Array of electromagnetically cantilevers for force-distance spectroscopy metrological investigations

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Various actuation methods of cantilever deflection have been proposed including thermomechanical and electromagnetic schemes. In the electromagnetic technique the magnetic field interacts with the current flowing through a conductive loop exciting the Lorentz force [1,2]. In our investigations we fabricated, measured and applied 1x4 arrays of electromagnetic cantilevers. The designed and fabricated array cantilevers are applied in force-distance (F-z) spectroscopy investigations of molecular forces acting between the functionalized flat cantilevers and a microspheres on the substrates[3]. The array setup and deflection control of every cantilever increases the investigation throughput and improves the reliability and repeatability of the conducted experiments. The arrays of electromagnetically cantilevers were fabricated in silicon on insulator (SOI) technology, which ensured that the beam geometry (beam thickness in particular) was the same within one array. As an input substrate the SOI 4" wafers with 1 and 1.5 micron thick buried oxide and device layer respectively was used. The handle and device layers are n-type conductivity and 3–5 Ohm cm resistivity. Boron doped layers deposition was applied to overcompensate the device layer for the p+ type. A 100nm thick gold layer was sputtered on the wafer and the metal mirrors and the contact pads were defined in a photolithography process. Plasma etching was applied to define the final shape of cantilever. After the mask definition in a back side photolithography, in two separate plasma dry etching processes the silicon (handle wafer 400 μm) and silicon dioxide (box 1 μm) were etched. Application of permanent magnets and Helmholtz coils enabled a metrological cantilever characterization. Various arrays were designed which made it possible to fabricate structures of various resonance frequency (from 5 to 20 kHz) and stiffness (from 0,01 N/m to 0,1 N/m)-Fig.1. The actuation sensitivity was characterized for static and resonance experiments, which confirmed that the fabricated sensors are of use in metrological force-distance spectroscopy-Fig.2. Results of model chemical interactions between functionalized cantilevers and microspheres will be presented and discussed.

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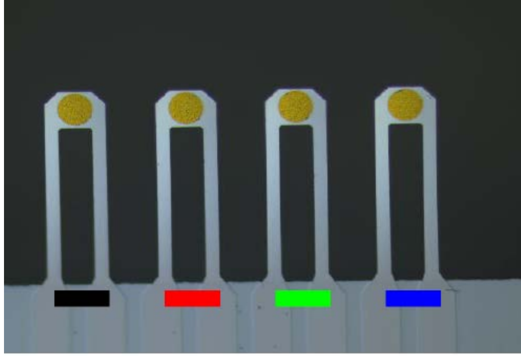
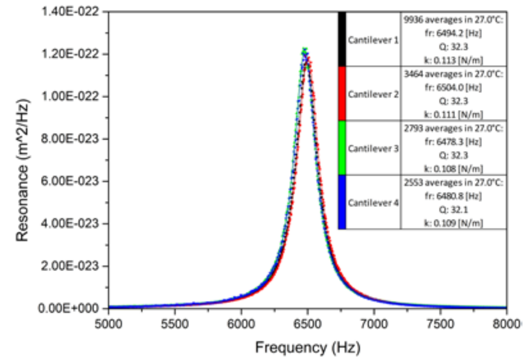
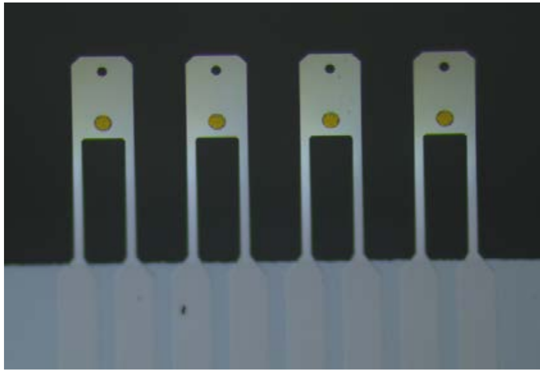
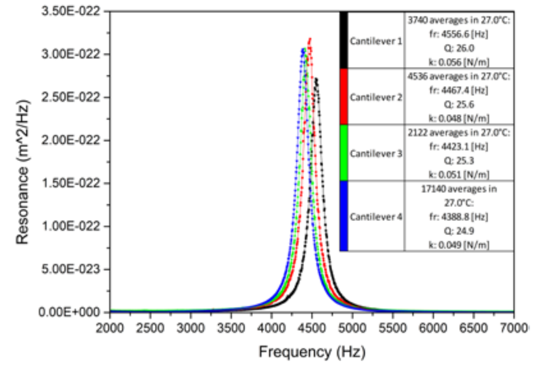




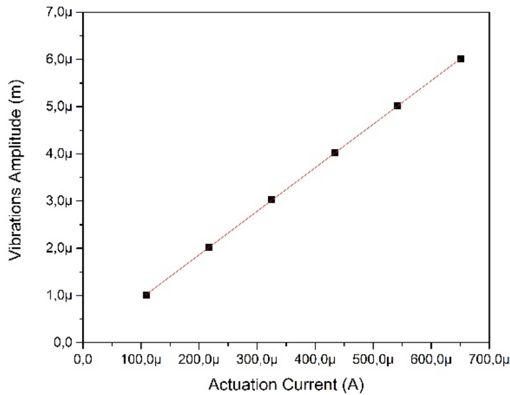
a)



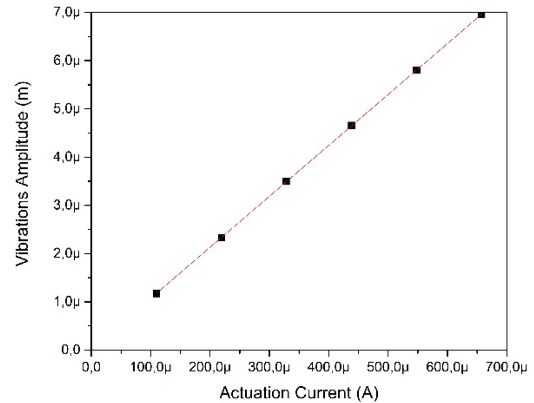


b)

Figure 1. Arrays of electromagnetically cantilevers: a) Type I b) Type II-for microsphere probes integration



a)



b)

Figure 2. Deflection sensitivity of electromagnetically actuated cantilevers a) Type I, b) Type II