Sensors and Materials, Vol. 22, No. 1 (2010) 25–37
MYU Tokyo

S & M 0786

Effect of Specimen Shape on Test Results of Au Freestanding Film Measured by Strip Bending Method

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(Received June 22, 2009; accepted August 6, 2009)

Key words: strip bending test, specimen shape, Au, stress-strain curve, finite element analysis

Strip bending is a simple and productive method for the mechanical characterization of thin-film materials used in micro-electromechanical systems (MEMS) applications. This method can yield a stress-strain curve as does a microtensile test, and can also yield the elastic modulus and strength. The strip bending test is much more useful than the microtensile test because of the ease of specimen fabrication, alignment, and handling. On the other hand, results obtained by the strip bending test can suffer from uncertainties related to specimen shape, and the specimen shape can affect the strain estimation and stress concentration of the specimen. In this study, two types of specimen were fabricated using a MEMS process to investigate the effect of specimen shape. Au was chosen as a thin-film material owing to its widespread use in MEMS applications. The stress-strain curves of Au thin film were measured using a strip bending apparatus equipped with an accurate laser displacement sensor and a load cell of 500 mN capacity. The difference caused by the specimen shape was clearly identified in the stress-strain curves of the two types of specimen of the same Au thin film. A carefully designed microtensile test was performed to accurately measure the stress-strain curve of the Au thin film, and the tensile data was compared with the data obtained by the strip bending method. To understand the mechanics of the strip bending method and the effect of specimen shape, finite element analysis (FEA) was performed for 3-dimensional models of the two types of strip bending specimen. A desirable test practice of the strip bending method was suggested for standardization purposes on the basis of experimental and FEA results.

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