Nanometrology of field emission phenomena from electron beam deposited nanowires operating as nano- and picodeflection sensors – FEmet

Today electronic devices and their components are striving for miniaturisation. Increasing interest is being focused on nanoelectromechanical and microelectromechanical systems (MEMSs) that are used, for example, as gyroscopes, pressure sensors, fluid flow sensors, acceleration sensors, and lab-on-a-chip sensors. Such sensors are applied in cars, mobile phones, microphones, or health monitoring devices. The advantage of MEMS sensors is the low energy needed for actuation, enabling the detection of phenomena at micro- and macroscale. Due to the small size of the sensors, quantum phenomena such as field emission are involved. **Field emission** is the phenomenon of an avalanche electron tunnelling through an insulator (e.g. vacuum, air). To decrease the voltage threshold required to initiate field emission, electrodes with the smallest possible radius of curvature are sought. Therefore, emitters in which one of the electrodes (the cathode) is the tip and the flat surface is the electron extraction electrode (the anode) are very popular. This leads to lower power consumption by electronic devices whose operating principle is based on this phenomenon.

The field emission phenomenon is currently used in screens. Field emission from a tip induces excitation of a luminophore, which radiates red, blue, or green light. Another concept is to create pressure sensors in which a pressure-bending plate (extraction electrode) would change the field emission current from the tip because of the variation in the distance between the electrodes.

In the proposed FEmet project, the objective is to develop a detection method based on field emission for the determination of cantilever deflection (figure 1a) under the influence of temperature change, photon force, and atomic interactions. **Field emitters** (nanowires) **will be fabricated** using focused electron and ion beam induced deposition technology. The method allows creating 3D and 2D structures on the nanoscale in a single step, so-called "direct writing". During the process, a precursor is injected into the vacuum chamber of a scanning electron microscope with a focused ion beam. Its molecules are absorbed on the surface of the sample. The material is deposited at the electron or ion beam scanning spot on the sample because of the emission of secondary electrons with sufficient energy to decompose the precursor molecules. The process scheme is shown in figure 1b. **The FEmet project will investigate** the electrical and durability properties of the deposited material, as well as the performance of the field emitters from deposited nanowires in vacuum and air.

The stages undertaken will develop a new design of field emitters. Previous designs relied on a complex, multistep fabrication process, which could be resolved in the proposed FEmet project. The investigated material is commercially used in focused electron and ion beam induced deposition processes, however, its investigation and application for the fabrication of field emitters will be innovative on a global scale.

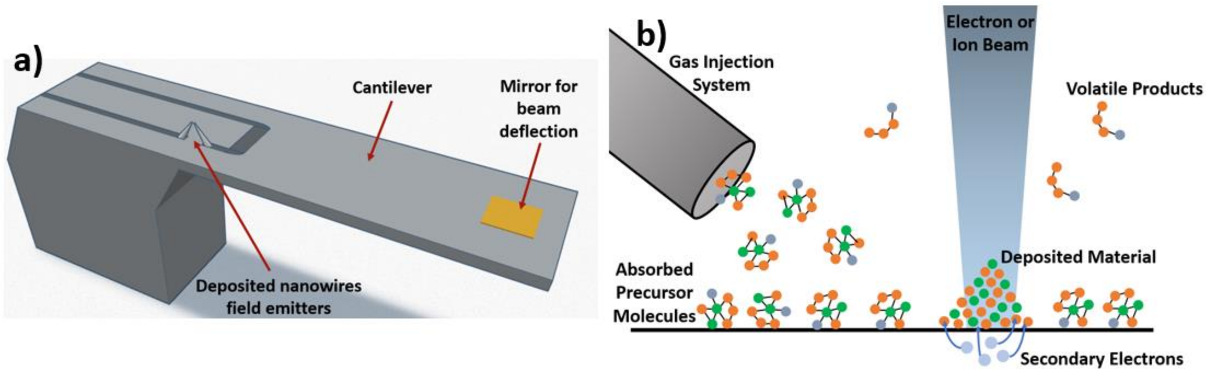

Figure 1. Schemes of: a) a sensor with deflection detection based on field emission phenomenon; b) a focused electron and ion beam induced deposition process.