Design, technology and application of piezoresistive scanning thermal probe for nanoscale investigations

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In this paper, a novel micromachined, piezoresistive scanning probe microscopy (SPM) micro-cantilevers with conductive platinum tips are presented. Batch lithography and patterning process combined with focused ion beam (FIB) modification allows to manufacture thermally active, resistive tips with a nanometer radius of curvature (fig. 1). This design makes the proposed nanoprobes especially attractive for their application in the measurement of the thermal or/and electrical behavior of micro- and nanoelectronic devices. Developed micro-cantilever is equipped with piezoresistive deflection sensor. The piezoresistive deflection detector enables metrological (in other words quantitative) analysis of interactions between the microprobe and the investigated surface. The proposed architecture of the cantilever probe enables its easy integration with micro- and nanomanipulators and scanning electron microscopes or FIB assisted experiments.

However presented 4-point cantilever dedicated to thermal measurements can be used in a standard setup with the optical AFM detection system.
In full paper, measurements methodology as well as the results of thermal scans of the surfaces will be presented and discussed. Fig.2 shows test scans of operating finFET 150nm transistor compared with modeling results.

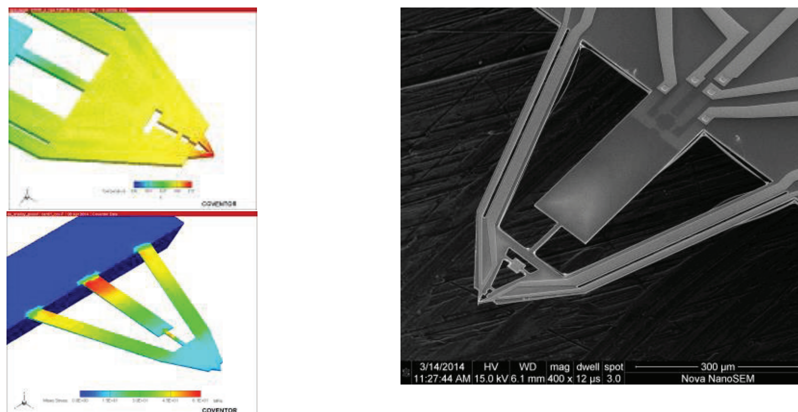
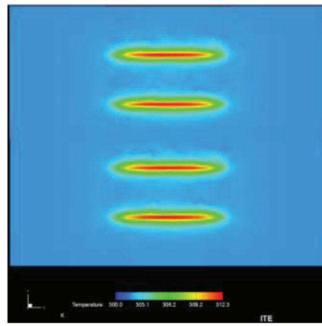
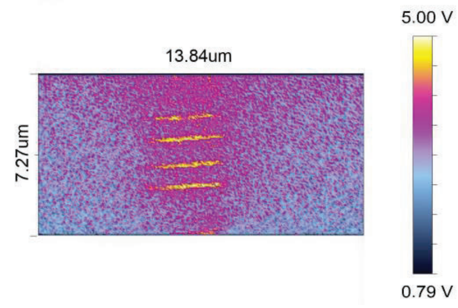


Fig.1 Piezoresistive thermal probe a) results of thermo-mechanical simulations b) piezoresistive cantilever with thermal tip - after FIB processing



a)



b)

Fig. 2 First experiments on test samples a) simulated temperature on 4-channel 150nm wide finFET transistor b) thermal signal measured on the surface loaded with current of 10uA.