The ability to image nanostructures plays a crucial role in the rapidly growing fields of nanoelectronics, molecular biology or fundamental research. The resolutions of scanning probe microscopy (SPM) are definitive tool in these fields, but the physical limits of SPM methods are being reached. Similarly, as microelectronics approaches the end of Moore's law, measurement methods using even more sensitive physical phenomena need to be explored. These include single electron tunneling in a quantum dot transistor (QDT).

The project entitled '*Tip quantum dot transistor picometrology: new paradigm to explore the quantum systems using scanning probe microscopy - SQTMet*' aims to develop a novel measurement technique in the form of scanning quantum dot transistor microscopy (SQTM). Critical to this task is the demonstration of the performance of a quantum dot transistor at room temperature placed on a measurement probe.

The SQTM technique will feature distance and charge measurement resolutions with resolutions previously unattainable by room-temperature measurement devices. Resolutions of distance below 10 pm and charge below 0.05 elementary charge *e* are envisaged.

Single-electron transistor microscope (SSETM) solutions have been presented in the literature, but these required complex technological processes to manufacture the probe and cryogenic temperatures to operate. The proposed solution breaks through the measurement capabilities achieved by microscopy methods used to date. For this purpose, a novel - ambient and measurement noise-tolerant - design of a near-interaction microscope will be developed. It will be placed in vacuum chamber accordingly to *SPM-in-SEM* paradigm.

In the research, an improved process for fabricating quantum dot transistors using focused electron beam deposition (FEBID) will be carried out to fabricate devices directly on the blade of active piezoresistive cantilevers (Fig. 1-I). Devices constructed in this way will be operated purely electrically, with electrical cantilever deflection definition and electrical deflection read out, also electrical signal from a quantum dot transistor. It will remove necessity of additional optical measurement setups.

Validation of the device's performance will be carried out by measuring test samples - planar CMOS-based electronic circuits and planar quantum dot transistors (Fig. 1-II). The resolution of the SQTM will make it possible to visualise the position of individual quantum dots by detecting the electric field of trapped charge carriers.

The proof-of-performance of the SQTM measurement system will state a picometrological breakthrough in the measurement technology of modern quantum systems. One of the main developmental limitations of nanotechnology and quantum technology is the lack of measurement tools tailored to verify and validate the performance of these systems. Proving the performance of surface scanning with a quantum dot transistor at room temperatures will be not only metrological, but also technological breakthrough.

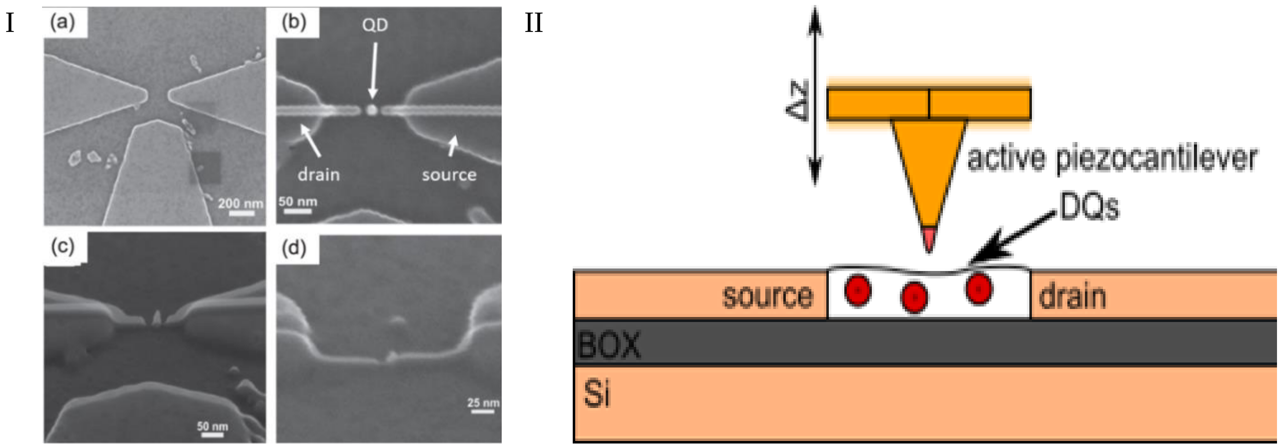

Fig. 1. Technical fabrication of a tunnel junction array for the design of a scanning single-electron transistor microscope operating at room temperature: I - dual tunnel junction array with a blade-shaped charge island fabricated using the FEBID technique (Durrani et al, Nanotechnology, 2017), II - schematic diagram of the measurement of a single-electron device using SQTMs.