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Integration of p-n Junction Diode to Cantilever Mass Sensor for Frequency Drift Compensation due to Temperature Fluctuation

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Silicon resonant sensors generally show frequency drift due to temperature fluctuation. A p-n junction diode was integrated to a resonant mass sensor using a silicon cantilever in one chip for frequency drift compensation due to temperature fluctuation. The diode could be fabricated by almost the same fabrication process simultaneously with piezoresistive stress gauges and showed good p-n junction characteristics for a temperature sensor. The sensor chip consisted of multiple cantilevers and the diode was assembled to a sensor package with a PZT vibrator and oscillated using a feedback electric circuit. Frequency drift trends under induced temperature changes could be almost compensated using the temperature read by the on-chip diode and a temperature coefficient. The temperature coefficients were −34 and −78 ppm/°C for gold-coated and polybutadiene-coated cantilevers, respectively, and found to depend strongly on the surface adsorption films on the sensor. Frequency drift compensation under a chemical sensing situation was also demonstrated, which was reduced from the original drift up to 30 Hz to almost 2 Hz. Temperature compensation using an on-chip temperature sensor is considered to be important for chemical sensing using silicon cantilevers where gas flows can easily change the temperature of the sensor.

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