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Thermoelastic damping in micromechanical resonators[1] THOMAS METCALF, BRADFORD PATE, DOUGLAS PHOTIADIS, BRIAN HOUSTON, Naval Research Laboratory — The performance of micro- and nano-mechanical resonators as sensors, filters, and in other devices is determined by the quality factor, Q, which measures the fractional energy loss per oscillation cycle of the resonator. In any given resonator, several energy loss mechanisms are likely to be simultaneously present. However, for micro- and nano-scale resonators, the relative strengths and identity of these mechanisms is largely unknown. We measure the temperature dependence of Q^{-1} of two resonant modes (460 kHz and 510 kHz) of a 1.5 μm thick silicon micromechanical plate resonator. In-situ ultra-high vacuum annealing lowers the background energy loss at 120 K to $Q^{-1} \leq 5 \times 10^{-7}$. The Q^{-1} increases with increasing temperature by different rates for the two modes, quantitatively agreeing with a modification of Zener's theory of thermoelastic damping. This provides strong evidence that thermoelasticity is the dominant energy loss mechanism in one resonant mode.

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