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Measurements of the Mechanical Behavior of Micromachined Aluminized Silicon and Silicon Nitride Diaphragms

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This paper mainly presents the experimental determination of the small deflection behavior of dynamically excited aluminized boron-implanted silicon nitride and highly boron-doped silicon diaphragms for micromachined silicon subminiature microphones and other sensors. By comparing the measured deflections (center deflections as well as 3D-deflection functions) with theoretical values obtained by standard plate theory including in-plane stress effects, the tensile stress may be evaluated easily in a wide stress range. The measurements have been performed using a Mach-Zehnder interferometer. In order to achieve a high sensitivity of the measuring setup and a low detectable deflection amplitude, a feedback configuration stabilizes the interferometer at the most sensitive operating points. A minimum detectable deflection of about $1.4 \times 10^{-13}\,\mathrm{m}/\sqrt{\mathrm{Hz}}$ has been measured at 1 kHz. The largest measurable deflection—where nonlinearities of the interferometer are negligible—is strongly influenced by the wavelength of the laser and is about 10 nm.