Non-linear Mode Coupling in Silicon Nitride Beams

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We report measurements of the non-linear response and harmonic mode coupling in Silicon Nitride beams at very low temperatures. Non-linear effects arise naturally in nanomechanical beams from the stretching of the beam as it is deflected. When a particular mode is strongly excited the non-linearity gives rise both to a Duffing type behaviour in that mode and also a coupling to other modes which shifts their frequencies. Measurements were conducted at a temperature of 115mK on the first, third and fifth flexural mode of a beam with dimensions: $L \sim 25.5$ μm, $w \sim 170$ nm, $t \sim 170$ nm and a 40 nm thick layer of gold on top. Results for the nonlinear response of each individual mode and the nonlinear modal coupling are presented. The frequency shift of a given mode varies quadratically with the amplitude of a second strongly driven mode in agreement with theory.