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BSI Standards Publication

Measurement procedures for materials used in photovoltaic modules

Part 6-3: Adhesion testing for PV module laminates using the single cantilevered beam (SCB) method

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The UK participation in its preparation was entrusted to Technical Committee GEL/82, Photovoltaic Energy Systems.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Measurement procedures for materials used in photovoltaic modules – Part 6-3: Adhesion testing for PV module laminates using the single cantilevered beam (SCB) method

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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IEC TS 62788-6-3 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
82/2012/DTS	82/2057A/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 http://www.iec.ch/standardsdev/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- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This document describes the single cantilevered beam (SCB) test, useful for characterizing adhesion in photovoltaic (PV) modules. This method is grounded in fundamental concepts of beam and fracture mechanics [1][1], [4], and allows for a quantitative measurement of adhesion strength. A method for calculating the debond length, $a_{f,}$ has been developed as an option to physical measurement.

PV modules are multi-layer structures that depend on adequate adhesion between each layer to ensure their reliable operation. Adhesion testing is described in current IEC PV standards for module safety qualification (IEC 61730-2) and component characterization (IEC 62788 series). The most commonly used tests are peel tests at either 180° for components (IEC TS 62788-7-2 test and IEC 62788-1-1), or at 90° for modules (IEC 61730-2 MST 35).

Peel tests are in practice simple to carry out, and provide a peel strength value, different from adhesion strength. Viscoelastic properties of the polymeric material and the mechanics of the pull tab have a strong influence on the result, making these tests of limited value in comparing either different materials, or the same material after stress exposures.

In the SCB method, an elastic width-tapered cantilever beam is adhered to the sample. When the beam is loaded at its apex, delamination will initiate at the weakest interface and advance upon continued loading. This measurement allows for calculation of the critical value of the energy release rate, G_c, which is the adhesion property for a given material interface. The value defined by this method is less dependent of the viscoelastic properties of the polymeric material, and so more useful for measuring differences or changes in adhesive strength.

The SCB method can be conducted at either the component or module level. Because it does not require using the backsheet as a pull tab, it is more likely to able to test the adhesion of a thin outer layer of the backsheet. These considerations give this test method good flexibility to use in applications related to PV modules. Examples for several specific use cases are provided.

This document offers a generalized method for performing the test, with the expectation that best practices for utilizing this test method will be developed for specific applications.

Examples of this method being employed to quantify and define the threshold values of encapsulant and backsheet adhesion for PV module reliability may be found in the literature [1] through [5].

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

MEASUREMENT PROCEDURES FOR MATERIALS USED IN PHOTOVOLTAIC MODULES –

Part 6-3: Adhesion testing for PV module laminates using the single cantilevered beam (SCB) method

1 Scope

This part of IEC TS 62788 provides a method for measuring the adhesion energy of most interfaces within the photovoltaic (PV) module laminate.

In contrast to other adhesion tests in general use, this method provides a measure of adhesive energy, via the critical energy release rate, and so is more useful for comparing adhesion of different specimen types; e.g. different materials, module or coupon samples, or materials before and after stress exposure.

This is a “weakest link” test, meaning that the weakest interface is the one most likely to fail in a given test. Adhesion of a specific layer may be difficult to intentionally measure if there is a weaker interface in the system.

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

ISO 7500-1, *Metallic materials – Calibration and verification of static uniaxial testing machines – Part 1: Tension/compression testing machines – Calibration and verification of the force-measuring system*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 apply, as well as the following.

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
cantilevered beam
beam supported at only one end such that the slope and deflection of that end is ideally zero