NEMS ON EPITAXIAL GaAs TECHNOLOGY: BREAK JUNCTION DISPLACEMENT SENSOR

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New physics and novel applications are envisaged as MEMS (Micro-electro-mechanical-systems) shrink towards the nanometer scale (NEMS). The most important component of such a system is the transducer capable to transform nanoscale mechanical displacements into a measurable electrical signal (ref. 1). In this work, we have developed a new fabrication method for sub-nanometric displacement measurements using a semiconductor microcantilever . Devices are based on a GaAs(n-type)/AlGaAs heterostructure grown by MBE and selective etching of AlGaAs sacrificial layers.

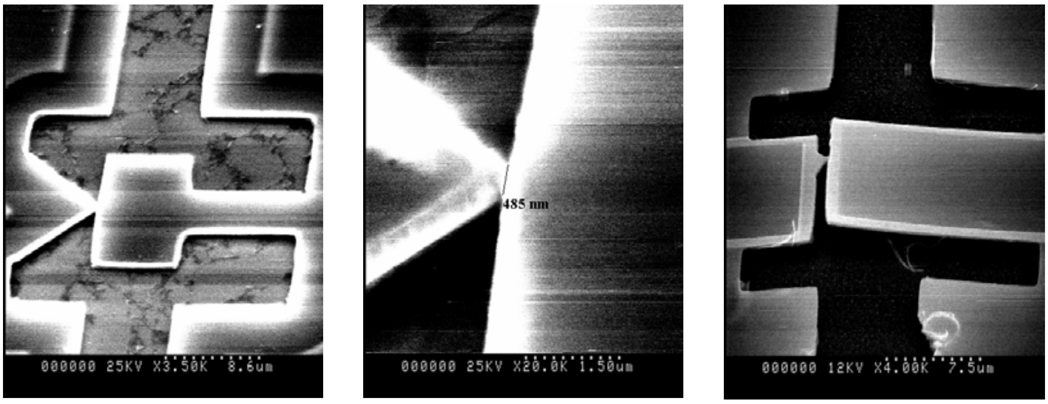
E-beam lithography is used to pattern devices. An electrical current, a direct measurement of the cantilever displacement in the nm range, is obtained at a gold nanocontact fabricated between the end of the cantilever and a reference electrode. The GaAs microcantilever is electrostatically actuated through a bottom electrode, and the resulting deflection is monitored by changes of the tunnel current, which has an exponential dependence of the gap distance. The deflection can be excited by ac or dc voltages, resulting in constant or oscillating amplitudes, whose resonance frequencies are in the megahertz range.

Among the future prospects are the detection of magnetic moments through their interaction with a resonant RF current fed through an integrated Au micro-coil, like for ferromagnetic resonance of a magnetic nanoparticle. Another line of related research is the development of modified devices as accelerometers in liquid environment using visco-elastic coupling.

References:

[1] A. N. Cleland & M. L. Roukes , NATURE **392** 12 MARCH 1998

Figures:



SEM micrographs show various device configurations and a detailed view of the nanocontact region