

On-machine nanometrology of diamond cutting tools

JPPN 2004-308605

Background

Single point diamond turning

The use of a diamond cutting tool

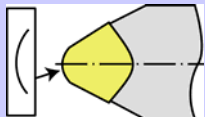
In nanometer cutting

The micro/nano-wear of the tool edge becomes a **big problem** of influencing the quality of machined surface.

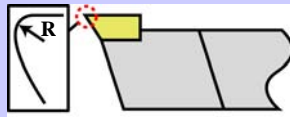
The wear of the tool edge is necessary to be measured accurately in on-machine condition.

★ On-machine measurement of tool edge wear is possible through mounting a **portable AFM unit** on the diamond turning machine.

The cutting edge profile
Arc contour: on the order of **10nm**



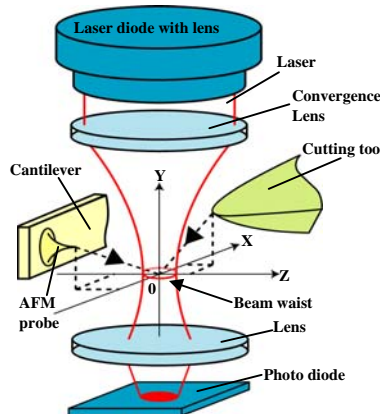
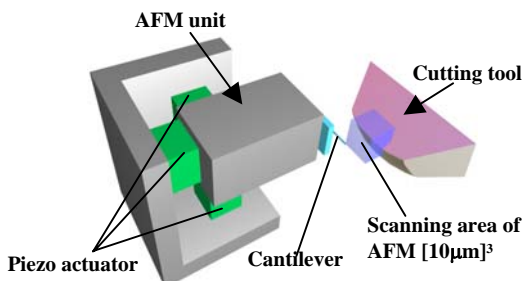
Very sharp tool edge
Radius: on the order of **10 nm**



Precision Positioning of AFM Tip to Diamond Cutting Tool Edge

For measurement of the tool edge profile by AFM, it is necessary to position the tool edge within the scanning area of AFM.

Proposal: The optical probe that can align the AFM tip to the diamond cutting tool edge in sub-micrometer range

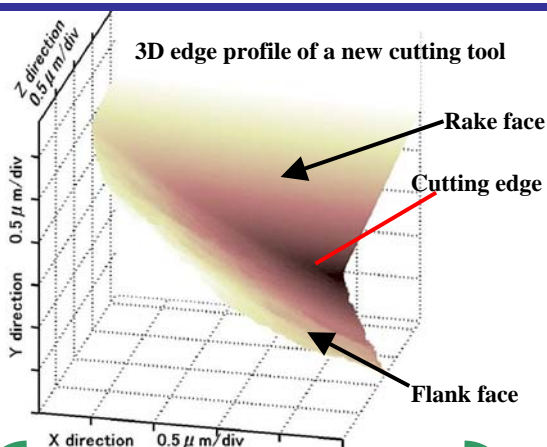


★ The origin of the coordinate system is defined as the center of the spot at the beam waist, which is called the base point for the alignment the AFM tip and the cutting tool edge.

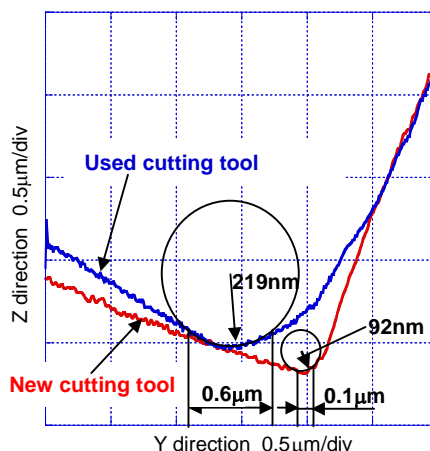
The optical probe is able to align the AFM tip and the tool edge in the **sub-µm range**, which is **sufficient for the purpose of measuring the tool edge by the AFM.**

Taking into consideration the tip/edge geometries of the cutting tool and the size of the AFM tip, it is necessary to accomplish the alignment in **sub-µm range.**

Measurement Result of Diamond Cutting Tool Edge Profile



★ Comparison of a new tool profile and a used tool profile



Sample: NWD-CL320 (New cutting tool)
Range: 2.8µm(X) x 2.8µm(Y) x 1.4µm(Z)
Number of measurement point: 100pixel(X) x 1000pixel(Y)
Scanning frequency: 1 Hz/line
Measurement time: 100 sec/frame

The wear of the edge of a used cutting tool is quantified