Enhanced Mechanical Strength of Ti-Au Bi-Layered Micro-Cantilever For MEMS Accelerometers

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Gold-based micro-electrical-mechanical systems (MEMS) components are gaining popularity for its high mass density (19.3×10^3 kg/m3 at 298K) which is effective in suppressing the Brownian noise. In previous study, our research group managed to fabricate a micro-cantilever of gold with 369 MPa yield strength by decreasing the grain size of gold via electrodeposition method [1]. To further increase the yield strength, Ti/Au bi-layered structure was proposed and preliminary study using finite element method was conducted, where positive impact on structure stability of micro-components using the Ti/Au bi-layer structure was observed [2]. However, it is still necessary to carry out real mechanical test to provide detailed information about the bi-layer structure for design of new MEMS accelerometers.

The specimens were prepared using electrodeposition method and micro-cantilever shape was fabricated using focus ion beam (FIB). Micro-bending tests of the micro-cantilevers were carried out using a custom-made test machine developed in our group especially for micro-specimens. The displacement rate for micro-bending test was set to 0.05 μm/s and the result can be seen in Fig.1 for 52% gold cantilever.

Fig. 2 showed that the bi-layer structure exhibited a much higher strength when compared to the pure specimens of gold or titanium. This high strength is suggested to be contributed by the interface incoherency between the gold and titanium. Additionally, it can also be observed from fig. 2 that the pure gold specimen exhibits higher strength than bulk gold (200MPa) due to its smaller grain size. Ti/Au bi-layer structure is an effective method to increase the strength of micro-components of gold-based MEMS devices and the strength increase with increasing gold ratio.

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Reference : [1] K. Asano, et al., *Microelectron. Eng.* **180** (2017) 15-19.
[2] M. Teranishi, et al., *Microelectron. Eng.*, **159** (2016) 90-93.

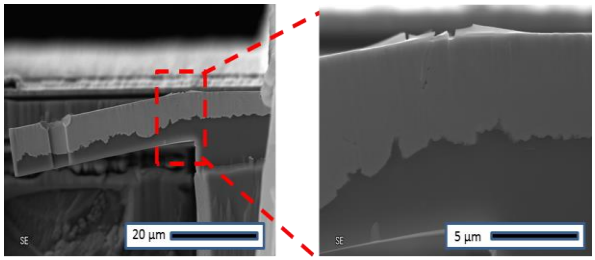

Fig. 1 SEM Image of 52% gold cantilever after deformation

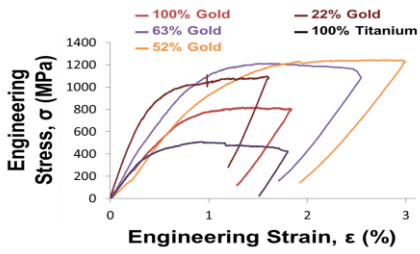

Fig. 2 Engineering stress-engineering strain curves

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