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Accelerated moisture resistance – Unbiased HAST

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Accelerated Moisture Resistance - Unbiased HAST

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JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

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ACCELERATED MOISTURE RESISTANCE – UNBIASED HAST

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Draft PAS	**Report on voting**
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ACCELERATED MOISTURE RESISTANCE - UNBIASED HAST

(From JEDEC Board Ballot JCB-00-56, formulated under the cognizance of the JC-14.1 Subcommittee on Reliability Test Methods for Packaged Devices.)

1 Purpose

The Unbiased HAST is performed for the purpose of evaluating the reliability of non-hermetic packaged solid-state devices in humid environments. It is a highly accelerated test which employs temperature and humidity under non-condensing conditions to accelerate the penetration of moisture through the external protective material (encapsulant or seal) or along the interface between the external protective material and the metallic conductors which pass through it. Bias is not applied in this test to ensure the failure mechanisms potentially overshadowed by bias can be uncovered (e.g. galvanic corrosion). This test is is used to identify failure mechanisms internal to the package and is destructive.

2 Scope

This test method applies primarily to moisture resistance evaluations and robustness testing, and may be used as an alternative to unbiased autoclave. Samples are subjected to a non-condensing, humid atmosphere, similar to the JESD-22-A101, "Steady State Temperature, Humidity and Bias Life Test", but with a higher temperature. For the temperature limits defined by this procedure, the test will typically generate the same failure mechanisms as those in an unbiased "85 °C/85%RH" Steady State Humidity Life Test, but caution must be used if higher temperatures are considered since non-realistic failure modes can be generated. The use of a non-condensing environment avoids many irrelevant external failures, e.g., pin-to-pin leakage or lead corrosion. However, because absorbed moisture typically decreases glass transition temperature for most polymeric materials, the combination of high humidity and high temperature (> T_g) may produce unrealistic material failures. Thus, caution is needed if and when Unbiased HAST is required for reliability or qualification purposes.

3 Apparatus

The test requires a pressure chamber capable of maintaining a specified temperature and relative humidity during ramp-up to, and ramp-down from, the specified test conditions.

3 Apparatus (cont'd)

3.1 Records

A permanent record of the temperature profile for each test cycle is recommended, so the stress conditions can be verified. Calibration records shall verify that the equipment avoids condensation on devices under test (DUTs) hotter than 50 °C during ramp-up and ramp-down for conditions of maximum thermal mass loading. Calibration records shall verify that, for steady state conditions and maximum thermal mass loading, test conditions are maintained within the tolerances specified in 3.1.

3.2 Devices Under Stress

Devices under stress must be placed in the chamber to minimize temperature gradients. Devices under stress shall be no closer than 3 cm from internal chamber surfaces, and must not be subjected to direct radiant heat from heaters. If devices are mounted on boards, the boards should be oriented to minimize interference with vapor circulation.

3.3 Ionic Contamination

Care must be exercised in the choice of any materials introduced into the chamber in order to minimize release of contamination, and minimize degradation due to corrosion and other mechanisms. Ionic contamination of the test apparatus shall be controlled to avoid test artifacts.

3.4 Distilled or Deionized Water

Distilled or deionized water with a minimum resistivity of 1 megohm-cm at room temperature shall be used.

4 Test conditions

Test conditions consist of a temperature, relative humidity, and duration.

Table 1 — Temperature, relative humidity and pressure

Test condition[3,4]	Temperature[1] (dry bulb °C)	Relative humidity[1] (%)	Temperature[2] (wet bulb, °C)	Vapor pressure[2] (psia/kPa)
A	130 ± 2	85± 5	124.7	33.3/230
B	110 ± 2	85± 5	105.2	17.7/122

NOTES

1 Tolerances apply to the entire usable test area.

2 For information only.

3 The test conditions are to be applied continuously except during any interim readouts. For interim readouts, devices should be returned to stress within the time specified in 5.4

4 The unbiased HAST duration is intended to meet or exceed an equivalent field lifetime under use conditions. The duration is established based on the acceleration of the stress (see JEP122). The stress duration is specified by internal qualification requirements, JESD47 or the applicable procurement document. Typical test durations are:

Condition	Duration
A	96 hours (-0,+2)
B	264 hours (-0, +2).

CAUTION: For plastic-encapsulated microcircuits, it is known that moisture reduces the effective glass transition temperature of the molding compound. Stress temperatures above the effective glass transition temperature may lead to failure mechanisms unrelated to operational use.

5 Procedure

The test devices shall be mounted in a manner that exposes them to a specified condition of temperature and humidity. Exposure of devices to conditions that result in condensation on them, particularly during ramp-up and ramp-down, shall be avoided. While devices are above 30 ^{o}C, R.H. must be ≥ 40% to ensure their moisture content is not reduced, i.e., inadvertant moisture bake out.

5 Procedure (cont'd)

5.1 Ramp-up

5.1.1 The time to reach stable temperature and relative humidity conditions shall be less than 3 hours.

5.1.2 Condensation shall be avoided by ensuring that the test chamber (dry bulb) temperature exceeds the wet-bulb temperature at all times, and that the rate of ramp up shall not be faster than a rate which ensures that the temperature of any DUT does not lag below the wet bulb temperature.

5.1.3 The dry- and wet-bulb temperature set points shall be maintained so that the relative humidity is not less than 50 % after significant heating begins. In a dry laboratory, the chamber ambient may initially be drier than this.

5.2 Ramp-down

5.2.1 The first part of ramp-down to a slightly positive gauge pressure (a wet bulb temperature of about 104 °C) shall be long enough to avoid test artifacts due to rapid depressurization, but shall not exceed 3 hours.

5.2.2 The second part of ramp-down from a wet bulb temperature of 104 °C to room temperature shall occur with the chamber vented. There is no time restriction, and forced cooling of the vessel is permitted.

5.2.3 Condensation on devices shall be avoided in both parts of the ramp down by ensuring that the test chamber (dry bulb) temperature exceeds the wet-bulb temperature at all times.

5.2.4 Ramp-down should maintain the moisture content of the molding compound encapsulating the die. Therefore, the relative humidity shall not be less than 50 % during the first part of the ramp-down, see 5.2.1.

5.3 Test Clock

The test clock starts when the temperature and relative humidity reach the set points, and stops at the beginning of ramp-down.

5 Procedure (cont'd)

5.4 Readout

Electrical test shall be performed not later than 48 hours after the end of ramp-down. Note: For intermediate readouts, devices shall be returned to stress within 96 hours of the end of ramp-down. The rate of moisture loss from devices after removal from the chamber can be reduced by placing the devices in sealed moisture barrier bags, the bags should be non-vacuum sealed without a N2 purge and without dessicant. When devices are placed in sealed bags, the "test window clock" runs at 1/3 of the rate of devices exposed to the laboratory ambient. Thus the 130 ^{o}C/85 %R.H. test window can be extended to as much as 144 hours, and the time to return to stress to as much as 288 hours by enclosing the devices in sealed moisture barrier bags.

5.5 Handling

Suitable hand-covering shall be used to handle devices, boards and fixtures. Contamination control is important in any highly accelerated moisture stress test.

6 Failure criteria

A device will be considered to have failed if parametric limits are exceeded, or if functionality cannot be demonstrated under nominal and worst-case conditions as specified in the applicable procurement document or data sheet.

7 Safety

Follow equipment manufacturer's recommendations and local safety regulations.

8 Summary

The following details shall be specified in the applicable procurement document:

(a) Test duration

(b) Test conditions

(c) Measurements after test.