The continuing trend towards miniaturization has been a driver for the development of micro-electro-mechanical systems (MEMS). Fueled by the resulting smaller size of components and products as well as the resulting higher performance such as the lower switching times and higher driving frequencies, the dimensions of these sensors and actuators are now reaching the nanoscale. With a size that is only a small multiple larger than the atoms of which they are composed, the mechanical and electrical behavior of nanostructures can no longer be calculated using scaling law. While quantum mechanics provides a theoretical basis to qualitatively understand the expected behavior, a quantitative way to measure the mechanics of these nanotubes, films and wires is needed for the accurate determination of the performance and design of reliable nanosystems. This work presents a nanorobotic system for the direct and accurate measurement of the mechanical properties of nanostructures. Testing principles such as compression-, tensile-, cyclic- or fracture-tests are enabled by pushing or pulling a microforce sensor on the nanostructures while using position encoders to measure their deformation. From the resulting force-versus-deformation (stress-versus-strain) curves, the material properties of these nanostructures are quantitatively determined.

In-situ Scanning Electron Microscopy (SEM) mechanical testing is demonstrated using the microrobotic system. The imaging capabilities of the SEM enable an accurate sample-to-sensor alignment as well as observation of the sample during the load application. Given the typical analytical working distance of SEMs between 5 and 8 mm, a highly compact MEMS-based microforce sensor has been developed that allows for the testing at this small space constrains. Furthermore, for the accurate measurement of the sample deformation a high resolution piezo-scanner is used with closed-loop capacitive position feedback. This allows for the mechanical testing of nanostructures with forces in the nano-to-millinewton and deformations in the sub-nanometer range.

**Keywords:** nanorobotics, nanomechanics, nanostructure

**References:**

**Presenting author’s email:** simon.muntwyler@femtotools.com