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IEC 62483

Edition 1.0 2013-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental acceptance requirements for tin whisker susceptibility of tin and tin alloy surface finishes on semiconductor devices

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Exigences de réception environnementale pour la susceptibilité des finis de surface en étain et alliage d'étain à la trichite d'étain sur les dispositifs à semiconducteurs

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CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
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ENVIRONMENTAL ACCEPTANCE REQUIREMENTS FOR TIN WHISKER SUSCEPTIBILITY OF TIN AND TIN ALLOY SURFACE FINISHES ON SEMICONDUCTOR DEVICES

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International Standard IEC 62483 has been prepared by IEC technical committee 47: Semiconductor devices.

This first edition is based on JEDEC documents JESD201A and JESD22-A121A and replaces IEC/PAS 62483, published in 2006. This first edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) The content of IEC/PAS 62483 was added to the content of JESD201A as Annex A.
b) A methodology was introduced for environmental acceptance testing of tin-based surface finishes and mitigation practices for tin whiskers.
c) A Clause 6 was introduced detailing the reporting requirements of test results.

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

FDIS	Report on voting
47/2171/FDIS	47/2180/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.

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INTRODUCTION

Many companies in the electronics industry have adopted tin-based surface finishes as one of the methods to comply with various legislative lead-free (Pb-free) initiatives, e.g., the European Union's RoHS directive. However, tin (Sn) and tin alloy surface finishes may be prone to tin whisker formation with associated possible reliability degradation. Appropriate mitigation practices may be incorporated to reduce tin whisker propensity to an acceptable level.

Test conditions in accordance with Annex A and qualification limits presented in this International Standard are based on known Sn whisker data from around the world. These test conditions have not been correlated with longer environmental exposures of components in service. Thus, there is at present no way quantitatively to predict whisker lengths over long time periods based on the lengths measured in the short-term tests described in this document. At the time of writing, the fundamental mechanisms of tin whisker growth are not fully understood and acceleration factors have not been established. Therefore, the testing described in this document does not guarantee that whiskers will or will not grow under field life conditions.

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ENVIRONMENTAL ACCEPTANCE REQUIREMENTS FOR TIN WHISKER SUSCEPTIBILITY OF TIN AND TIN ALLOY SURFACE FINISHES ON SEMICONDUCTOR DEVICES

1 Scope

This International Standard describes the methodology applicable for environmental acceptance testing of tin-based surface finishes and mitigation practices for tin whiskers on semiconductor devices. This methodology may not be sufficient for applications with special requirements, (i.e. military, aerospace, etc.). Additional requirements may be specified in the appropriate requirements (procurement) documentation.

This International Standard does not apply to semiconductor devices with bottom-only terminations where the full plated surface is wetted during assembly (for example: quad-flat no-leads and ball grid array components, flip chip bump terminations). Adherence to this standard includes meeting the reporting requirements described in Clause 6.

2 Terms and definitions

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

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2.1
base metal
metal alloy residing beneath all surface finish(es) and/or underplate

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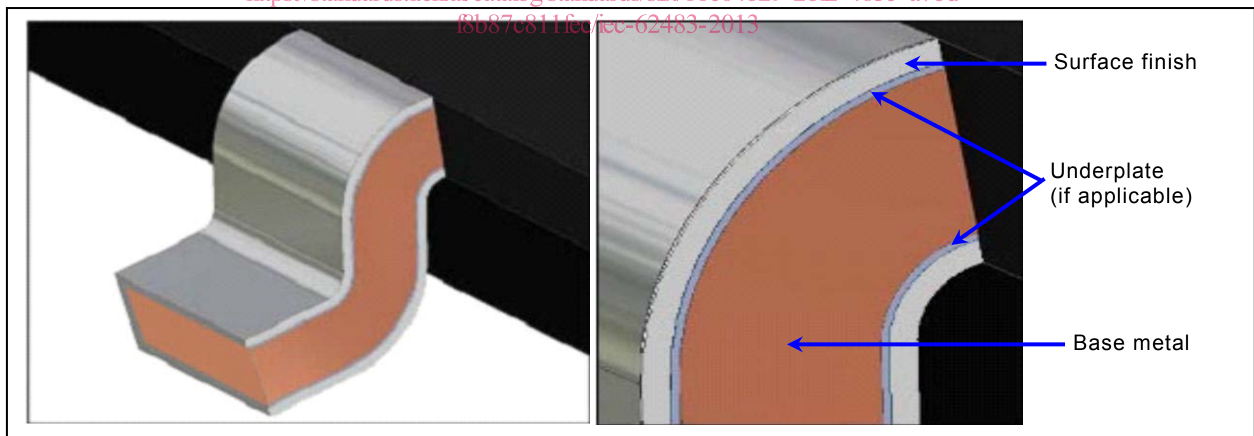

Figure 1 – Cross-sectional view of component surface finishes

2.2
tin and tin alloy surface finish
tin-based outer surface finish for external component terminations and other exposed metal

2.3
tin whisker mitigation practice
process(es) performed during the manufacture of a component to reduce the propensity for tin whisker growth by minimizing the surface finish internal compressive stress

2.4
manufacturing process change acceptance
acceptance testing of a change to a surface finish manufacturing process already accepted by technology acceptance tests (qv)

2.5
similarity acceptance
acceptance of a change to a surface finish manufacturing process based upon similarity and data available from previous tin whisker technology and manufacturing process change acceptance tests

2.6
surface corrosion
localized change to a silver-coloured tin surface finish appearing in an optical microscope as non-reflective dark spots ranging in size from about 25 μm on the longest dimension to the entire termination

Note 1 to entry: While tin oxide is ubiquitous on tin surface finishes, surface corrosion creates a locally thick layer of tin oxide that may span from the substrate to the surface of the deposit at the black spot. Typical photos of termination corrosion are shown in Figure 2 (a) to d)).

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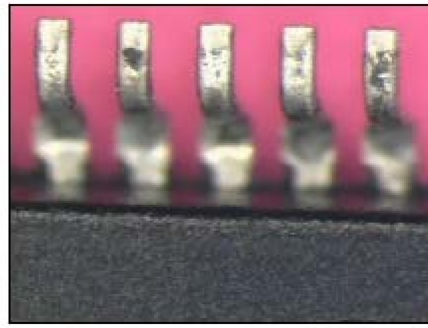

a) Matte Sn on Cu with Ni plate (optical)

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b) Matte Sn on Cu (optical)

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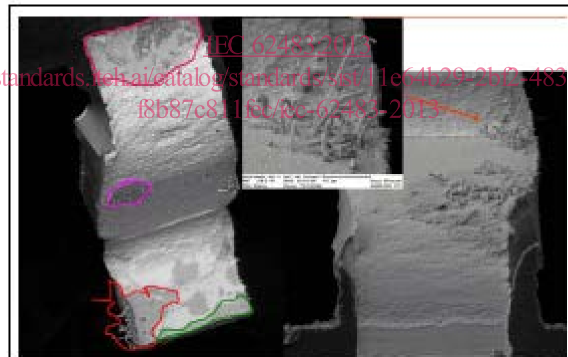
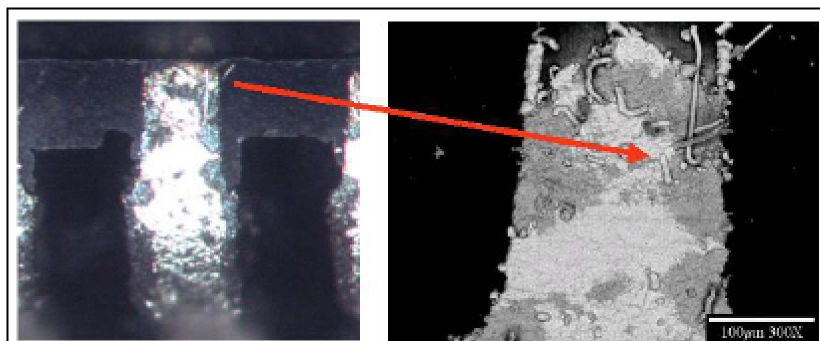


c) Matte Sn on Cu (SEM)



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d) Matte Sn on Cu (optical/SEM)

Figure 2 – Typical photographs of termination corrosion

2.7
surface finish technology acceptance
acceptance testing of surface finish material set and manufacturing processes that includes a defined set of base metals, underplating metals, surface finish alloy, surface finish bath chemistry and process flow steps

2.8
underplate
underlay
plated layers between the base metal and the outer surface finish

2.9
whisker
spontaneous columnar or cylindrical filament, usually of monocrystalline metal, emanating from the surface of a finish

EXAMPLE See Figure 3 for example pictures of tin whiskers.

Note 1 to entry: For the purposes of this document, whiskers have the following characteristics:

- they have an aspect ratio (length/width) greater than 2;
- they can be kinked, bent, or twisted;
- they usually have a uniform cross-sectional shape;
- they typically consist of a single columnar filament that rarely branches;
- they may have striations along the length of the column and/or rings around the circumference of the column;
- they have a length of 10 µm or more (features less than 10 µm may be deemed important for research but are not considered significant for this test method).

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Note 2 to entry: Whiskers are not to be confused with dendrites, fern-like growths on the surface of a material which can be formed as a result of electromigration of an ionic species or produced during solidification. (See Figure 4 for a picture of a typical solidification dendrite.)

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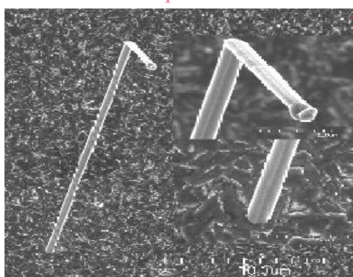
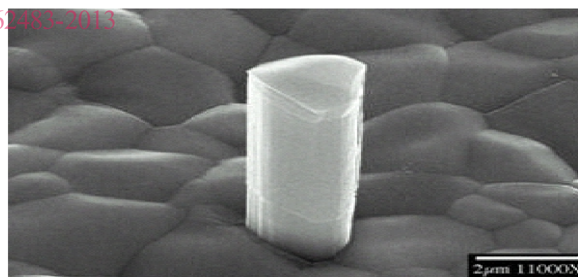
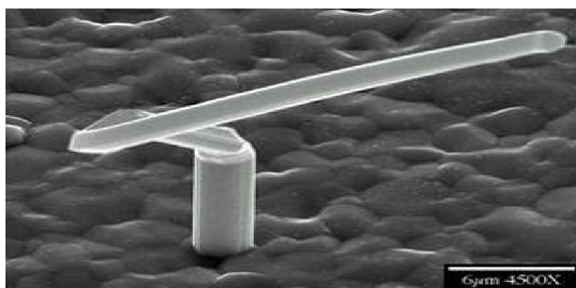


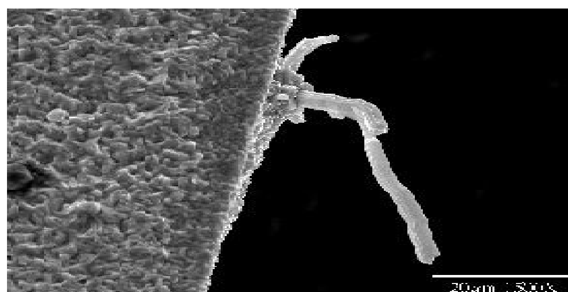
a) Tin whisker filaments



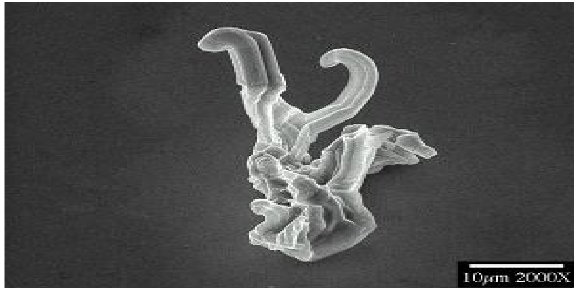
b) Whisker with a consistent cross section



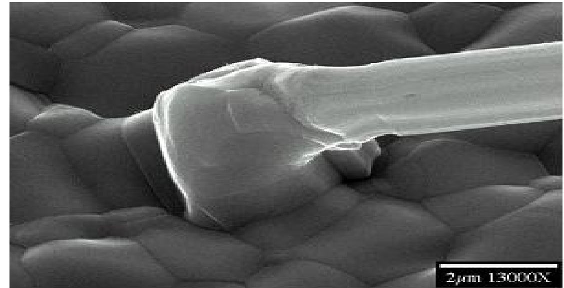
c) Kinked whisker



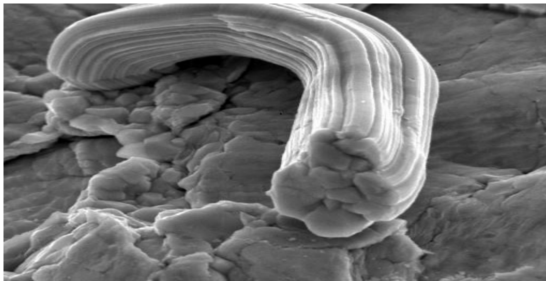
d) Kinked whiskers growing from a nodule



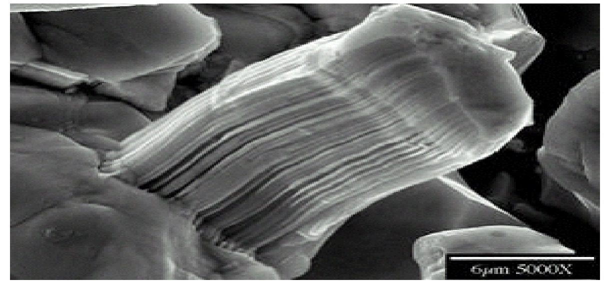
e) Branched tin whiskers on bright tin (rare)



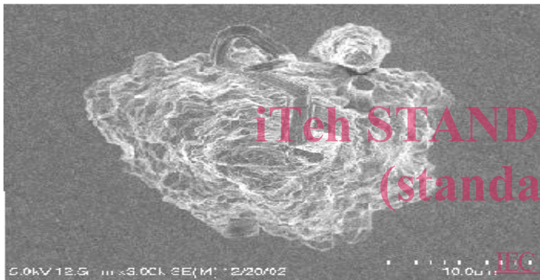
f) Whisker initiating from a hillock



g) Tin whisker filament with striations



h) Tin whisker filament with striations



i) Kinked whisker on odd-shaped eruptions

j) Tin whisker with rings

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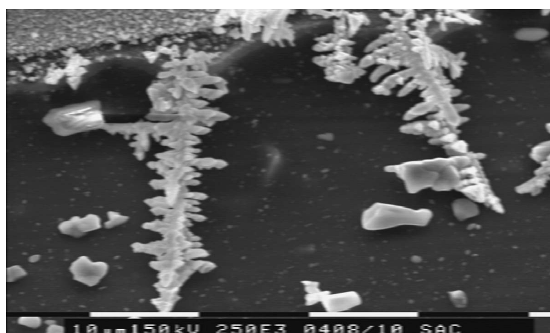
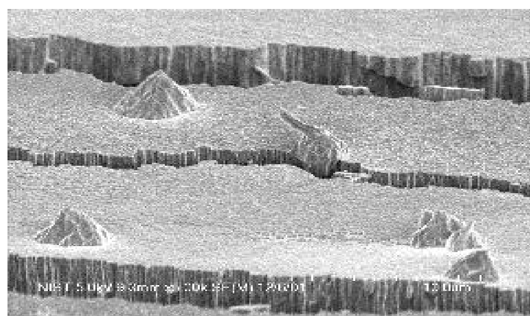
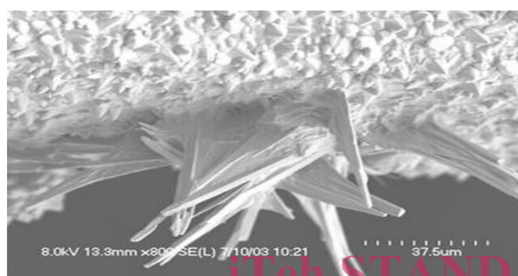
Figure 3 – Examples of tin whiskers



a) Dendrites are fern-like growths formed for example as a result of solidification. They are not whiskers



b) Hillocks may be precursors to whiskers in some cases, but are not considered whiskers for the purposes of this test method



c) "Flower" created on a tin plating exposed to the test condition of high-temperature humidity storage and is most likely a result of a combination of surface contamination and condensation

d) Dendrites formed on a tin surface during plating. These are not tin whiskers

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https://standards.iteh.ai/catalog/standards/sist/11e64b29-2bf2-4835-a7bd-f8b87c811fec/iec-62483-2013

Figure 4 – Non-whisker surface formations

2.10
whisker length
straight line distance from the point of emergence of the whisker to the most distant point on the whisker

Note 1 to entry: The whisker length is the radius of a sphere containing the whisker with its centre located at the point of emergence, see Figure 5.

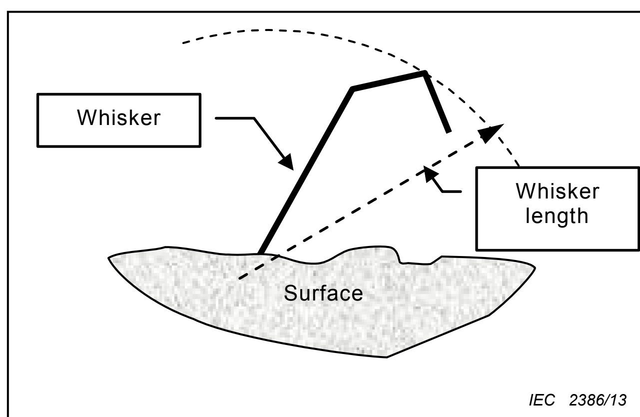

Figure 5 – Whisker length measurement