

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Semiconductor devices –

Part 1: Time-dependent dielectric breakdown (TDDB) test for inter-metal layers

Dispositifs à semiconducteurs –

Partie 1: Essai de rupture diélectrique en fonction du temps (TDDB) pour les couches intermétalliques



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2010 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Semiconductor devices –

Part 1: Time-dependent dielectric breakdown (TDDB) test for inter-metal layers

Dispositifs à semiconducteurs –

Partie 1: Essai de rupture diélectrique en fonction du temps (TDDB) pour les couches intermétalliques

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

P

ICS 31.080

ISBN 978-2-88912-178-6

CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Terms and definitions	5
3 Test equipment.....	6
4 Test samples.....	6
4.1 General.....	6
4.2 Test structure	6
5 Procedures.....	8
5.1 General.....	8
5.2 Pre-test.....	8
5.3 Test conditions.....	8
5.3.1 General.....	8
5.3.2 Electric field	8
5.3.3 Temperature.....	9
5.4 Failure criterion	9
6 Lifetime estimation	10
6.1 General.....	10
6.2 Acceleration model.....	10
6.3 Formula of E model	10
6.4 A procedure for lifetime estimation	10
7 Lifetime dependence on inter-metal layer area	13
8 Summary.....	13
Annex A (informative) Engineering supplementation for lifetime estimation	14
Bibliography.....	16
Figure 1 – Schematic image of test structure (comb and serpent pattern)	7
Figure 2 – Schematic image of test structure (comb and comb pattern)	7
Figure 3 – Cross-sectional image of test structure for line to stacked line including via	8
Figure 4 – Cross-sectional image of test structure for stacked line to stacked line including via	8
Figure 5 – Test flow diagram of constant voltage stress method	9
Figure 6 – Weibull distribution plot.....	11
Figure 7 – Procedure to estimate the acceleration factor due to the electric field dependence	12
Figure 8 – Procedure to estimate the activation energy using an Arrhenius plot.....	12

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –

**Part 1: Time-dependent dielectric breakdown (TDDb)
test for inter-metal layers**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62374-1 has been prepared by IEC technical committee 47: Semiconductor devices.

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

FDIS	Report on voting
47/2063/FDIS	47/2077/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 the parts in the IEC 62374 series, under the general title *Semiconductor 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

SEMICONDUCTOR DEVICES –

Part 1: Time-dependent dielectric breakdown (TDDB) test for inter-metal layers

1 Scope

This part of IEC 62374 describes a test method, test structure and lifetime estimation method of the time-dependent dielectric breakdown (TDDB) test for inter-metal layers applied in semiconductor devices.

2 Terms and definitions

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

2.1 leakage current of inter-metal layer

I_{leak}
current through the dielectric layer when a use voltage is applied

2.2 initial leakage current of inter-metal layer

$I_{\text{leak-0}}$
leakage current of inter-metal layer before a stress voltage is applied

2.3 compliance current

I_{comp}
maximum current of the voltage-forcing equipment

NOTE A compliance limit can be specified for a particular test.

2.4 measured leakage current of inter-metal layer

I_{meas}
measured current in constant voltage stress (CVS) test

2.5 breakdown time

t_{bd}
summation of time during which stress voltage is applied to inter-metal layer until failure

NOTE In CVS test, applied stress voltage is interrupted by measuring and assessing repeatedly (see Figure 5).

2.6 dielectric layer thickness

t_{d}
physical thickness of dielectric layer which is pitched between metal lines

2.7 stress voltage

V_{stress}
voltage applied during CVS test