Micro compression test using non-tapered micro-pillars of electrodeposited Cu

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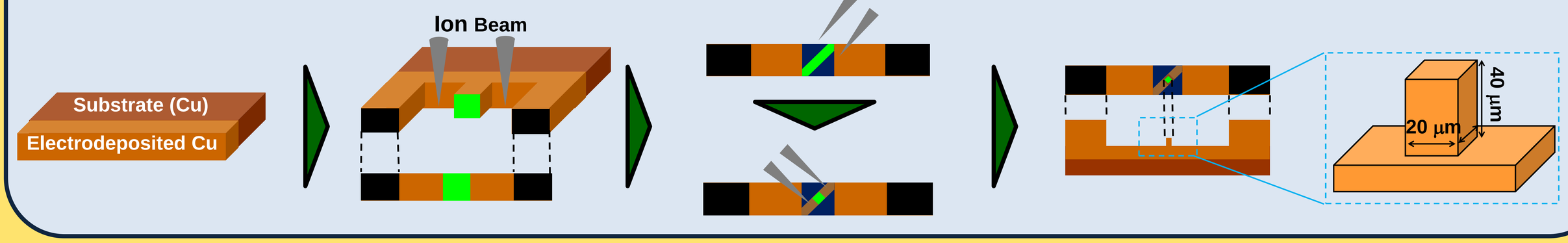
Introduction

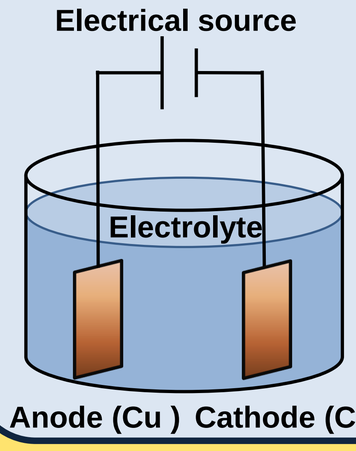
New evaluation method of electrodeposited Cu film for application in MEMS devices

Fabrication of Micro-Pillar specimen using Focused Ion Beam



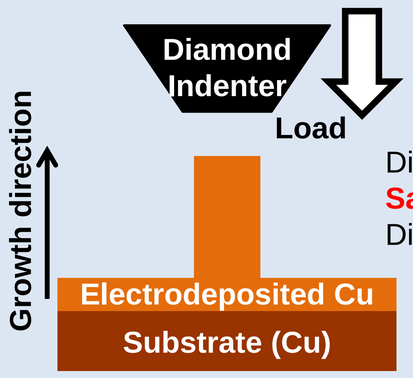
Experimental

Cu Electroplating

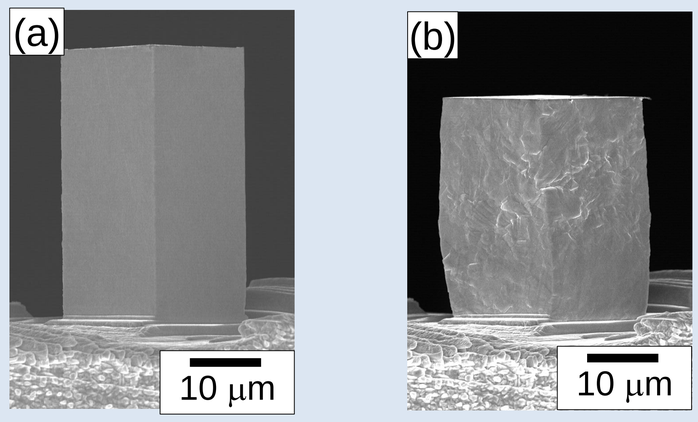


Anode: Copper
Cathode: Copper substrate
Current density: 0.5, 2.0 ,5.0 A/dm^2
Temperature: 298 K
Electrolyte: $CuSO_4 \cdot 5H_2O$ (0.85 mol/l) , H_2SO_4 (0.55 mol/l)

Micro Compression Test

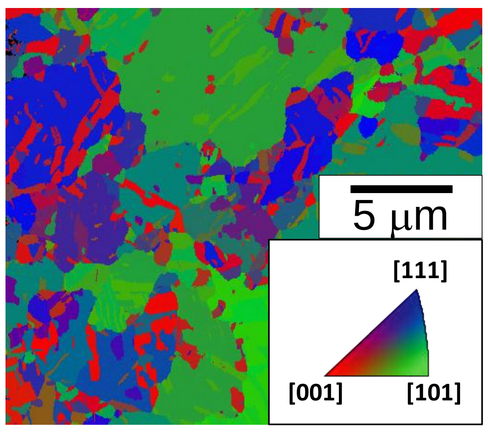
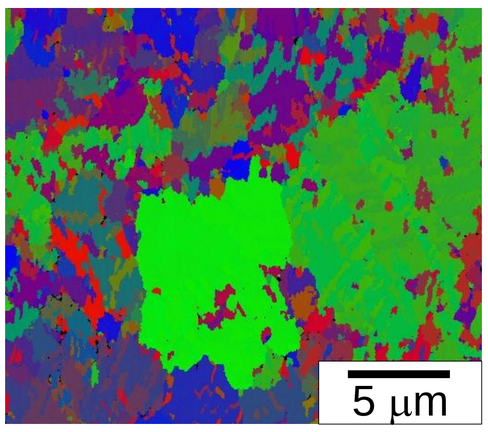
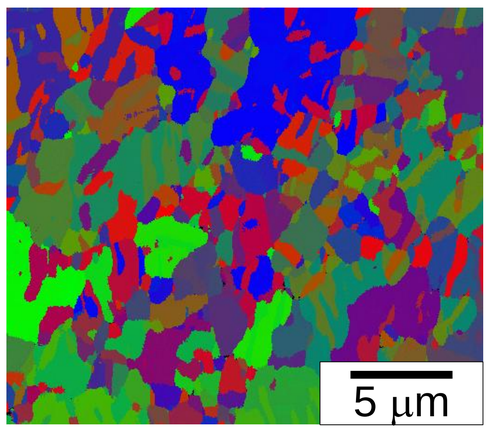
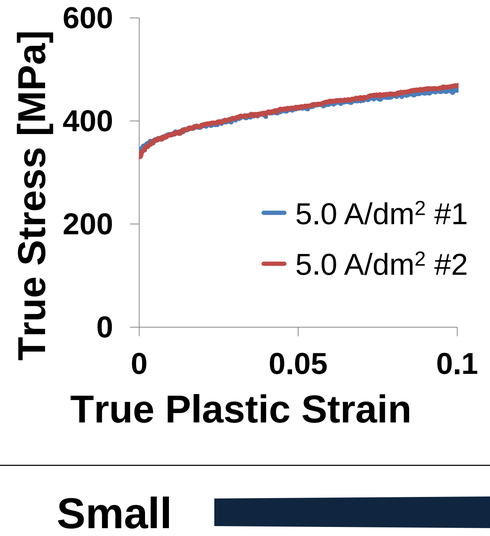
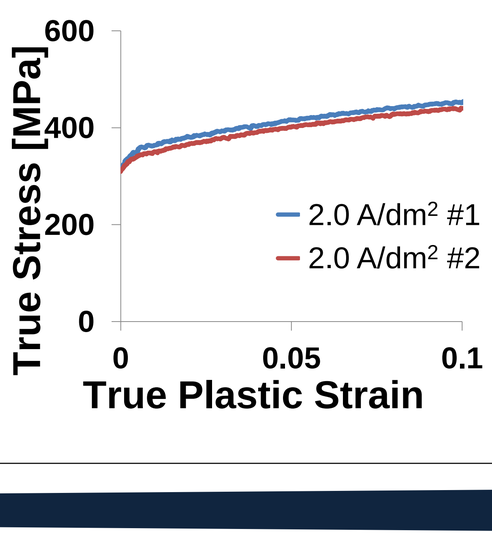
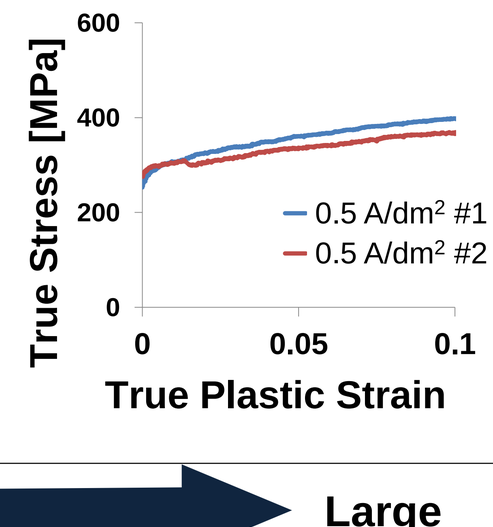


Diameter of tip: 50 μm
Sample size: 20×20×40 μm
Displacement rate : 0.1 μm/s



SEM images of the Cu pillars electrodeposited at 0.5 A/dm^2 (a) as-prepared, (b) deformed

Result and Discussion

Current density	5.0 A/dm^2	2.0 A/dm^2	0.5 A/dm^2
EBSD Analysis (Orientation maps taken from surface normal of these electrodeposited Cu films)			
Grain Size	**0.64 μm**	**0.78 μm**	**0.93 μm**
S/G ratio (Ratio of specimen size to grain size of the pillar)	**31.3** Specimen size: 20 μm	**25.6**	**21.5**
Micro Compression Test			
Difference between two curves	**Small** → **Large** The effect of crystal anisotropy became stronger with smaller S/G ratio		

Conclusions

1. The mechanical property of the electrodeposited Cu films were precisely evaluated using this new method.
2. Effect of crystal anisotropy is stronger with higher ratio between specimen size and grain size of pillar
3. The pillar electrodeposited at higher current density has higher strength because Cu film electrodeposited at higher current density has smaller grain.

Acknowledgement

This work was supported by Funding Program for Next Generation World-leading Researchers (NEXT Program), Cabinet Office (CAO), Japan.