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Standard Terminology Relating to Measurements Taken on Thin, Reflecting Films[1]

This standard is issued under the fixed designation E2444; 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.

ε^1 NOTE—Additional sources for terms were added editorially in August 2012.

1. Scope

1.1 This standard consists of terms and definitions pertaining to measurements taken on thin, reflecting films, such as found in microelectromechanical systems (MEMS) materials. In particular, the terms are related to the standards in Section 2, which were generated by Committee E08 on Fatigue and Fracture. Terminology E1823 Relating to Fatigue and Fracture Testing is applicable to this standard.

1.2 The terms are listed in alphabetical order.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1823 Terminology Relating to Fatigue and Fracture Testing

E2244 Test Method for In-Plane Length Measurements of Thin, Reflecting Films Using an Optical Interferometer

E2245 Test Method for Residual Strain Measurements of Thin, Reflecting Films Using an Optical Interferometer

E2246 Test Method for Strain Gradient Measurements of Thin, Reflecting Films Using an Optical Interferometer

3. Terminology

3.1 *Terms and Their Definitions:*

2-D data trace—a two-dimensional group of points that is extracted from a topographical 3-D data set and that is parallel to the *xz*- or *yz*-plane of the interferometric microscope. **E2244, E2245**

3-D data set—a three-dimensional group of points with a topographical *z*-value for each (*x*, *y*) pixel location within the interferometric microscope's field of view. **E2244, E2245, E2246**

anchor—in a surface-micromachining process, the portion of the test structure where a structural layer is intentionally attached to its underlying layer. **E2244, E2245, E2246**

anchor lip—in a surface-micromachining process, the freestanding extension of the structural layer of interest around the edges of the anchor to its underlying layer.

DISCUSSION—In some processes, the width of the anchor lip may be zero. **E2244, E2245, E2246**

bulk micromachining—a MEMS fabrication process where the substrate is removed at specified locations. **E2244, E2245, E2246**

cantilever—a test structure that consists of a freestanding beam that is fixed at one end. **E2244, E2245, E2246**

fixed-fixed beam —a test structure that consists of a freestanding beam that is fixed at both ends. **E2244, E2245**

in-plane length (or deflection) measurement, *L* (or *D*) [L]—the experimental determination of the straight-line distance between two transitional edges in a MEMS device.

DISCUSSION—This length (or deflection) measurement is made parallel to the underlying layer (or the *xy*-plane of the interferometric microscope). **E2244, E2245, E2246**

interferometer—a non-contact optical instrument used to obtain topographical 3-D data sets.

DISCUSSION—The height of the sample is measured along the z-axis of the interferometer. The x-axis is typically aligned parallel or perpendicular to the transitional edges to be measured. **E2244, E2245, E2246**

MEMS—microelectromechanical systems. **E2244, E2245, E2246**

microelectromechanical systems, MEMS—in general, this term is used to describe micron-scale structures, sensors, actuators, and technologies used for their manufacture (such as, silicon process technologies), or combinations thereof. **E2244, E2245, E2246**

residual strain, ε_r—in a MEMS process, the amount of deformation (or displacement) per unit length constrained within the structural layer of interest after fabrication yet

[1] This test method is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.02 on Standards and Terminology.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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before the constraint of the sacrificial layer (or substrate) is removed (in whole or in part) E2245, E2246

sacrificial layer—a single thickness of material that is intentionally deposited (or added) then removed (in whole or in part) during the micromachining process, to allow freestanding microstructures. E2244, E2245, E2246

stiction—adhesion between the portion of a structural layer that is intended to be freestanding and its underlying layer. E2245, E2246

(residual) strain gradient, s_g [L^{-1}]—a through-thickness variation (of the residual strain) in the structural layer of interest before it is released.

DISCUSSION—If the variation through the thickness in the structural layer is assumed to be linear, it is calculated to be the positive difference in the residual strain between the top and bottom of a cantilever divided by its thickness. Directional information is assigned to the value of '*s*.' E2245, E2246

structural layer—a single thickness of material present in the final MEMS device. E2244, E2245, E2246

substrate—the thick, starting material (often single crystal silicon or glass) in a fabrication process that can be used to build MEMS devices. E2244, E2245, E2246

support region—in a bulk-micromachining process, the area that marks the end of the suspended structure. E2244, E2245, E2246

surface micromachining—a MEMS fabrication process where micron-scale components are formed on a substrate by the deposition (or addition) and removal (in whole or in part) of structural and sacrificial layers. E2244, E2245, E2246

test structure—a component (such as, a fixed-fixed beam or cantilever) that is used to extract information (such as, the residual strain or the strain gradient of a layer) about a fabrication process. E2244, E2245, E2246

transitional edge—the side of a MEMS structure that is characterized by a distinctive out-of-plane vertical displacement as seen in an interferometric 2-D data trace. E2244, E2245, E2246

underlying layer —the single thickness of material directly beneath the material of interest.

DISCUSSION—This layer could be the substrate. E2244, E2245, E2246

4. Keywords

4.1 cantilevers; definitions; fixed-fixed beams; interferometry; length measurements; microelectromechanical systems; MEMS; polysilicon; residual strain; stiction; strain gradient; terminology; test structure

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