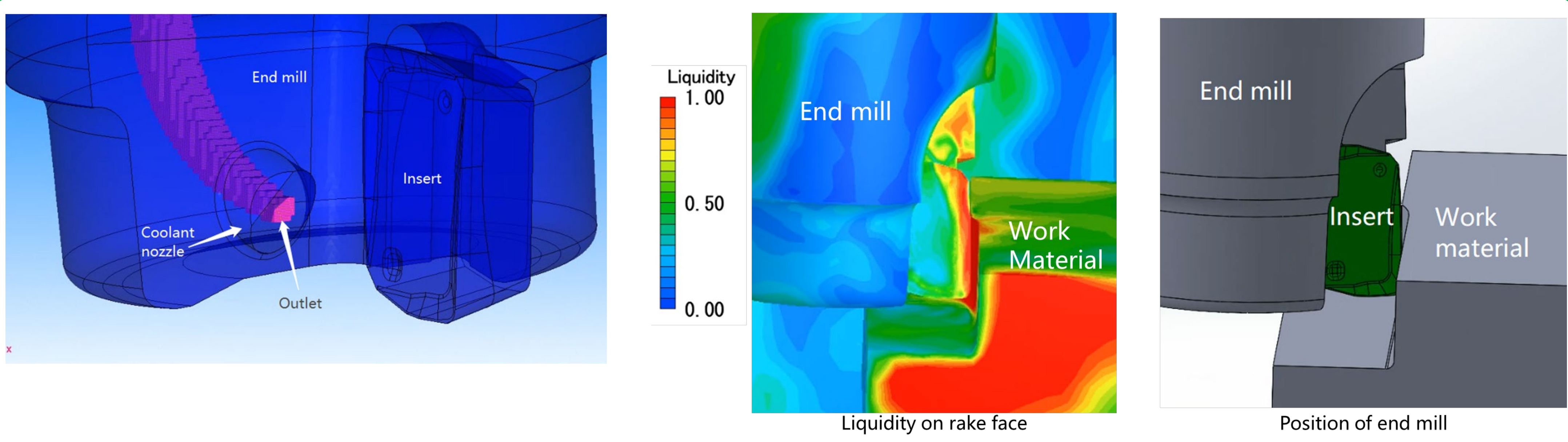


3D design model of cutting tool

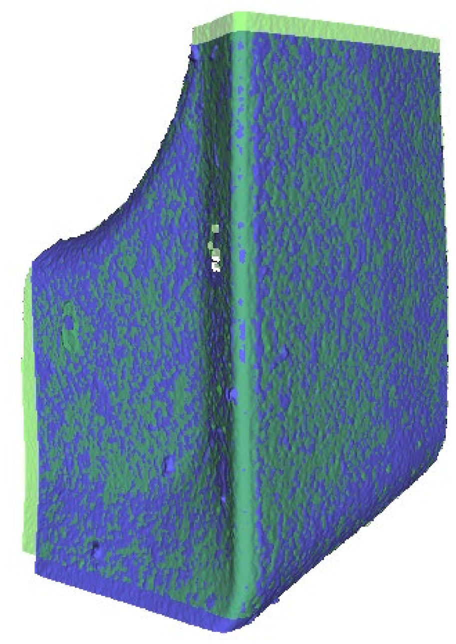
Appearance of the manufactured tool



Ejection from the coolant hole built into the tool



Optimization of coolant ejection holes by fluid simulation



Measuring tool life with a tool microscope