2^{nd} Stakeholder Workshop on Multifunctional ultrafast microprobes for on-the-machine measurements

June 23rd, 2021, 13:00-15:30 CET

Meeting link: **https://conf.dfn.de/webapp/#/?conference=979149428**
PIN: 5100#

Streaming link: https://www.conf.dfn.de/stream/nr5hytrbr6p72

Traceable measurements of surface form and property are essential for controlling the use of or assessing the condition of machined parts and tools in high precision mechanical manufacturing machines especially when these components are subject to wear and surface contamination. Therefore, this project will develop new tactile microprobes for reliable and ultrafast, on-the-machine (i.e. in-line) topographical micro-form and roughness measurements that are 30 times faster than conventional methods and fast methods using contact resonance and force-distance curves to measure adhesion, stiffness, friction, coating thickness and to detect contaminants through adhesion contrast.

13:00-13:15 Introduction to the project MicroProbes

Uwe Brand, PTB (Physikalisch-Technische Bundesanstalt)

Possibilities with Microprobes and possible applications are presented.

13:15-13:30 Mechanical Properties Measured with a Customized Microprobe for AFM

Sebastian Friedrich, BAM (Bundesanstalt fuer Materialforschung und -pruefung)

Customized piezoresistive cantilever microprobes were developed for operation in a commercial Cypher AFM from Asylum Research. In this setup both the piezoresistive signal from a Wheatstone bridge at the base of the cantilever and the laser signal from the common optical lever method can be used to detect the cantilever deflection. Two different methods are available for the analysis of mechanical properties: force distance curves (FDC) and contact resonance (CR).

FDCs allow the determination of the stiffness and the adhesion of a sample. Through a force volume, i.e., a rectangular array of FDCs with a well-defined spacing in between single curves, a contrast in topography, mechanical properties, and adhesion could be detected on a lithographically patterned photoresist film (AZ 5214E) on a silicon substrate.

Another measure of mechanical properties is the contact resonance frequency, i.e., the resonance frequency of the cantilever when the tip is in contact with the sample. Using the dual AC resonance tracking (DART) mode, the contact resonance frequency can be determined in every point while scanning the sample. On a patterned photoresist film on silicon, a contrast with a higher contact resonance frequency on silicon has been observed, confirming the larger elastic modulus of silicon.

13:30-13:45 Contact Resonance Operation of Piezoresistive Microprobes

Michael Fahrbach and Erwin Peiner, TUBS (Technische Universitaet Braunschweig)

Contact resonance (CR) is a fast method to measure mechanical properties of samples using tactile cantilever microprobes. Here, the cantilever is excited into resonance while the probing tip remains in contact with the surface of the sample. The resulting frequency is then analyzed to obtain information about the aforementioned mechanical properties. Two common techniques to actuate the cantilever are

- Ultrasonic atomic force microscopy (UAFM), where vibrations of the cantilever are excited by an external actuator at the base of the probe
- and Atomic force acoustic microscopy (AFAM), where these vibrations are excited by an external actuator underneath the sample.

In this presentation, CR operation of commercial 5 mm long, 200 µm wide and 50 µm thick piezoresistive microprobes (CAN50-2-5, CiS Forschungsinstitut für Mikrosensorik GmbH) is evaluated using both techniques. Additionally, new self-exciting microprobes, with the same dimensions as CAN50-2-5 microprobes, are introduced. The performance of their integrated actuators is assessed and compared to external actuators.

13:45-14:00 Fast topography measurements using optimized cantilevers with active Q-control and passive damping

Chris Schwalb, GETec (GETec Microscopy GmbH)

We will present latest results for fast topography measurements using optimized self-sensing cantilevers. These cantilevers are used in combination with an in-situ AFM setup that can be integrated inside the high-vacuum environment of a SEM system. We will show results for fast topography measurements on different samples using active Q-control to modify the Q-factor of the cantilevers, as well as results for adding a passive damping layer that can also reduce the Q-factor. With this setup AFM imaging speeds in vacuum of more than 200 µm/s can be realized.

14:00-14:15 Microprobe system with integrated „high-speed“ feed unit – Microprofiler

Benjamin Mall, bmt (Breitmeier Messtechnik GmbH)

Description and results of the developed microprobe system called “Microprofiler”. Overview of the technical design, measuring range and scanning speed as well as the technical limits due to the Microprofiler design. An outlook and an improvement plan e.g. for the signal to noise ratio are given.

14:15-14:30 In-line measurement of surface texture of rolls using microprobes

Thomas Widmaier RRI (Rollresearch), Linus Teir VTT (Teknologian tutkimuskeskus VTT Oy)

There are several industrial measurement applications where microprobes can be useful. The measurement of roughness of paper machine rolls was selected to be tested. The integration of a microprobe in an existing roll measurement device is presented together with measurement results. The results are promising indicating that measurements using a microprobe can give useful data on the grinding process.

14:30-14:45 In Situ Measurement of Wear using Mechanical Microprobes

Mark Gee, John Nunn, Timothy Kamps, Peter Woolliams NPL (National Physical Laboratory)

This talk will describe how mechanical microprobes can be used to evaluate wear in situ on tribological test systems. The use of the microprobes is being evaluated by experiments on three different test systems:

- A scratch testing system
- A pin on disc test system
- A microtribometer installed in a Scanning Electron Microscope

Results from experiments on the scratch testing are described showing the improvement in the quality of data that can be achieved through the use of the microprobe evaluation system compared to conventional post experiment evaluation. The imminent implementation of the microprobes on the other two test systems will also be described. The utility of the microprobe measurements are also compared with non-contact optical probe systems.

14:45-15:05 Conclusions of results and outlook

Uwe Brand, PTB (Physikalisch-Technische Bundesanstalt)

15:05-15:30 Stakeholder comments & discussion

Uwe Brand, PTB (Physikalisch-Technische Bundesanstalt)

The 17IND05 MicroProbes project has received funding from the EMPIR programme co-financed by the Participating States and from the European Union’s Horizon 2020 research and innovation programme.

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States