Sub-10 cm³ Interferometric Accelerometer with Nano-g Resolution

Personnel

N. Loh (S. Manalis)

Sponsorship

Media Lab Things That Think Consortium

In this project, a high-resolution accelerometer with a bulk-micromachined silicon proof mass and an interferometric position sensor was developed for measuring vibratory accelerations. The interferometer consists of interdigitated fingers that are alternately attached to the proof mass and support substrate (see Figure 33).

Illuminating the fingers with coherent light generates a series of diffracted beams. The intensity of a given beam depends on the out-of-plane separation between the proof mass fingers and support fingers and is given by

$$I(d) = I_o \sin^2\left(\frac{2\pi d}{\lambda}\right)$$

where d is the offset and l is the illumination wavelength.

Proof masses with mechanical resonances ranging from 80 Hz to 1 kHz were fabricated with a two mask process involving two deep reactive ion etches, an oxide etch stop, and a polyimide protective layer. Figure 34 shows a 4 inch wafer containing accelerometers with various sized proof masses. The devices were packaged with a laser diode and photodiode into 8.6 cm3 acrylic housings. The 80 Hz resonant proof mass has a noise equivalent acceleration of 40 ng/rt Hz and a dynamic range of 85 dB at 40 Hz.

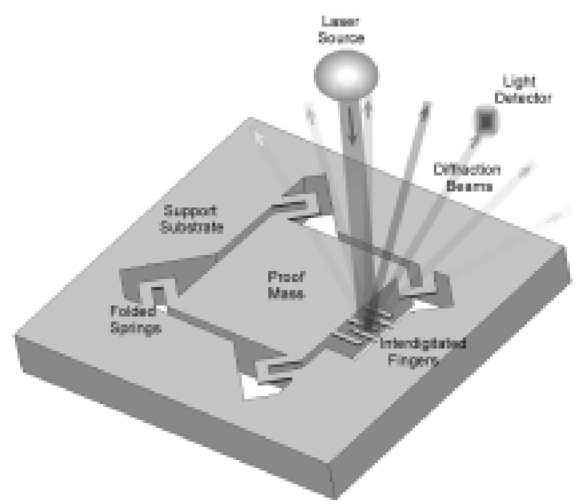

Fig. 33: Drawing of folded-pinwheel interferometric accelerometer. The intensity of a diffraction mode reflected off the interdigitated fingers is used to determine the displacement of the proof mass normal to the plane of die.

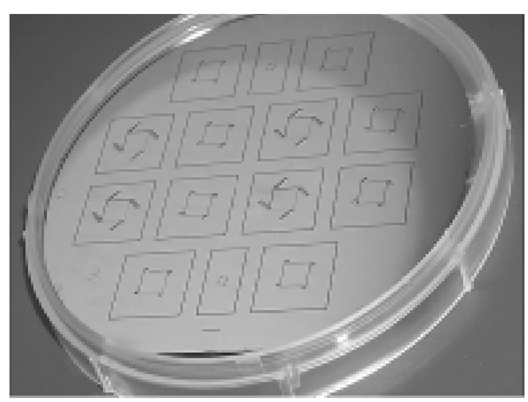

Fig. 34: 4-inch wafer containing 14 functional accelerometers.