SLOVENSKI STANDARD
SIST EN 62047-8:2011

01-julij-2011

Polprevodniški elementi - Mikroelektromehanski elementi - 8. del: Preskusna metoda z upogibanjem traku za merjenje nateznih lastnosti tankih plasti

Semiconductor devices - Micro-electromechanical devices - Part 8: Strip bending test method for tensile property measurement of thin films

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English version

Semiconductor devices - Micro-electromechanical devices - Part 8: Strip bending test method for tensile property measurement of thin films

(IEC 62047-8:2011)

Dispositifs à semiconducteurs -
Dispositifs microélectromécaniques -
Partie 8: Méthode d'essai de la flexion de bandes en vue de la mesure des propriétés de traction des couches minces
(CEI 62047-8:2011)

Halbleiterbauelemente -
Baueelemente der Mikrosystemtechnik -
Teil 8: Streifen-Biege-Prüfverfahren zur Messung von Zugbeanspruchungsmerkmalen dünner Schichten
(IEC 62047-8:2011)

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CENELEC
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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

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The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-01-18
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-04-18

Endorsement notice

The text of the International Standard IEC 62047-8:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 62047-2:2006	NOTE Harmonized as EN 62047-2:2006 (not modified).
IEC 62047-3:2006	NOTE Harmonized as EN 62047-3:2006 (not modified).

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colour inside

Semiconductor devices – Micro-electromechanical devices –
Part 8: Strip bending test method for tensile property measurement of thin films

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CONTENTS

FOREWORD 3
1 Scope 5
2 Normative references 5
3 Terms and definitions 5
4 Test apparatus 5
4.1 General 5
4.2 Actuator 6
4.3 Load tip 6
4.4 Alignment mechanism 6
4.5 Force and displacement sensors 6
4.6 Test environment 6
5 Test piece 6
5.1 General 6
5.2 Shape of test piece 7
5.3 Measurement of test piece dimension 7
6 Test procedure and analysis 8
6.1 General 8
6.2 Data analysis 8
7 Test report 9
Annex A (informative) Data analysis: Test results by using nanoindentation apparatus 10
Annex B (informative) Test piece fabrication: MEMS process 13
Annex C (informative) Effect of misalignment and geometry on property measurement 15
Bibliography 18

Figure 1 – Thin film test piece 7
Figure 2 – Schematic of strip bending test 9
Figure A.1 – Three successive indents for determining the reference location of a test piece 10
Figure A.2 – A schematic view of nanoindentation apparatus 11
Figure A.3 – Actuator force vs. deflection curves for strip bending test and for leaf spring test 11
Figure A.4 – Force vs. deflection curve of a test piece after compensating the stiffness of the leaf spring 12
Figure B.1 – Fabrication procedure for test piece 13
Figure C.1 – Finite element analysis of errors based on the constitutive data of Au thin film of 1 μm thick 16
Figure C.2 – Translational (d) and angular (α, β, γ) misalignments 17

Table 1 – Symbols and designations of a test piece 7

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 8: Strip bending test method for tensile property measurement of thin films

FOREWORD

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International Standard IEC 62047-8 has been prepared by subcommittee 47F: Micro-electromechanical systems, of IEC technical committee 47: Semiconductor devices

The text of this standard is based on the following documents:

FDIS	Report on voting
47F/71/FDIS	47F/77/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62047, under the general title *Semiconductor devices – Micro-electromechanical devices* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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SEMICONDUCTOR DEVICES –
MICRO-ELECTROMECHANICAL DEVICES –

Part 8: Strip bending test method for tensile property measurement of thin films

1 Scope

This international standard specifies the strip bending test method to measure tensile properties of thin films with high accuracy, repeatability, moderate effort of alignment and handling compared to the conventional tensile test. This testing method is valid for test pieces with a thickness between 50 nm and several µm, and with an aspect ratio (ratio of length to thickness) of more than 300.

The hanging strip (or bridge) between two fixed supports are widely adopted in MEMS or micro-machines. It is much easier to fabricate these strips than the conventional tensile test pieces. The test procedures are so simple to be readily automated. This international standard can be utilized as a quality control test for MEMS production since its testing throughput is very high compared to the conventional tensile test.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NONE

3 Terms and definitions

For the purposes of this document the following terms and definitions apply.

3.1
deflection

w

displacement of a test piece at the middle of the length, which is measured with respect to the straight line connecting two fixed ends of the test piece

3.2
deflection angle

β

angle between the deformed test piece and the straight line connecting two fixed ends of the test piece

NOTE Test piece in this document is often referred to as a strip bending specimen.

4 Test apparatus

4.1 General

A test apparatus is composed of an actuator, a load-sensor, a displacement sensor, and alignment mechanism as other mechanical testers such as micro-tensile tester and nanoindentation apparatus. A test piece in a form of strip is very compliant and experiences large deflection under a small load when comparing it with a micro-tensile test piece with similar dimensions. In this respect, the load-sensor should have an excellent resolution and the displacement sensor should have a long measuring range. Details on each component of test apparatus are described as follows.

4.2 Actuator

All actuating devices that are capable of linear movement can be used for the test, e.g. piezoelectric actuator, voice coil actuator, servo motor, etc. However, a device with fine displacement resolution is highly recommended due to small dimensions of the test piece. The resolution shall be better than 1/1 000 of maximum deflection of test piece.

4.3 Load tip

The load tip which applies a line contact force to the test piece is shaped like a conventional wedge type indenter tip and can be made of diamond, sapphire or other hard materials. The radius of the tip shall be comparable to or larger than the thickness of the test piece, and less than $L/50$ (refer to Annex C.3).

4.4 Alignment mechanism

The load tip shall be installed on the test apparatus aligned with the load and the displacement measuring axes, and the misalignment shall be less than 1 degree. The load tip shall be also aligned to the surface of the test piece with the deviation angles less than 1 degree (refer to Annex C for definition of deviation angles and error estimation of misalignment). It is desirable to equip the apparatus with tilt stages for adjusting the deviation angle. The load tip is to be positioned at the centre of the test piece and the positional accuracy shall be less than $L/100$.

4.5 Force and displacement sensors

Force and displacement sensors shall have resolutions better than 1/1 000 of the maximum force and deflection during the test. The accuracy of the sensors shall be within ± 1 % of the range. The displacement sensors can be capacitive type, LVDT type, or optical type with acceptable resolution and accuracy. In practice, the deflection can be measured from the motion of the load tip using a capacitive sensor or from the deflection of the test piece using an optical method.

4.6 Test environment

It is recommended to perform a test under constant temperature and humidity. Temperature change can induce thermal drift during deflection measurement. The temperature change or thermal drift shall be checked before and after the test.

5 Test piece

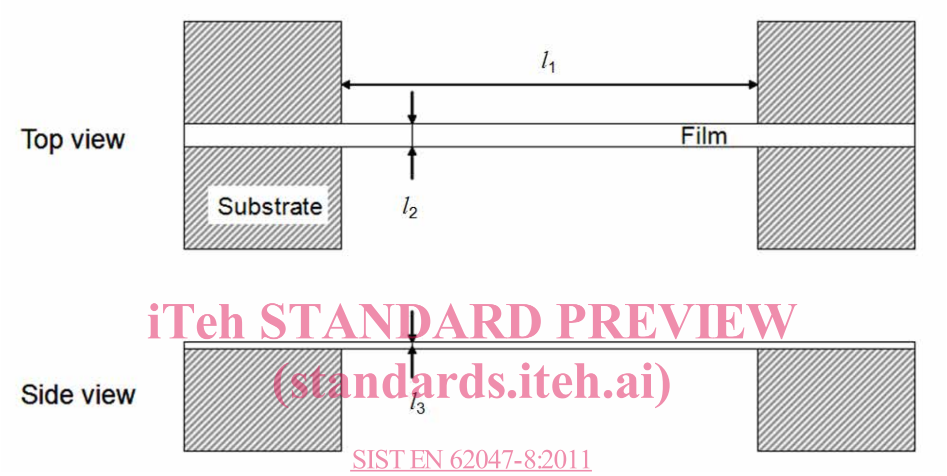
5.1 General

The test piece shall be prepared by using the same fabrication process as the actual device fabrication. To minimize the size effect of a test piece, the structure and size of the test piece shall be similar to those of the device components.

There are many fabrication methods of the test piece depending on the applications. As an example, the fabrication of the test piece based on MEMS process is described in Annex B. A lot of strip bending test pieces can be fabricated on a die or a substrate.

5.2 Shape of test piece

The shape of test piece and symbols are given in Figure 1 and Table 1, respectively. The test piece shall be designed to minimize the bending moment effect. In order to minimize the effect, the maximum deflection shall be more than 40 times the thickness of the test piece, and the length of the test piece shall be more than 300 times the thickness of the test piece, and the width shall be more than 10 times the thickness of the test piece, and the length shall be 10 times larger than the width. The thickness of the substrate shall be more than 500 times that of the test piece. The dimension of the substrate is limited by the capacity of the test apparatus. The geometry of the fixed ends supporting the test piece can affect the test results. When etching the sacrificial layer and the supporting substrate of test pieces, the region beneath the test pieces can be over-etched, and this is called by under-cut. The under-cut at the fixed ends shall be minimized (anisotropic etching would be desirable rather than isotropic etching).



IEC 499/11

Figure 1 – Thin film test piece

Table 1 – Symbols and designations of a test piece

Symbol	Unit	Designation
l_1	µm	Length of a test piece (=$2L$)
l_2	µm	Width of a test piece (=B)
l_3	µm	Thickness of a test piece (=h)

5.3 Measurement of test piece dimension

To analyze the test results, the accurate measurement of the test piece dimensions is required since the dimensions are used to extract mechanical properties of test materials. The length ($2L$), width (B), and thickness (h) shall be measured with very high accuracy with less than ± 5 % error. Useful information on thickness measurement can be found in Annex C of [1] [1] and in Clause 6 of [2].

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[1] Figures in square brackets refer to the Bibliography.