AN ARRAYED MEMS ACCELEROMETER WITH A WIDE RANGE OF DETECTION

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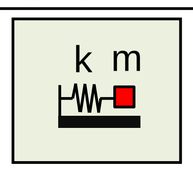
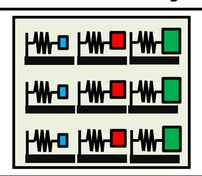
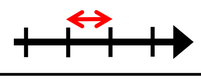
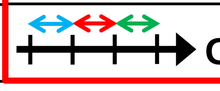
An arrayed MEMS accelerometer has been developed for a CMOS-MEMS motion sensor, where a wide range of detection and a minimal chip size would help to continuously monitor the various activities of human. High density of gold for the proof mass has allowed us to downscale the device size without compromising the sensitivity. Moreover, the gold electroplating with the maximum process temperature of below 400°C can be used as a reliable post-CMOS process for implementing MEMS sensors onto a sensing LSI chip.

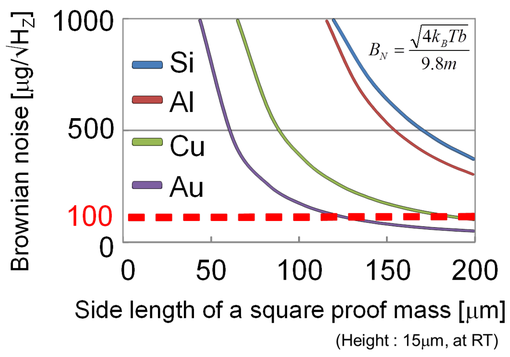
Background & Motivation

Arrayed MEMS accelerometer

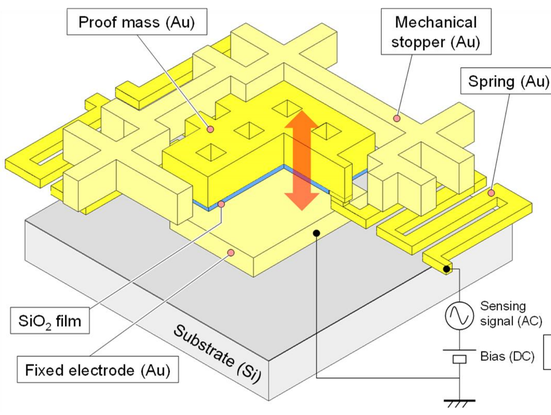
	Single proof mass	Arrayed proof mass
Accelerometer design		 Issue: Trade-off Size Sensitivity
Sensing range		 Advantage: Wide sensing range

Approaches for "miniaturized" arrayed MEMS accelerometer

- **Gold MEMS to minimize BN**
- **CMOS-MEMS integration for minimal chip size and improve overall performance**

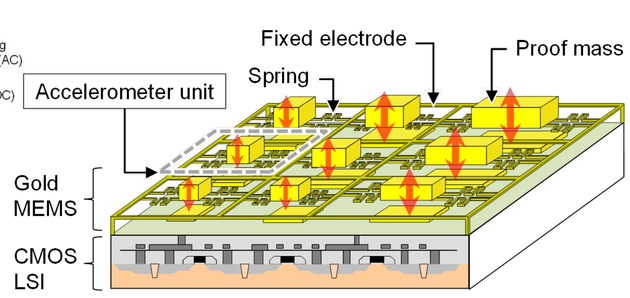


Low Brownian noise on gold proof mass



- **Multilayer for design flexibility**
- **Mechanical stopper to avoid destruction**

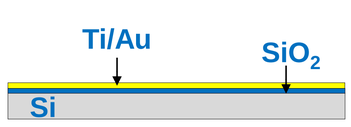
Gold plated single-axis MEMS accelerometer



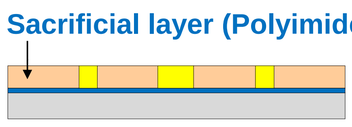
Concept image of an arrayed CMOS-MEMS accelerometer

Microfabrication

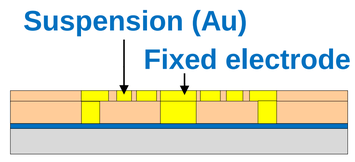
Process temp. < 400°C



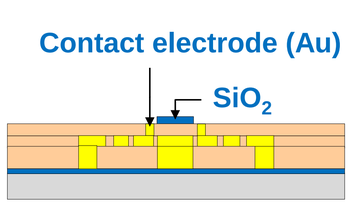
(a) Seed layer deposition



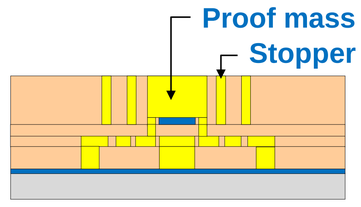
(b) 1st Au electroplating



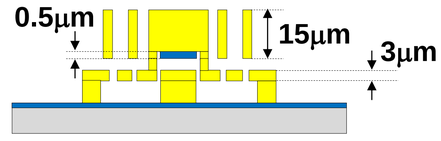
(c) 2nd Au electroplating



(d) SiO_2 and contact electrode patterning



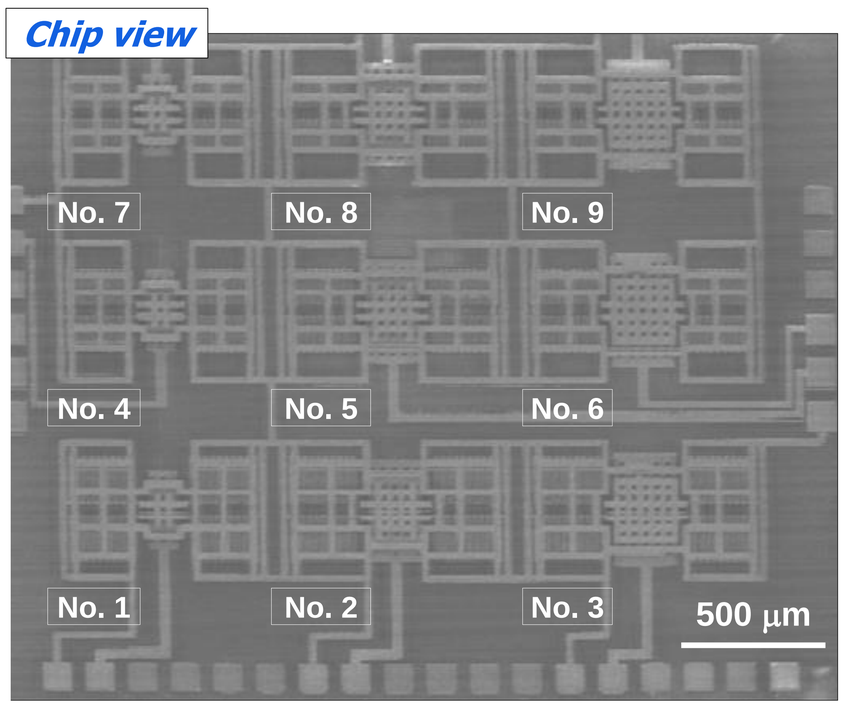
(e) 3rd Au electroplating



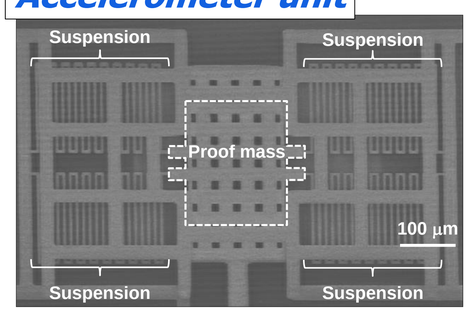
(f) Sacrificial layer releasing by O_2 plasma

Microfabrication process for post-CMOS integration

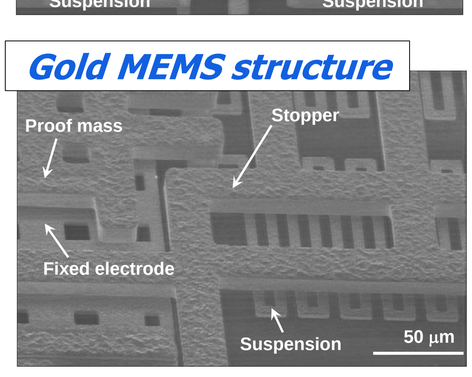
Chip view



Accelerometer unit

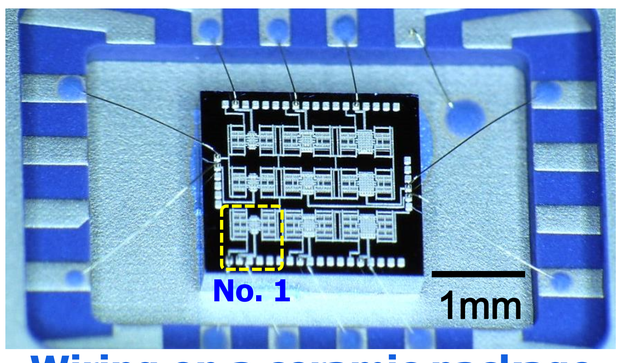


Gold MEMS structure

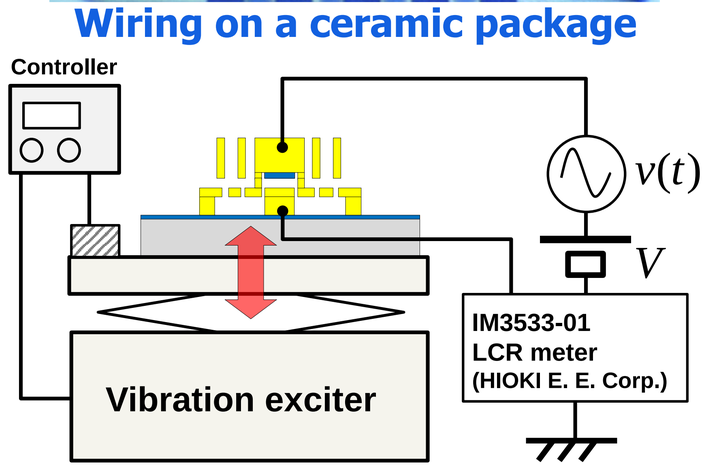


SEM images of the developed 3-by-3 MEMS accelerometer

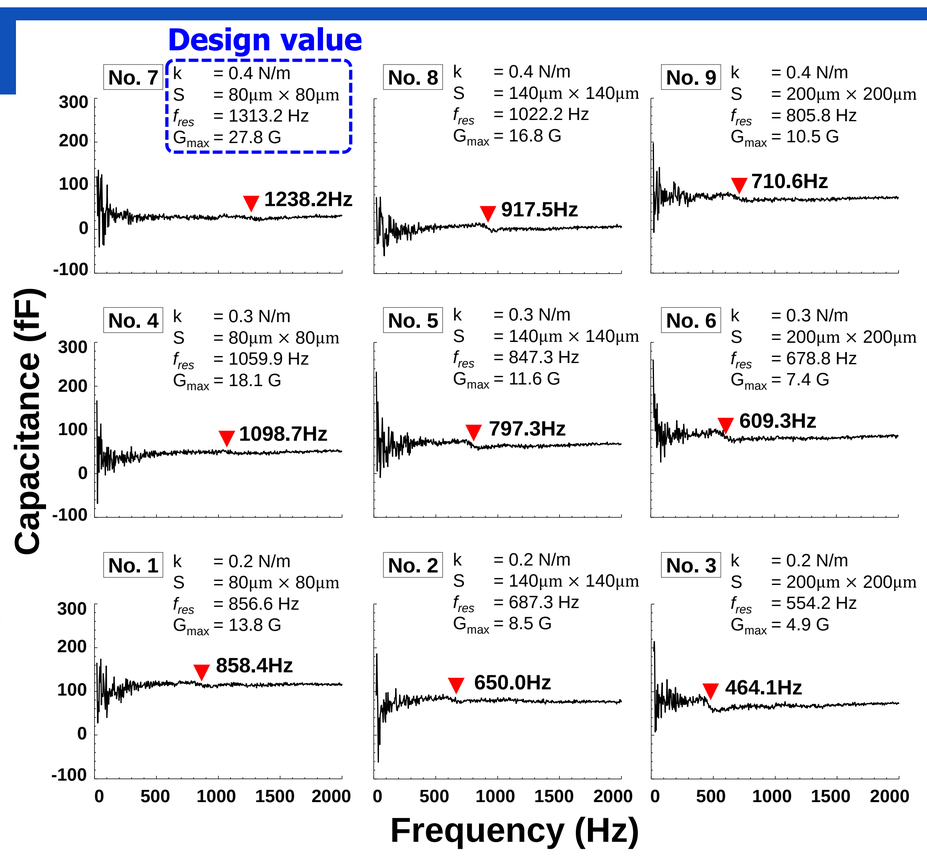
Evaluation Results



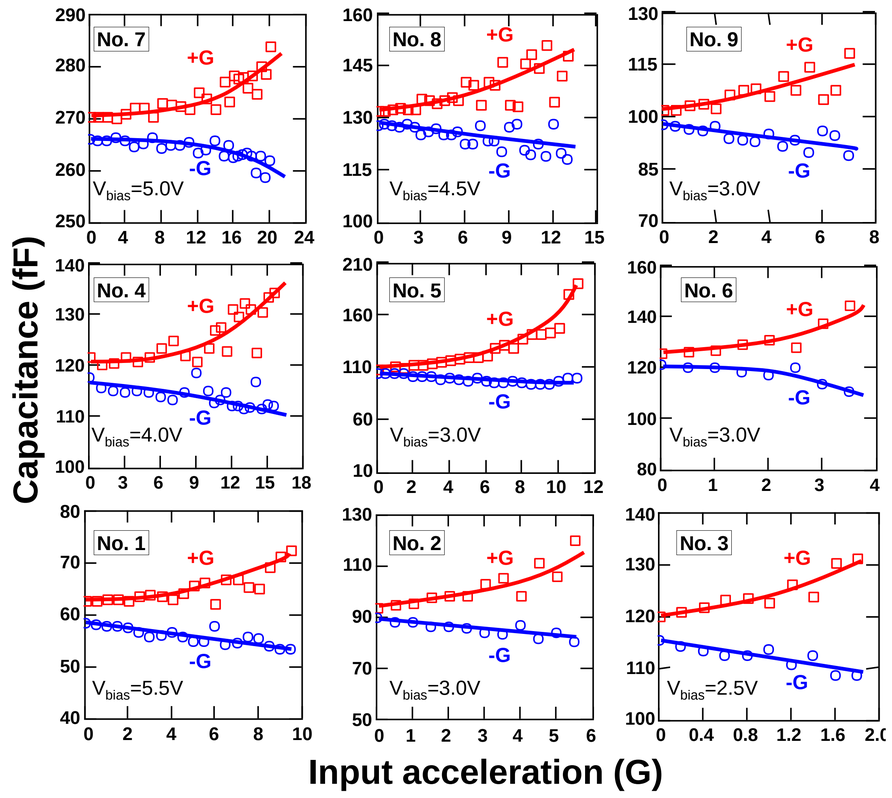
Wiring on a ceramic package



Experimental setup



Measured capacitance as a function of sensing signal frequency



Measured capacitance as a function of input acceleration

Conclusion

The fabrication process (max. process tem. < 400°C) and the evaluation results of the developed arrayed MEMS accelerometer indicate the feasibility of a miniaturized CMOS-MEMS accelerometer with a wide sensing range (from 1.7 G to 20 G). The measured data were found to be in a good agreement with the design values.

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