[Abstract No. E3-P-0011]

Micro-Tensile Test Using Micro-Sized Gripper and Specimen Fabricated by FIB

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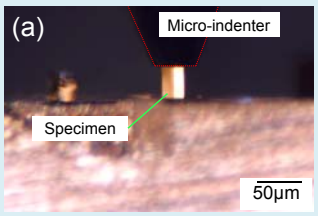
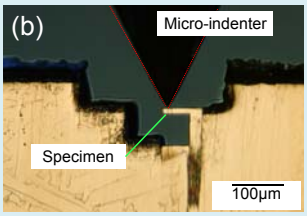
Introduction

Mechanical testings for micro-specimens





(a) Micro-compression
(b) Micro-bending

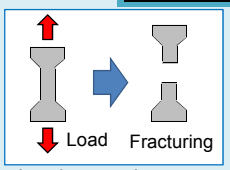
Evaluate mechanical properties of micro-components used in MEMS

Provide
- Mechanical property in micro-scale
- Size effects contributed by specimen size

Shortcomings

Cannot provide
- Fractured strength
- Elongation

Micro-tensile test



- Fractured strength
- Elongation

In micro-scale

Gripper specimens

- Alignment
- Fabrication

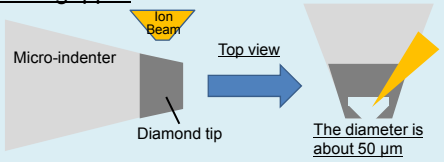
→ Difficult

Objective of this study is development of a micro-tensile test using micro-gripper and specimen fabricated by FIB

Experimental Procedures

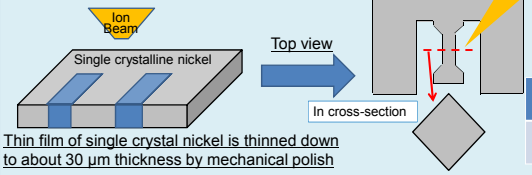
Fabrication method

Micro-gripper



Gripped part of the specimen is similar to diamond gripper

Micro-specimen



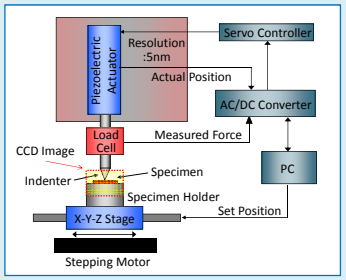
Thin film of single crystal nickel is thinned down to about 30 μm thickness by mechanical polish

Gauge part of the specimen has a square cross-section

Material of specimens	Dimension of the gauge part [μm]
Single crystal nickel	7.5 × 7.5 × 40 10 × 10 × 40

Test machine designed for micro-sized specimens

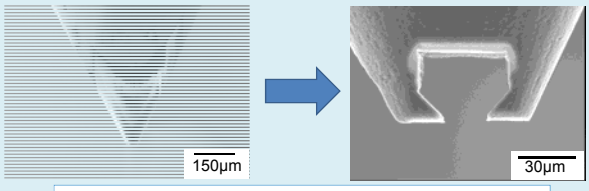
Testing condition



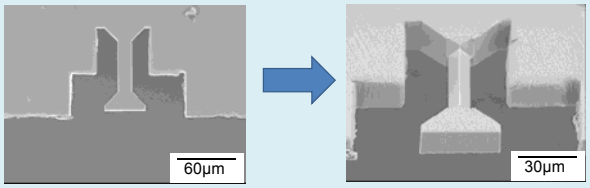
Control	Displacement rate	Load resolution
Displacement control	0.1 [μm/s]	10 [mN]

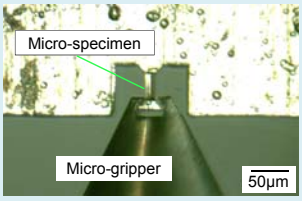
Results & Discussion

Micro-gripper and specimen



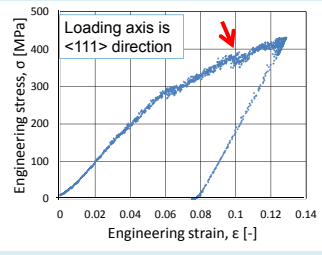
SEM images of the micro-gripper and micro-tensile specimen fabricated by focused ion beam(FIB)

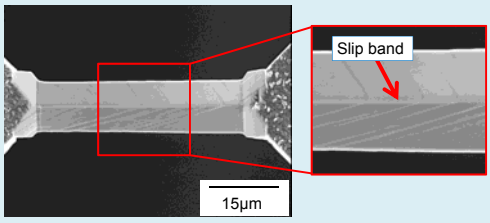




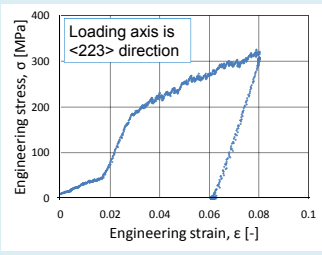
Optical image of the micro-gripper and micro-specimen during the micro-tensile test

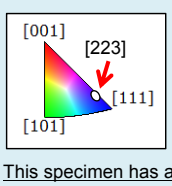
Stress-strain curves and deformation behavior





Similar to work reported on tensile testing of single crystal copper micro-specimen [D. Kiener, W. Grosinger, G. Dehm and R. Pippan, Acta Materialia **56** (2008) 580-592]





This specimen has a higher schmid factor than the <111> specimen

Loading axis: <111>

Rank	Schmid factor
1	0.332892
2	0.316529
3	0.296836

Loading axis: <223>

Rank	Schmid factor
1	0.439154
2	0.425891
3	0.355462

Difference in stress-strain curves is related to the value of Schmid factor, which also occurs in the case of bulk materials

Conclusions

1. We fabricated micro-gripper and micro-specimens by FIB and conducted micro-tensile test using a test machine designed for micro-sized specimens.
2. Results obtained in this work have a good agreement with works reported before, so the testing method is reliable and can be applied in micro-tensile test.