A Fibre Interferometer for Low Temperature Measurements of High-Stress Silicon Nitride Nano-mechanical Devices

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We present both room and low temperature optical interferometry measurements on several different types of nanomechanical resonators made from pre-stressed stoichiometric silicon nitride on a silicon substrate. Mechanical resonances have been measured in doubly-clamped beams, three paddle torsional resonators and cantilevers at frequencies ranging from 5 MHz to above 10 MHz. Previous research has measured the temperature dependent dissipation in silicon nitride membranes and cantilevers to 1 K [1]. The fiber interferometer discussed here has been specifically designed and constructed to enable measurements on nanomechanical systems at temperatures below 1 K. As the devices are cooled the quality factors increase substantially. As an example, the quality factor of one of the doubly clamped beams increases from $\sim 10 \times 10^3$ at room temperature to $> 250 \times 10^3$ at low temperature. The temperature dependence of the dissipation in the different types of resonator, all fabricated simultaneously on the same substrate, will be presented.

[1]D. R. Southworth, R. A. Barton, S. S. Verbridge, B. Ilic, A. D. Fefferman, H. G. Craighead, and J. M. Parpia , Phys. Rev. Lett. **102**, 225503 (2009).