A MEMS Electrometer for Gas Sensing

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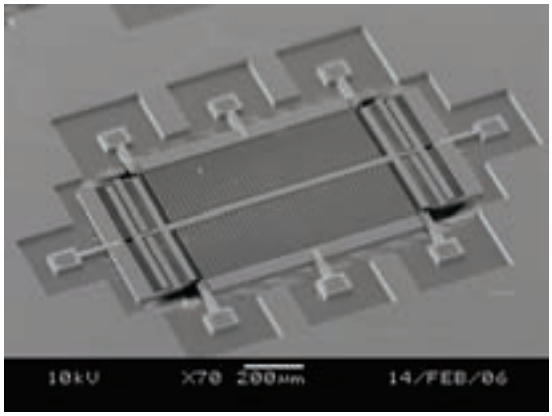
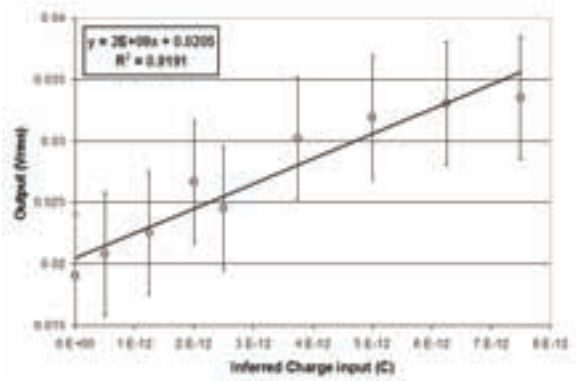
The DARPA-funded micro gas analyzer program aims to develop portable, low-power, fast, and reliable gas analyzer technology for a wide range of applications. The system architecture of the gas analyzer contemplates a MEMS electrometer at the end of the system. The electrometer characterizes the ionized species that are filtered by the quadrupole. The sensitive element of the electrometer is a MEMS structure embedded in a feedback loop of a precise oscillator circuit. The electrometer has a comb drive that sets the electrometer to oscillate. Shifts in the oscillation frequency are related to changes in the capacitance of the electrometer due to ion interception. The resolution of the device is estimated at 100 e/√Hz in vacuum [1]. Figure 1 shows a fabricated MEMS electrometer. Figure 2 shows the experimental data of one of these MEMS electrometers, in air. The experimental resonant frequency is 6.2 kHz, and the conversion gain was estimated at 2×10^9 V/C (theoretical value is 7×10^9 V/C). Current research focuses on implement lock-in detection, which will remove the noise from the drive signal because the output has twice the frequency of the input signal.



▲ Figure 1: A micro-fabricated MEMS electrometer. The comb drive (central part) sets the electrometer in oscillation. Changes in the variable capacitors (comb structures at both sides of the central comb drive) cause shifts in the oscillation frequency that are directly related to the ion current that impact the MEMS.



▲ Figure 2: Voltage versus charge characteristics for the MEMS quadrupole in air.

REFERENCES

[1] P. Riehl *et al.*,"Electrostatic charge and field sensors based on micro-mechanical resonators," *J. of Micromechanical Systems*, vol. 12, no. 5, p. 577, Oct. 2003.