Panasonic, Imec present new thin film packaged MEMS resonator

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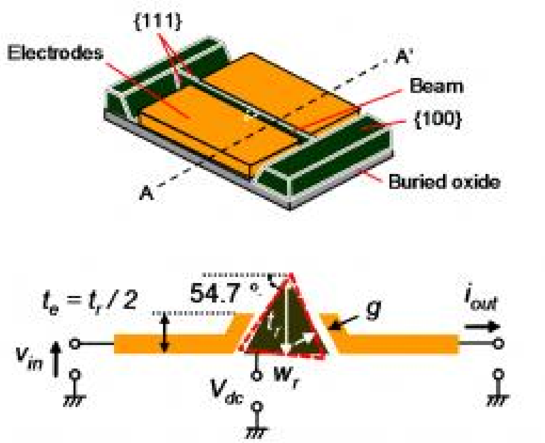
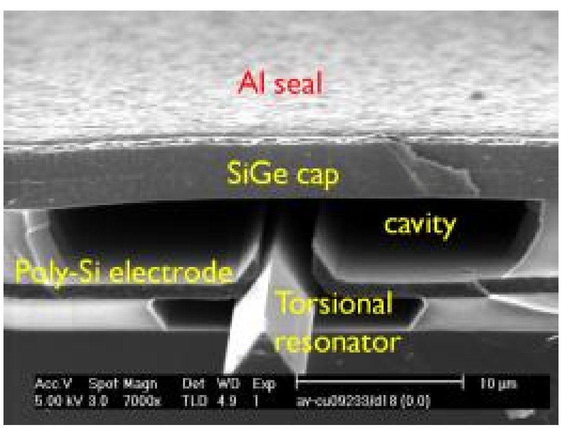


Illustration of the torsional vibration mode

Panasonic and imec present at the International Electron Devices Meeting in San Francisco an innovative SiGe (silicon germanium) thin film packaged SOI-based MEMS resonator featuring an industry-record Q factor combined with a low bias voltage. The high Q factor was achieved by implementing a resonator that operates in a torsional vibration mode, and, by vacuum encapsulation of the resonator in a thin film package. This groundbreaking resonator paves the way towards miniaturization and low power consumption of timing devices used in a variety of applications such as consumer electronics and automotive electronics.

MEMS resonators offer enhanced miniaturization over conventional resonators such as quartz crystals and piezoelectric ceramics. However, state-of-the art MEMS resonators suffer from a low Q factor and a high bias voltage. Panasonic and imec developed a novel packaged MEMS resonator achieving the highest Q factor reported in the industry until now (220,000 at a resonant frequency f=20MHz (f•Q product of 4.3X1012Hz)) and low bias voltage by combining different advanced MEMS technologies.

The application of a torsional vibration mode enables low anchor losses and lower squeeze film damping compared to flexural mode resonators, resulting in a higher Q factor. Since the Q factor also depends on the ambient pressure and starts to decrease above a critical pressure due to viscous and squeeze film damping, imec and Panasonic vacuum encapsulated the resonator in a hermetically sealed environment. This thin-film encapsulation of the MEMS with a 4µm thick SiGe film is realized with a monolithic fabrication process with the MEMS.



SEM of a cross-sectional structure of the developed packaged MEMS resonator.

The narrow 130nm gap between the beam and drive and sense electrodes enables a low bias voltage (1.8Vdc) and thus eliminates a charge pump in the oscillator circuit. Moreover, using sacrificial layer etching through a microcrystalline silicon germanium layer minimizes the chances of deposition of the sealing material inside the cavity and thus enables to position the etching holes right above the beam surface, leading to a smaller chip size.

The packaged MEMS resonator was realized as part of Imec's CMORE service which offers heterogeneous integration services to the industry. Imec builds on its expertise in many research areas to tune and extend CMOS processes with new processing steps to make novel CMOS micro- and nanodevices, adding functions other than logic and memory to the chips. Possible applications of such MEMS devices are smart sensors, actuators, power scavengers, resonators, biochips, micro-implantable appliances, or solar cells. Imec's CMORE services range from development-on-demand, over prototyping, to low-volume production.

Provided by IMEC

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