Testing procedure for optical probes integrated on ultra-precision diamond turning machines

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Abstract

The ability to verify the geometrical quality of a workpiece on the machine tool itself can be a crucial advantage in ultra-precision diamond turning. This work presents a test procedure for single point distance measuring optical probes integrated on diamond turning machines (DTMs). To be able to specify the probe´s characteristics a strategy using the axis of the DTM itself is developed.

Figure 1 shows the experimental setup consisting of a measurement target mounted on the *z*-axis and the probe mounted on the *x*-axis of the DTM. The flat metallic diamond turned surface used as measurement target is positioned orthogonal to the *z*-axis. While running a NC program, which commands a specific trajectory, for example a sinusoidal path, the glass scale signal of the DTM and the probe´s distance signal is recorded with a frequency of up to one kilohertz. By analyzing the glass scale signal the actual movement of the *z*-axis can be extracted and used as a nominal value to evaluate the quality of the probe signal and its characteristics. An estimation of deviations caused by misalignment of the probe and measurement target is described. Besides that, effects caused by a possible time delay, temperature drifts and dynamic effects of the machine axis are taken into account and strategies to contain these effects are shown.

By adjusting the programmed trajectory the probe´s measuring range to be tested can be varied. Furthermore, by tilting the probe in regard to the measurement target´s surface (see Figure 1 (b)), the important behavior in non-orthogonal measurements on high reflective surfaces can be investigated. In the present work an interferometric probe is employed. The obtained deviations slightly differ depending on the probe´s tilt and distance value. With a linear compensation for a measuring range of four micrometers the maximum error can be reduced by fifty percent to residual deviations of less than twenty nanometers.

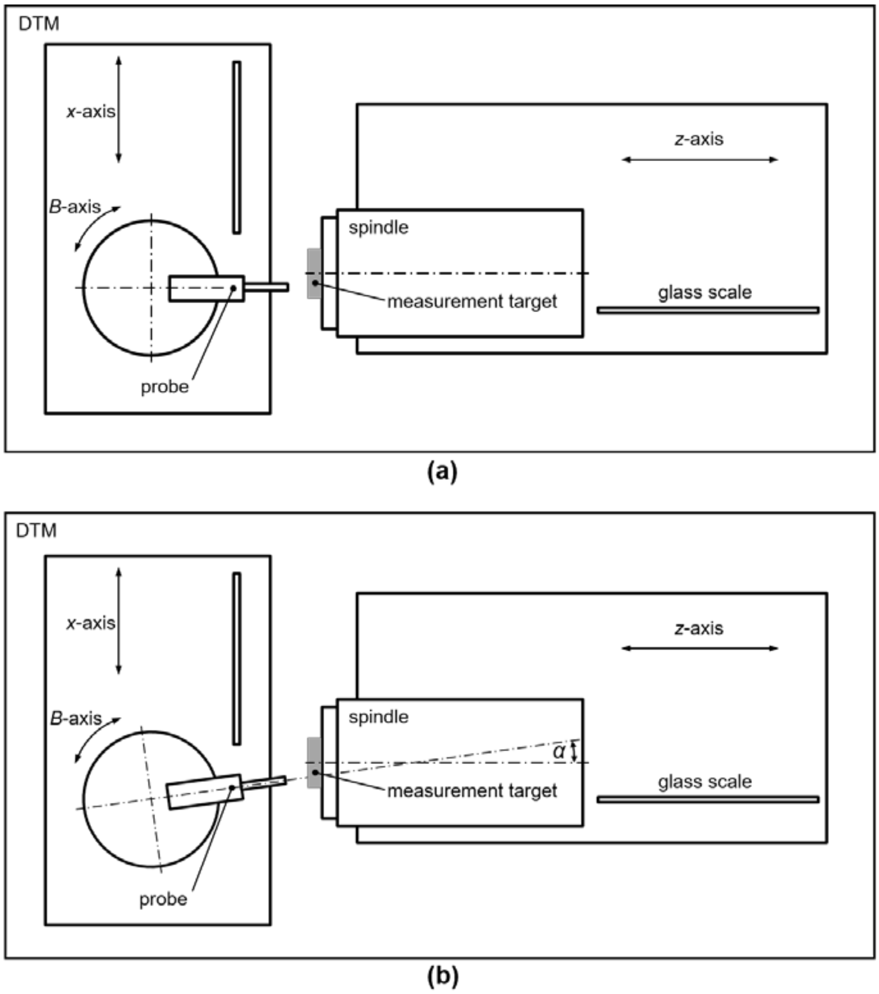

Figure 1. Experimental setup on a DTM. Linear axis: *x*-axis and *z*-axis, Rotational axis: *B*-axis. (a) Orthogonal measurement, (b) Non-orthogonal measurement.