

## Travel displacement of a nano positioning unit at 4 K

Surfaces are inspected with nanometre resolution for Atomic Force Microscopy (AFM). The test item must be able to be moved in the nanometre range for a surface topography. attocube systems AG in Munich has developed actuator motors for such precise positioning. Using a positioning unit with piezo ceramics, movement in the x, y and z-axes is possible. The positioning range, which is measured by the sensors, is 1.2mm x 1.2mm. The complete microscope head is cooled with liquid helium to 4K above the absolute zero point of -273°C (corresponds to 0K). The traversing units operate at 4K ambient temperature in an ultra-high vacuum and under the highest magnetic fields.

In order to measure the x and y movement, attocube systems AG uses two capacitive sensors from Micro-Epsilon on the nano positioning unit. With a measuring range of 1mm, the sensors have a precision of less than 5nm and operate completely without contact. The extreme ambient conditions are a particular challenge. The sensors must provide identical results at 4K as at room temperature. This is possible due to the use of special materials for the sensor and cable, which provide stable measurements due to low thermal expansion. The sensors are not influenced by extreme ambient conditions. This application can only be solved using capacitive measurement technology. No precise statements about the measurement results were possible using eddy current sensors, as the temperature gradient of the target at 4K is very low and the specific current flow characteristics change.

### Requirements for the measuring system:

- Constant technical characteristics at 4K
- As small as possible thermal expansion
- Nanometre resolution

### Ambient conditions:

- Ambient temperature -270°C (4K)
- Use in ultra-high vacuum

### Sensor series used:

capaNCDT 6300 CSH1FL

