High quality mechanical resonator based on suspended nanowire

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In this work we present an experimental investigation of nanomechanical resonators based on suspended silicon nanowires. It was developed an original fabrication technique based on CMOS- compatible processes only [1]. The resonators of 2 to 5 um length, 50 to 150 nm width and 130 nm height were fabricated from silicon-on-insulator (SOI) and coated with a thin layer of aluminum. Their mechanical properties were carefully investigated at temperature of 20 mK.

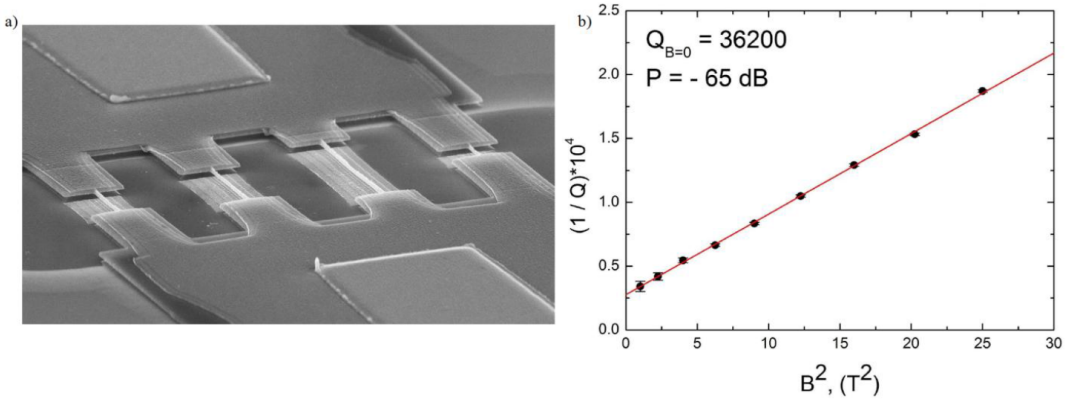

Figure 1: (*a*) SEM images of four nanomechanical resonators, fabricated in parallel on one chip; (*b*) The experimental data and linear approximation of oscillation amplitude for 5-μm-long resonator versus the square of the magnetic field strength.

For nanowires with a length of 5.0, 3.0 and 2.0 mkm, the resonant frequencies were 32.46 MHz, 71.99 MHz and 150.245 MHz respectively [2]. These experimentally measured values are well consistent with Euler- Bernoulli theory. The quality factor of the resonator of 5 um length was reached very high value — 36 200 (fig. 1 *b*). It is shown that the resonator switches to a nonlinear operating regime with an increase in pump power. The maximum oscillation amplitude was estimated by the frequency shift. For resonators of 2 um length, 85 nm width and 130 nm height it was 2.5 nm at maximum input power.

The high-quality resonator based on the suspended nanowire coupled to an nitrogen-vacancy (NV) center can be used as the basis of a quantum gravimeter. It is shown [3] that the proposed gravimeter could achieve 10^{-10} relative measurement precision of gravitational acceleration. Such systems can be highly demanded in various fields of science and technology, for example, in geology and geodesy.

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References

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