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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices – Reliability test method by inductive load switching for gallium nitride transistors

Dispositifs à semiconducteurs – Méthode d'essai de fiabilité par la commutation sur charge inductive pour les transistors au nitrure de gallium

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CONTENTS

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SEMICONDUCTOR DEVICES – RELIABILITY TEST METHOD BY INDUCTIVE LOAD SWITCHING FOR GALLIUM NITRIDE TRANSISTORS

FOREWORD

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Draft	Report on voting
47/2753/FDIS	47/2763/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

INTRODUCTION

Gallium nitride (GaN), one of the wide bandgap semiconductors, has superior properties over conventional silicon (Si) for power devices, such as high breakdown electric field and high saturation velocity. Two dimensional electron gas with high mobility and high concentration is induced by forming heterojunction of GaN with aluminum gallium nitride (AlGaN) due to polarization effects, which is another merit of GaN related materials. Moreover, several kinds of materials such as Si, sapphire, silicon-carbide (SiC) or GaN can be selected as epitaxial growth substrates in terms of device performances and costs. Recently, GaN power transistors have been widely developed and commercialized.

GaN power transistors have some unique failure modes due to device construction differences and carrier trapping effects. In addition, GaN power transistors are more compact, so are exposed to higher fields. Further, some hot-carrier and robustness tests for silicon Field Effect Transistors (FETs) are not applicable to GaN FETs. For example, the hot carrier injection (HCI) test for lateral MOSFETs is not applicable to lateral GaN FETs due to the blocking nature of the buffer, and the unclamped inductive switching (UIS) test is not useful because it could cause damage. Therefore, several unique reliability test methods, which are not generally requested for Si power transistors, are performed as reliability examination, for example, test methods of dynamic on-resistances. Especially, switching test methods and reliability procedures are significant for practical use and need to be standardized in order to establish switching reliability of GaN power transistors.

This document is a guideline focusing on inductive load switching in order to confirm the conditions under which GaN power transistors are used reliably. Since the inductive load switching is considered to be an important stress application for power devices, this guideline will promote the acceptance of GaN power transistors in the power device market. However, it is important to note that there are other application relevant stress conditions, such as soft-switching at high frequencies, which will not be covered by this document.

SEMICONDUCTOR DEVICES – RELIABILITY TEST METHOD BY INDUCTIVE LOAD SWITCHING FOR GALLIUM NITRIDE TRANSISTORS

1 Scope

This document covers the protocol of performing a stress procedure and a corresponding test method to evaluate the reliability of gallium nitride (GaN) power transistors by inductive load switching, specifically hard-switching stress.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
gallium nitride
GaN
compound semiconductor material composed of gallium and nitrogen

3.2
aluminum gallium nitride
AlGaN
compound semiconductor alloy of aluminum nitride and gallium nitride

3.3
on-state resistance
resistance of the device at nominal current conditions

3.4
dynamic on-state resistance
ratio of on-state drain-source voltage(v_{DS}) to drain current(i_D) at switching

3.5
dynamic high temperature operating life test
DHTOL test
reliability test of continuous switching stress with high junction temperature

Note 1 to entry: The term DHTOL is used broadly, encompassing both switching accelerated life test (SALT), where failures are expected for wearout modelling, and HTOL, where failures are not expected.

3.6
switching locus
trajectory showing relationship between v_{DS} and i_D during switching