Structure Stability of High Aspect Ratio Ti/Au Two-Layered Cantilevers for Applications in MEMS Accelerometers

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Introduction

Gold materials

High chemical stability, corrosion resistance, electrical conductivity and density.

Previous study

Sub-1g MEMS accelerometer composed of gold materials[1]

Need to investigate structure stability of the gold materials

Objective

Evaluate the movable structure stability of Ti/Au two-layered cantilevers with high aspect ratio (length/thickness) in microscale by 3D optical microscope and COMSOL Multiphysics simulation.

Experimental

Process flow of micro cantilevers

Ti/Au layers were sputtered on Si/SiO2 substrate. Patterns was formed by photolithography. Au was deposited by electroplating.

Schematic of the Ti/Au cantilever

Ti/Au cantilever was formed and annealed at 310°C. Sacrificial layer was released by dry-etching.

Images of the Ti/Au cantilevers

Evaluation of the Ti/Au cantilevers

- Scanning electron microscope (SEM)
- 3D optical microscope (OM)
- COMSOL Multiphysics simulation

Results and Discussion

Height profile of the Ti/Au micro-cantilevers

COMSOL MultiPhysics simulation for Ti/Au micro-cantilevers

• Tip deflection downward
  ⇒ The difference in thermal expansion between Ti and Au.
  ⇒ The results obtained from COMSOL were different from those observed by the OM.
  ⇒ Titanium could be oxidized when it is heat-treated in air.
  ⇒ High temperature can accelerate formation of an intermetallic layer at Ti/Au interface.

Deflection curve of micro-cantilevers with length varied from 100 to 1000 μm

Conclusions

- Ti/Au cantilevers with different aspect ratio were fabricated using lithography method and electroplating in microscale.
- COMSOL MultiPhysics simulation showed downward deflection for all of the cantilevers.
- We revealed that the Ti/Au two-layered structure can enhance stability of the movable structure and reliability of materials.

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