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Measurement procedures for materials used in photovoltaic modules – Part 8-1: Electrically conductive adhesive (ECA) – Measurement of material properties

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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IEC TS 62788-8-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
82/2200/DTS	82/2241/RVDTS

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 Technical Specification 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/publications.

A list of all parts in the IEC 62788 series, published under the general title *Measurement procedures for materials used in photovoltaic modules*, can be found on the IEC website.

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- withdrawn, or
- revised.

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INTRODUCTION

Electrically conductive adhesive (ECA) is a material composed of conductive fillers blended with an organic adhesive polymer matrix. Already widely used as an interconnect material in electronic packaging and interconnection technologies for electronic devices, ECA is beginning to replace metallic solders as an innovative interconnection method in recent designs of photovoltaic (PV) modules. In a typical shingled PV module, solar cells are cut into strips and these solar cell strips overlap each other. ECA is applied in between the top electrode of one cell strip and the bottom electrode of the adjacent cell strip to form the electric interconnection. In some back-contact PV module designs, ECA allows the interconnection of solar cells' rear busbars to a conductive backsheet. In some PV modules where the solar cells are sensitive to high soldering temperatures, ECA is used to connect PV ribbons to the electrodes of the solar cells. The solar cell interconnections based on ECA can effectively reduce mechanical stress, shading loss and interconnect ohmic loss, and have been profiled as a promising alternative to traditional soldering process.

ECA can be used for wiring and surface assembly in PV modules. Initial performance and environmental endurance in application are highly dependent on its inherent material characteristics. For instance, adhesive properties are the primary requirement for ECA. Good adhesion between ECA and the adherends enables the structural integrity and long-term durability of the bonded joint over its service lifetime. Furthermore, the electrical performances of ECA, including volume resistance and contact resistance, are essential for the output performance and field durability of PV modules. Other characteristics such as viscosity, fineness, and conditions of use have a significant impact on the process conditions in manufacturing.

It is impractical to perform all the tests on ECA at the PV module level. Evaluation of the inherent material characteristics of ECA is highly desirable for pre-qualification of materials. This document defines test methods for key characteristics of ECA intended for use in photovoltaic modules.

The material property tests in this document cover general characteristics, mechanical characteristics, adhesion characteristics, electrical characteristics, thermal characteristics and the conditions of use.

MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 8-1: Electrically conductive adhesive (ECA) – Measurement of material properties

1 Scope

This document defines test methods and datasheet reporting requirements for key characteristics of ECA used in photovoltaic modules, involving mechanical characteristics, adhesive characteristics, electrical characteristics, thermal characteristics, etc.

The object of this document is to offer a standard test procedure to ECA manufacturers for product design, production and quality control, and to PV module manufacturers for the purpose of material screening, material inspection, process control, and failure analysis.

This document is intended to be applied to ECA used in solar PV modules.

For non-conductive adhesives or tapes used in PV modules, the applicable test methods except for electrical characteristics in this document may be used.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC TS 62788-2, *Measurement procedures for materials used in photovoltaic modules – Part 2: Polymeric materials – Frontsheets and backsheets*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 37:2017, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

ISO 291, *Plastics – Standard atmospheres for conditioning and testing*

ISO 1524:2020, *Paints, varnishes and printing inks – Determination of fineness of grind*

ISO 2393, *Rubber test mixes – Preparation mixing and vulcanization – Equipment and procedures*

ISO 2811-1, *Paints and varnishes – Determination of density – Part 1: Pycnometer method*

ISO 4587, *Adhesives – Determination of tensile lap-shear strength of rigid–to–rigid bonded assemblies*

ISO 4664-1:2022, *Rubber, vulcanized or thermoplastic – Determination of dynamic properties – Part 1: General guidance*

ISO 5893, *Rubber and plastics test equipment – Tensile, flexural and compression types (constant rate of traverse) – Specification*

ISO 7500-2, *Metallic materials – Verification of static uniaxial testing machines – Part 2: Tension creep testing machines – Verification of the applied force*

ISO 7886-1, *Sterile hypodermic syringes for single use – Part 1: Syringes for manual use*

ISO 8510-2, *Adhesives – Peel test for a flexible-bonded-to-rigid test specimen assembly – Part 2: 180 degree peel*

ISO 10365, *Adhesives – Designation of main failure patterns*

ISO 11358-1, *Plastics – Thermogravimetry (TG) of polymers – Part 1: General principles*

ISO 11358-2, *Plastics – Thermogravimetry (TG) of polymers – Part 2: Determination of activation energy*

ISO 11359-1, *Plastics – Thermomechanical analysis (TMA) – Part 1: General principles*

ISO 11359-2:2021, *Plastics – Thermomechanical analysis (TMA) – Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

ISO 16525-1:2014, *Adhesives – Test methods for isotropic electrically conductive adhesives – Part 1: General test methods*

ISO 16525-2:2014, *Adhesives – Test methods for isotropic electrically conductive adhesives – Part 2: Determination of electrical characteristics for use in electronic assemblies*

ISO 17212, *Structural adhesives – Guidelines for surface preparation of metals and plastics prior to adhesive bonding*

ISO 23529:2016, *Rubber – General procedures for preparing and conditioning test pieces for physical test methods*

ASTM D1337-10, *Standard practice for storage life of adhesives by viscosity and bond strength*

ASTM D4287-00, St*andard Test Method for High – Shear Viscosity Using a Cone/Plate Viscometer*