Dissipation in Stressed Silicon Nitride Beams at Very Low Temperatures

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We report measurements of the dissipation and the frequency shift in gold-coated, high stress silicon nitride nanomechanical resonators. The measurements were carried out in the temperature range 40 mK to 1.5 K using the magnetomotive transduction scheme. Devices of lengths 4.4, 6.4 and 25.5 μm of thickness 170 nm with 80 nm of gold deposited on top and one device with length 25.5 μm and 40 nm of gold were studied. Quality factors and frequency shifts were determined for the fundamental modes with frequencies in the range 5 MHz to 56 MHz and higher harmonics of the longer beams. Throughout most of the temperature range measured, the dissipation decreased linearly with temperature. The resonant frequency increased logarithmically with temperature at the lowest temperatures, with saturation observed at the higher temperatures observed for the flexural modes of the 25.5 μm long beams. The strong variation of the damping and the logarithmic dependence of the resonant frequency on temperature suggest that tunnelling two-level systems are an important source of dissipation in nanomechanical resonators. Our results also confirm that a metallic layer on top of a dielectric resonator can have significant impact on the magnitude and the temperature dependence of the dissipation.