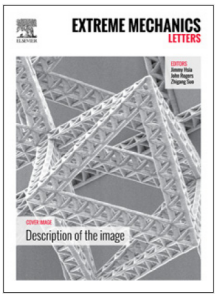
Accepted Manuscript



A novel mems stage for *in-situ* thermomechanical testing of single crystal silicon microbeams under bending

Mohamed Elhebeary, M. Taher A. Saif

PII: S2352-4316(18)30119-6
DOI: https://doi.org/10.1016/j.eml.2018.06.009
Reference: EML 386

To appear in: *Extreme Mechanics Letters*

Received date : 28 May 2018
Revised date : 27 June 2018
Accepted date : 27 June 2018

Please cite this article as: M. Elhebeary, M.T.A. Saif, A novel mems stage for *in-situ* thermomechanical testing of single crystal silicon microbeams under bending, *Extreme Mechanics Letters* (2018), https://doi.org/10.1016/j.eml.2018.06.009

A NOVEL MEMS STAGE FOR *IN-SITU* THERMOMECHANICAL TESTING OF SINGLE CRYSTAL SILICON MICROBEAMS UNDER BENDING

Mohamed Elhebeary, and M. Taher A. Saif *
University of Illinois at Urbana-Champaign, Urbana, IL, USA

ABSTRACT

We present a novel silicon MEMS stage for *in-situ* bending test of micro/nanoscale samples at high temperature. The stage minimizes uniaxial state of stress in the sample, but maximizes the bending stress over a small volume such that high stresses can be reached without a premature failure by flaw induced fracture. A test setup is designed to carry the stage inside an SEM which enables to heat the sample up to 450°C. A piezo actuator of the setup stretches the stage which translates into bending the sample. Analytical and finite element (FE) models are developed to predict the behavior of the bending stage and calculate the stresses in the sample. Single crystal silicon (SCS) micro-beams oriented along [0 1 1] are tested at room temperature under bending. They showed higher strength compared to the uniaxial tension test results. The calculated modulus of elasticity of the samples matches the value reported in literature. In addition samples with thickness 2-5 μm exhibited brittle-to-ductile transition (BDT) at 400ºC, about 150ºC below the bulk BDT temperature.

Keywords

Silicon, brittle-to-ductile transition, in-situ thermomechanical testing, micromechanics

*Corresponding author: saif@illinois.edu