

JEDEC STANDARD

Test Method for the Measurement of Moisture Diffusivity and Water Solubility in Organic Materials Used in Electronic Devices

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JEDEC SOLID STATE TECHNOLOGY ASSOCIATION



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STANDARD TEST METHOD FOR THE MEASUREMENT OF MOISTURE DIFFUSIVITY AND WATER SOLUBILITY IN ORGANIC MATERIALS USED IN ELECTRONIC DEVICES

(From JEDEC Board Ballot JCB-21-27, formulated under the cognizance of the JC-14.1 Subcommittee on Reliability test methods for packaged Devices.)

1 Scope

The purpose of this test method is to provide a means for determining the moisture sorption properties of organic materials used in the packaging of electronic devices.

This standard details the procedures for the measurement of characteristic bulk material properties of moisture diffusivity and water solubility in organic materials used in the packaging of electronic devices. These two material properties are important parameters for the effective reliability performance of plastic packaged surface mount devices after exposure to moisture and subjected to high temperature solder reflow.

2 Normative references

J-STD-020, *Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices*.

ASTM Standard D570-10, *Standard Test Method for Water Absorption of Plastics*.

SEMI G66-0811, *Test Method for the Measurement of Water Absorption Characteristics for Semiconductor Plastic Molding Compounds*.

DIN EN ISO 62: 2008, *Plastics Determination of Water Absorption*.

SEMI MS10-0812, *Test Method to Measure Fluid Permeation through MEMS Packaging Materials*.

3 Apparatus

- 3.1 Analytical balance capable of resolution of either 0.00001g or 0.001% of sample weight.
- 3.2 High temperature oven capable of maintaining uniform temperatures from 100 °C – 250 °C +/-2 °C.
- 3.3 Temperature / humidity chamber(s) capable of maintaining temperatures of 30 °C – 85 °C and relative humidity's from 60%RH – 85%RH. Within the chamber working area, temperature tolerance must be +/-2 °C and the RH tolerance must be +/- 3%RH.
- 3.4 Perforated stainless steel trays or wire mesh baskets used for holding samples and for placement into ovens.
- 3.5 Large aluminum plate or disk used for heat sink capability.
- 3.6 Desiccator for holding dry samples.

4 Test samples

- 4.1 Test samples must be flat parallel-sided discs or coupons. The linear dimensions must be accurately measured to within $\pm 10\%$ of the linear dimension
- 4.1.1 To approximate one-dimensional diffusion behavior with edge effects limited to less than 5% of the total diffusional moisture mass uptake, the free surface area in the thickness dimension must be less than 5% of the flat-sided free surface area of the sample. For a disc of radius r , and thickness h , the following relation must be met:

$$h < 0.05r \quad (1)$$

for a coupon of length L , and width W ,

$$h < \frac{0.05(W \times L)}{W + L} \quad (2)$$

Recommended sample thickness should be in the range from 0.3 – 1.0mm, however, characterization of some materials, e.g., underfill, epoxy film, etc., may require a disc thickness <0.3mm. It is recommended that the maximum sample thickness not exceed 1.0mm, because the time to achieve moisture saturation at temperatures below 60°C will be excessively long for slow diffusing compounds.

- 4.1.2 An analytical method for thicker laminate samples is presented in 5.4

5 Procedure

5.1 Sample preparation

- 5.1.1 Prepare samples by using proper processing parameters as recommended by the material supplier.
- 5.1.2 Process and cure the samples using recommended processing conditions per the manufacturer's specification.
- 5.1.3 To obtain the appropriate sample thickness of homogeneous materials as given by relations (1) or (2), samples may be sectioned and finely polished from larger bulk specimens. Care must be taken to maintain near-parallel sided flatness for samples prepared in this manner.
- 5.1.4 The prepared samples should be inspected for voids by Acoustic Microscopy (AM) or x-ray, both internal and surface. The ideal samples must be 95% of theoretical maximum density.

5.2 Absorption measurements below 100 °C

- 5.2.1 Measure the linear dimensions of the prepared sample to the nearest $\pm 10\%$ of that linear dimension target. Record the sample thickness, h , and calculate the sample volume, Vol , using the appropriate geometric relationship based on the sample shape.

NOTE Calculating the volume by measuring the linear dimensions is never accurate. The error is smaller when the sample is big. One accurate way of determining the volume is to use Archimedes's principle, which is to measure the sample weight in air and immersed in a liquid with known density (alcohol, IPA, etc.). In this way, volume of a sample with irregular shape can also be determined.

- 5.2.2 The dry weight of the sample **shall** be determined, as per J-STD-020, first by baking the sample for 24 hours at $125 \pm 5/0$ °C and continue baking and weigh the sample every 12 hours until no further weight loss is observed to ensure that the sample(s) are dry. The dry weight is determined when no further weight loss is observed, less than 0.002% difference, after two consecutive measurements with a minimum baking interval of 12 hours. Within 30 minutes after removal from the oven, weigh the sample(s) using the analytical balance equipment in 3.1 and determine the dry weight per 5.2.4. Note: As per J-STD-020, small sample(s) (less than 1.5 mm total height), devices should be weighed within 30 minutes after removal from oven

NOTE As per J-STD-020, small sample(s) (less than 1.5 mm total height), devices should be weighed within 30 minutes after removal from oven. Remove the sample(s) from the bake oven and immediately cool by placing in contact with the heat sink of 3.5. If more than one sample is to be measured, the samples and heat sink should be placed into a desiccator to limit moisture uptake during the weight measurements.

- 5.2.3 Weigh the sample and record weight as DryW(1). Read Points: At the desired read point; remove the sample(s) from the bake oven. Within 30 minutes after removal of the sample(s) from the bake oven, remove the sample(s) from the container and determine their weight using the analytical balance equipment in 3.1. Within 30 minutes after weighing the samples, place them in a clean, dry, shallow container so that the sample bodies do not touch each other. Return the sample(s) to the bake oven for the desired time. Continue until the sample(s) have lost all their moisture as determined by the dry weight in 5.2.2.