Designation: E 2246 – 02

Standard Test Method for
Strain Gradient Measurements of Thin, Reflecting Films Using an Optical Interferometer[1]

This standard is issued under the fixed designation E 2246; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure for measuring the strain gradient in thin, reflecting films. It applies only to films, such as found in microelectromechanical systems (MEMS) materials, which can be imaged using an interferometer. Measurements from cantilevers that are touching the underlying layer are not accepted.

1.2 This test method uses a non-contact optical interferometer with the capability of obtaining topographical 3-D data sets. It is performed in the laboratory.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 2244 Test Method for In-Plane Length Measurements of Thin, Reflecting Films Using an Optical Interferometer[2]

E 2245 Test Method for Residual Strain Measurements of Thin, Reflecting Films Using an Optical Interferometer[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *2-D data trace, n*—a two-dimensional data trace that is extracted from a topographical 3-D data set and that is parallel to the *xz*- or *yz*-plane of the interferometer.

3.1.1.1 *Discussion*—The height of the sample is measured along the *z*-axis of the interferometer. The interferometer's *x*-axis (as shown in Figs. 1-3) is typically aligned parallel or perpendicular to the transitional edges to be measured.

3.1.2 *3-D data set, n*—a three-dimensional data set with a topographical *z*-data value for each (*x*, *y*) pixel location within the interferometer's field of view.

3.1.3 *anchor, n*—in a surface-micromachining process, the portion of the test structure where the mechanical layer makes contact with the underlying layer (see Figs. 1 and 2).

3.1.4 *anchor lip, n*—in a surface-micromachining process, the extension of the mechanical layer around the edges of the anchor (see Figs. 2 and 3).

3.1.5 *bulk micromachining, adj*—a MEMS fabrication process where the substrate is removed at specified locations, which can create structures suspended in air.

3.1.6 *cantilever, n*—a test structure that consists of a beam suspended in air and anchored or supported at one end (see Figs. 1-3, and Fig. X1.1).

3.1.7 *fixed-fixed beam, n*—a test structure that consists of a beam suspended in air and anchored or supported at both ends.

3.1.8 *in-plane length measurement, n*—a length (or deflection) measurement made parallel to the underlying layer (or the *xy*-plane).

3.1.9 *interferometer, n*—a non-contact optical instrument (such as shown in Fig. 4) used to obtain topographical 3-D data sets.

3.1.10 *mechanical layer, n*—in a surface-micromachining process, the patterned layer (as shown in Fig. 2) that is anchored to the underlying layer where cuts are designed in the sacrificial layer and that is suspended in air where no cuts are designed in the sacrificial layer.

3.1.11 *MEMS, adj*—microelectromechanical systems.

3.1.12 *out-of-plane, adj*—perpendicular (in the *z*-direction) to the underlying layer.

3.1.13 *out-of-plane measurements, n*—measurements taken on structures that are curved out-of-plane in the *z*-direction.

3.1.14 *residual strain, n*—in a surface-micromachining process, the strain present in the mechanical layer after fabrication yet before the sacrificial layer is removed. In a bulk-micromachining process, the strain present in the suspended layer after fabrication yet before the substrate is removed at specified locations.

3.1.15 *sacrificial layer, n*—in a surface-micromachining process, the layer fabricated between the mechanical layer and the underlying layer. This layer is removed after fabrication. If cuts are designed in this sacrificial layer (as shown in Fig. 2), an anchor is created allowing the mechanical layer to contact the underlying layer in that region.

3.1.16 *stiction, n*—in a surface-micromachining process, a structure exhibits this when a non-anchored portion of the

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[1] This test method is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.05 on Cyclic Deformation and Fatigue Crack Formation.

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[2] *Annual Book of ASTM Standards*, Vol 03.01.

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