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Requirements for Printed Electronics Functional Dielectric Materials

Developed by the Printed Electronics Functional Dielectric Materials Task Group (D-63A) of the Printed Electronics Committee (D-60) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

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1 SCOPE

This standard establishes the classification system and the qualification and quality conformance requirements for functional dielectric materials used in printed electronics applications. The intended applications include but are not limited to dielectric materials as protective dielectric or insulator/insulation layer(s), capacitive layer(s), crossovers and encapsulant(s) for devices in printed electronics systems.

1.1 Purpose The purpose of this standard is to provide a detailed list of parameters and their characterization methods for the intended application of functional dielectric materials used in printed electronics.

1.2 Classification IPC standards recognize that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in manufacturability, complexity, functional performance requirements, and verification (inspection/test) frequency. It should be recognized that there may be overlaps of equipment between classes.

CLASS 1 General Electronic Products

Includes products suitable for applications where the major requirement is function of the completed assembly.

CLASS 2 Dedicated Service Electronic Products

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end-use environment would not cause failures.

CLASS 3 High Performance/Harsh Environment Electronic Products

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

1.3 Measurement Units All dimensions and tolerances in this specification are expressed in hard SI (metric) units and bracketed soft imperial [inch] units. Users of this specification are expected to use metric dimensions. All dimensions ≥ 1 mm [0.0394 in] will be expressed in millimeters and inches. All dimensions < 1 mm [0.0394 in] will be expressed in micrometers and microinches.

1.4 Definition of Requirements The words **shall** or **shall not** are used in the text of this document wherever there is a requirement for materials, preparation, process control or acceptance.

The word "should" reflect recommendations and is used to reflect general industry practices and procedures for guidance only.

Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this Standard. The text takes precedence over the figures.

1.5 Process Control Requirements The primary goal of process control is to continually reduce variation in the processes, products, or services to provide products or processes meeting or exceeding user requirements. Process control tools such as IPC-9191 or other user-approved system may be used as guidelines for implementing process control.

A documented process control system, if established, **shall** define process control and corrective action limits.

This may or may not be a statistical process control system. The use of statistical process control (SPC) is optional and should be based on factors such as design stability, lot size, production quantities and the needs of the manufacturer (see 4.12).

When a decision or requirement is to use a documented process control system, failure to implement process corrective action and/or the use of continually ineffective corrective actions **shall** be grounds for disapproval of the process and associated documentation.

1.6 Order of Precedence The contract **shall** take precedence over this standard, referenced standards and drawings.

In the event of conflict, the following order of precedence applies:

1) Procurement as agreed and documented between user and supplier.

2) Master drawing, design brief or tech pack reflecting the user's detailed requirements.

3) When invoked by the customer or per contractual agreement, this standard.

When documents other than this standard are cited, the order of precedence **shall** be defined in the procurement documents. The user can specify alternate acceptance criteria.

1.6.1 Conflict In the event of conflict between the requirements of this standard and the applicable drawing(s) and documentation, the applicable user-approved drawing(s) and documentation govern.

Some examples of documentation include the contract, purchase order, technical data package, engineering specification or performance specification. In the event of a conflict between the text of this standard and the applicable documents cited herein, the text of this standard takes precedence. In the event of conflict between the requirements of this standard and drawing(s) and documentation that has not been user approved, this standard governs.

1.6.2 Clause References When a clause in this document is referenced, its subordinate clauses apply, unless the requirement references specific subordinate clauses.

1.6.3 Procurement Documentation The procurement documentation **shall** provide sufficient information to the supplier so the supplier can produce functional nonconductive dielectric materials and ensure the user receives the desired product. The procurement documentation should specify the requirements that can be selected from within this standard.

1.7 Quality Conformance This standard establishes a quality conformance system for suppliers to demonstrate the continual conformance of materials to the quality requirements of the standard. See Section 4 for quality conformance inspection requirements.

1.8 Abbreviations and Acronyms When used, periodic table elements are abbreviated in the standard.

1.9 Terms and Definitions Terms and definitions **shall** be in accordance with 1.9.1 through 1.9.9, IPC-T-51 and IPC-T-50.

1.9.1 Functional Dielectric Material A material or material composite typically containing a component or components that have intrinsic material properties providing dielectric and/or insulative function to the final (postprocessed) printed pattern (thin or thick film).

As-supplied and preprocessed functional dielectric material typically includes both volatile and nonvolatile components. Volatiles are liquid solvents. Nonvolatiles are solids responsible for the functional properties of the printed pattern.

1.9.2 Postprocessed The state of material following deposition and any curing or drying process.

1.9.3 Preprocessed State of material following deposition but prior to any curing or drying process.

1.9.4 Solids Content (Nonvolatile Content) Component(s) of a preprocessed functional material that cannot be removed by evaporation or decomposition through thermal treatment (drying) or curing. They form a printed pattern which provides the dielectric functionality to the printed pattern after postprocessing.

1.9.5 Solution Processable A material which has rheological properties that enable it to be processed via a liquid-phase dispensing technology.

1.9.6 Solvent A nonreactive liquid which is added to a vehicle to enable the process of printing the functional material and removed during postprocessing.

Typical solvents could be organic or aqueous.

1.9.7 Surface Tension The property of the surface of a liquid that allows it to resist an external force. The cohesive forces between the liquid molecules are responsible for surface tension. Expressed in Newton per meter (N/m) or dyne per cm (dyn/cm).

1.9.8 Vehicle A liquid component which carries the functional material and binds it to the surface of the substrate during the drying process. It typically comprises a resin (binder), solvent(s) and additive(s). The composition of the vehicle is strongly dependent on the printing process and the substrate.

1.9.9 Volatiles Component(s) of a preprocessed functional material that can be removed by evaporation through thermal treatment (drying) or curing.

1.10 Designation System The user has the responsibility to specify on the procurement documentation materials capable of meeting the requirements of this specification and end-item use.

Note: When possible, material callout information should be reviewed with the supplier to obtain concurrence that the part will meet customer requirements and, if necessary, to update the procurement documentation accordingly.

The classification system defined in 1.10.1 identifies functional dielectric materials for printed electronics applications.

1.10.1 Functional Dielectric Material Designation The functional dielectric material designation is intended for use on material purchase orders (see 6.1).