

## **Monitoring oxide thin film growth with in-situ scanning force microscopy**

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Scanning Force Microscopy (SFM) is one of the most important tools in nanotechnology and surface science. Because of recent developments, it is nowadays also used to study dynamic processes, such as thin film growth and surface reaction mechanisms.

We have realized a system, in which SFM can be performed during Pulsed Laser Deposition (PLD). Deposition and force microscopy are performed in one vacuum chamber and via a fast transfer (in the order of seconds) the surface of a sample can be scanned. In our system we take advantage of the *pulsed* deposition process, because microscopy measurements can be carried out between the pulses. This provides real-time morphology information on the microscopic scale during growth. The transfer mechanism allows switching between microscopy and deposition with a re-position accuracy of  $\pm 500$  nm which gives new opportunities to study growth processes. Furthermore, it can provide information if RHEED is not possible, for example during amorphous and polycrystalline growth.

In our experiments, we used an inverted fiber SFM, based on a commercially available SFM (Ultraobjective from SIS GmbH, Germany). The piezo-scanner is thermally isolated from the heat source by placing a 20mm long macor-tube on top of the scanner. The geometry of the electrodes of the piezo scanner is such that, at the maximum applied voltage, no voltage breakdown is expected in the pressure range of interest.

Using the modified SFM, measurements at elevated temperature are possible in which the maximum operating temperature merely depends on the thermal load. To minimize this load, we developed a low power heating stage. Small thermal mass heaters are designed to obtain stable monitoring at temperatures  $>700^\circ\text{C}$  in a high-pressure environment.

In this contribution, the in-situ SFM will be presented as well as the latest equipment developments. With high-temperature microscopy, growth characterization at typical deposition conditions of complex oxides becomes feasible.