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# **Examination Standard for Cleanroom Materials**

**Class Number 4910**

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# Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of a this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

# TABLE OF CONTENTS

<b>1 INTRODUCTION</b> .....	<b>1</b>
1.1 Purpose.....	1
1.2 Scope.....	1
1.3 Basis for Requirements .....	1
1.4 Basis for Certification .....	1
1.5 Basis for Continued Certification .....	2
1.6 Effective Date.....	2
1.7 System of Units .....	2
1.8 Normative References.....	2
1.9 Terms and Definitions.....	2
<b>2 GENERAL INFORMATION</b> .....	<b>4</b>
2.1 Product Information.....	4
2.2 Certification Application Requirements.....	4
2.3 Requirements for Samples for Examination.....	4
<b>3 GENERAL REQUIREMENTS</b> .....	<b>5</b>
3.1 Review of Documentation.....	5
3.2 Markings .....	5
3.3 Manufacturer's Installation Instructions .....	5
3.4 Calibration.....	5
3.5 Retesting of Materials .....	6
3.6 Testing of Regrind Materials.....	6
<b>4 PERFORMANCE REQUIREMENTS</b> .....	<b>7</b>
4.1 Fire Propagation Apparatus Testing .....	7
4.2 8 ft. (2.4 m) Parallel Panel Testing .....	8
4.3 Infrared Spectra for Quantitative Analysis (FTIR).....	8
4.4 Infrared Thermal Desorption Gas Chromatography Mass Spectrometry (TD/GC/MS) .....	8
<b>5 OPERATIONS REQUIREMENTS</b> .....	<b>9</b>
5.1 Demonstrated Quality Control Program.....	9
5.2 Surveillance Audit .....	10
5.3 Manufacturer's Responsibilities.....	10

# 1 INTRODUCTION

## 1.1 Purpose

- 1.1.1 This test standard states testing and certification requirements for the evaluation of materials used in cleanroom occupancies mainly, but not restricted, for use in the semiconductor industry. The test evaluates the materials' fire propagation behavior and potential for smoke contamination using two indices: Fire Propagation Index (FPI) and Smoke Damage Index (SDI).
- 1.1.2 This test standard does not qualify end use products for certification based solely on these test results, as the end use of the product will determine the applicable certification standard requirements, if available, which will also have to be met to achieve certification.
- 1.1.3 Testing and certification criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

## 1.2 Scope

- 1.2.1 This test standard describes minimum performance requirements for materials which are intended for use in cleanroom facilities. This test standard evaluates the ability of the components to limit fire spread and smoke damage.
- 1.2.2 This standard is intended to verify that the product as described will meet minimum specific stated conditions of performance, safety, and quality, useful in determining the potential suitability for end-use conditions of these products.

## 1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of cleanroom materials for the purpose of obtaining Certification. Cleanroom materials having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated.
- 1.3.3 Meeting these requirements does not qualify an end use product for certification. Additional testing and requirements for certification are specified in the certification standards which are based on the end use of the product.

## 1.4 Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate
  - the suitability of the product;
  - the performance of the product as specified by the manufacturer and required for certification; and as far as practical,
  - the durability and reliability of the product.

- 1.4.2 An examination of the manufacturing facilities and audit of quality control procedures may be made to evaluate the manufacturer's ability to consistently produce the product which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

### 1.5 Basis for Continued Certification

The basis for continual certification may include, but is not limited to, the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agencies product surveillance program.

### 1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is the publication date of the standard for compliance with all requirements.

### 1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

### 1.8 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 cited edition applies.

ASTM E2058, *Standard Test Method for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*

### 1.9 Terms and Definitions

For purposes of this standard, the following terms apply:

*Critical Heat Flux (CHF)* – maximum heat flux at or below which there is no ignition

*Fire Propagation Index (FPI)* – an index representing the propensity of the material to support fire propagation

*Ignition Zone* – area of the surface of a material heated by an outside source resulting in ignition

*Smoke Damage Index (SDI)* – smoke yield multiplied by FPI. It is an indicator of the extent of smoke contamination of the environment during fire propagation

*Smoke Yield ( $y_s$ )* – ratio of the total mass of smoke released to the total mass of the material vaporized

*Thermal Response Parameter (TRP)* – indicator of the ignition resistance of a material

## 2 GENERAL INFORMATION

### 2.1 Product Information

Materials for use in cleanroom occupancies are usually supplied in sheet form or as resins that are either powders or pellets. They are tested as plaques or sheets in either a Fire Propagation Apparatus (FPA, ASTM E2058) or an 8 ft. (2.4 m) parallel panel test.

### 2.2 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes, and options for the products being submitted for certification consideration;
- A complete list of all the formulations for the products being submitted for certification consideration;
- Brochures, sales literature, spec. sheets, process flow diagrams and quality control documentation; and
- The number and location of manufacturing facilities.
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

### 2.3 Requirements for Samples for Examination

2.3.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:

- Sample requirements to be determined by the certification agency following review of the preliminary information
- A representative of the certification agency shall inspect the manufacturing facility for, witness the production of, and place their identifying mark on, each sample to be evaluated.
- If a resin material is being submitted, the production of the resin as well as production of the sheet material used for testing manufactured from the resin shall be witnessed by a representative of the certification agency.
- If a formulated resin material or other formulated components from external suppliers are used in the composition of the material being examined for certification, prior to witnessing of the test samples, the certification agency may require a representative to inspect the manufacturing facility for, witness the production of, and place their identifying mark on, containers of the formulated component to be used in test sample production.

2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.

### 3 GENERAL REQUIREMENTS

#### 3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The certification examination results may further define the limits of the final certification.

#### 3.2 Markings

3.2.1 Marking on the product or, if not possible due to size, on its packaging or label accompanying the product, shall include the following information:

- name and address of the manufacturer or marking traceable to the manufacturer;
- date of manufacture or code traceable to date of manufacture or lot identification;
- model number, size, rating, capacity, etc., as appropriate.

3.2.2 When hazard warnings are needed, the markings should be universally recognizable.

3.2.3 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity.

3.2.4 The certification agency's mark of conformity (Specification tested to FM 4910) shall be displayed visibly and permanently on the product and/or packaging as appropriate and in accordance with the requirements of the certification agency. The manufacturer shall exercise control of this mark as specified by the certification agency and the certification scheme.

3.2.5 All markings shall be legible and durable.

#### 3.3 Manufacturer's Installation Instructions

3.3.1 The manufacturer shall

- prepare instructions for the installation and maintenance of the product;
- provide facilities for repair of the product and supply replacement parts, if applicable; and
- provide services to ensure proper installation, inspection, or maintenance for products of such nature that it would not be reasonable to expect the average user to be able to provide such installation, inspection, or maintenance.

#### 3.4 Calibration

3.4.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A



copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.

- 3.4.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of this equipment.

### **3.5 Retesting of Materials**

- 3.5.1 A retest of materials shall be required when a fifth formulation modification has been requested and the previous four revisions have been accepted without additional testing.

### **3.6 Testing of Regrind Materials**

- 3.6.1 Materials requested to be examined for certification with a percentage range of regrind material shall be examined at both the minimum and maximum percentage of regrind.

## 4 PERFORMANCE REQUIREMENTS

Test criteria for the examination of materials for cleanrooms are presented. When samples are examined in the Fire Propagation Apparatus (FPA) the criteria are represented by the FPI and SDI. When samples are examined in the 8 ft. (2.4 m) Parallel Panel Test the criteria are represented by various parameters focused on heat release and smoke production rates.

Samples with thicknesses greater than or equal to 0.25 in (6 mm) shall be tested in the ASTM E2058 Fire Propagation Apparatus (FPA)<sup>1</sup> and subjected to three types of tests: 1) an ignition series test; 2) fire propagation testing; and 3) combustion testing. The ignition test series is performed to quantify the ignition resistance of the material, expressed as the Thermal Response Parameter (TRP). Fire propagation testing is performed to quantify the chemical heat release rate during fire propagation. Combustion testing is performed to quantify the yield of smoke.

Materials thinner than 0.25 in. (6 mm) are tested in the 8 ft. (2.4 m) Parallel Panel test. During the 8 ft. (2.4 m) Parallel Panel Test visual observations for fire propagation, flame height, chemical heat release rate, and heat flux data are used to assess propagating versus non-propagating behavior.

### 4.1 Fire Propagation Apparatus Testing

4.1.1 Materials tested in the FPA shall satisfy FPI and SDI requirements listed below. Cleanroom materials shall satisfy both criteria.

- $FPI \leq 6 \text{ (m/s}^{1/2}\text{)/(kW/m)}^{2/3}$ . The FPI is used as a criterion for non fire propagation beyond the ignition zone. The FPI value is the maximum value calculated from a 15 second running average of the data
- $SDI \leq 0.40 \text{ [(m/s}^{1/2}\text{)/(kW/m)}^{2/3}] \text{ [g/g]}$ . The SDI is used as a criterion for significantly limiting smoke concentration for non propagating fires beyond the ignition zone.

4.1.2 The TRP, FPI and SDI are calculated in accordance with FM Approvals Piloted Ignition FPA Test Procedure, FM Approvals Propagation FPA Test Procedure and FM Approvals Combustion FPA Test Procedure.

4.1.3 In the reported test data, FPI is rounded to the nearest whole number (e.g., 1.0) and SDI is rounded to the nearest tenth (e.g., 0.1).

4.1.4 For the purpose of obtaining a certification listing, the reported FPI shall be determined as the average from three individual propagation tests and one ignition series test.

4.1.5 For the purpose of obtaining a certification listing, the reported SDI shall be determined as the average from three individual combustion tests and three individual propagation tests.

4.1.6 The third propagation test may be waived if the first two propagation tests' 15 second average peak chemical heat release rate are within 10% of each other.

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<sup>1</sup> Materials with thicknesses greater than or equal to 0.25 in (6 mm) may be tested in the 8 ft. (2.4 m) Parallel Panel Test as an alternative to testing in the FPA if:

- the material is not suitable for testing in the FPA (e.g., some composites, products that melt, drip when tested, etc.);
- the material has failed to meet the FPI and SDI requirements, or;
- time to ignition of the material could not be determined in the FPA

- 4.1.7 The third combustion test may be waived if the first two combustion tests' smoke yield are within 10% of each other.

#### **4.2 8 ft. (2.4 m) Parallel Panel Testing**

- 4.2.1 Samples not examined in the Fire Propagation Apparatus shall be subjected to the 8 ft. (2.4 m) Parallel Panel Test.
- 4.2.2 Test/Verification:  
The 8 ft. (2.4 m) Parallel Panel test is conducted in accordance with the FM Approvals Cleanroom Materials Flammability Test Method for the Parallel Panel Test.

#### **4.3 Infrared Spectra for Quantitative Analysis (FTIR)**

- 4.3.1 For each formulation of material tested, or as applicable, FTIR Spectra shall be determined and reported at the sole discretion of the certification agency.

Note: This test is for identification purposes only. No limits on the values obtained.

- 4.3.2 Test/Verification:  
Infrared Spectra for Quantitative Analysis testing is conducted in accordance with ASTM E1252, Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis

#### **4.4 Infrared Thermal Desorption Gas Chromatography Mass Spectrometry (TD/GC/MS)**

- 4.4.1 For each formulation of material tested, or as applicable, TD/GC/MS Spectrograms shall be determined and reported at the sole discretion of the certification agency.

Note: This test is for identification purposes only. No limits on the values obtained.

- 4.4.2 Test/Verification:  
Infrared Thermal Desorption Gas Chromatography Mass Spectrometry (TD/GC/MS) testing is conducted in accordance with ASTM E1642, Standard Practice for General Techniques of Gas Chromatography Infrared (GC/IR) Analysis

## 5 OPERATIONS REQUIREMENTS

### 5.1 Demonstrated Quality Control Program

5.1.1 A quality assurance program is required to assure that subsequent cleanroom materials produced by the manufacturer shall present the same quality and reliability as the specific products examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests and may be documented in the certification report.
- Continued conformance to this standard is verified by the certifiers surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and testing.

5.1.2 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping; and
- handling and disposition of non-conforming materials.

#### 5.1.3 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

#### 5.1.4 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

#### 5.1.5 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained.

**5.2 Surveillance Audit**

- 5.2.1 An audit of the manufacturing facility may be part of the certification agency's surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to insure a uniform product consistent with that which was listed as certified.
- 5.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification label is not permitted at any other location prior to disclosure to the certification agency.

**5.3 Manufacturer's Responsibilities**

- 5.3.1 The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.