

Dew cycle test in reliability testing of electrical/electronic components/assemblies

Dew cycle test

background:

nowadays electronic devices are more and more subject to changing environments where dew condensation initiates migration effects which might result in failures of the often miniaturized circuits.

Especially mobile electronic devices such as mobile phones, PDA, digital cameras and electronic assemblies used in automobiles are of concern.

Reliability testing for the affected products is therefore an essential task to ensure the quality of these products.

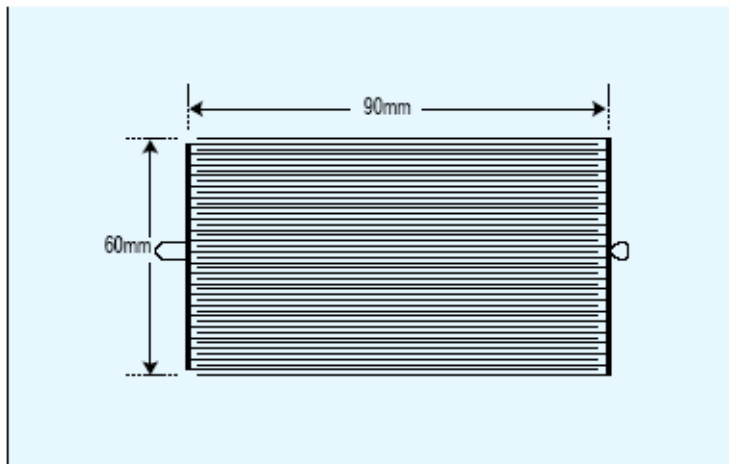
The following will explain our research activity to find the method for a dew condensation test and will show the existing common test methods used by us and the Japanese Industry.

Dew cycle test

Research:

Beginning in the early 90's ESPEC did some evaluations to find the effects of migration on printed circuit boards (PCB), initiated by dew condensation.

Leakage current measurement between the cam structured circuit patterns was chosen as a suitable method to detect and measure the migration effects.



gold plated patterns on glass-epoxy substrate board.

test conditions

Temperature, Humidity	5±2°C 60±5%RH (25 minutes) ←→25±2°C 90±5%RH (15 minutes)	
Specimen	Material	Glass epoxy substrate board
	Pattern	Tandem compound electrode pattern corresponding to JIS type 2
	Sample number	n=9
	Substrate board dimensions	50 mm x 120 mm
	Voltage applied	DC 5V

Dew cycle test

Research: (continued...)

Results:

- the measured leakage current is related to the pattern pitch and to the thermal mass of the test sample
- the wettability of the substrate board increases with the cycle counts
- with increasing wettability of the substrate board the leakage current is increasing
- the amount of dew condensing is in relation to the measured leakage current

to intensify our research we used Teflon substrate boards and applied a alternating voltage for the leakage current measurements.

With this modified test setup we got reproducible results to show the relation between measured peak current values and amount of dew condensation.

We used this setup to find the relation between amount of dew condensation and duration of dew condensation.

Dew cycle test

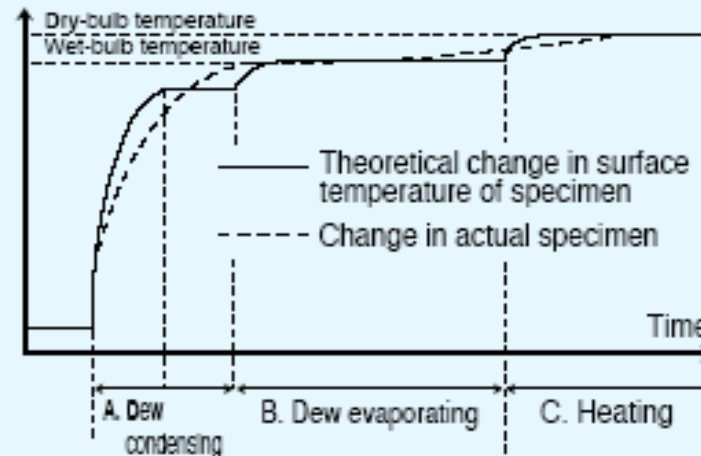
Research: (continued...)

The Dew condensation process goes from condensation (A) to evaporation (B) to heating (C).

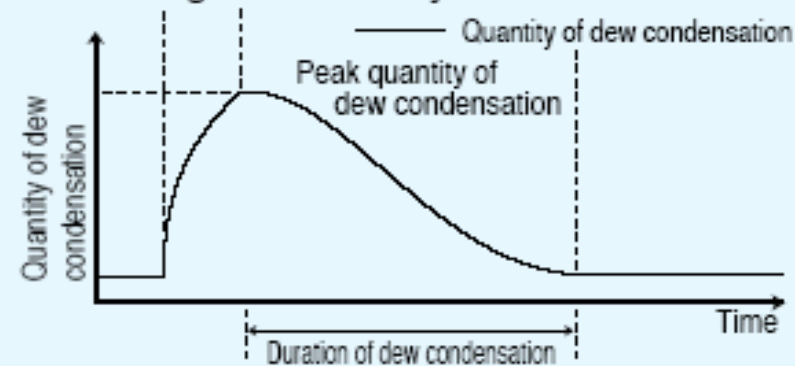
Dew condensation is present on the sample during periods A and B.

This characteristic can be verified with visual inspection using a video camera.

■ Change in Specimen Temperature



■ Change in Quantity of Dew Condensation



Dew cycle test

Research: (continued...)

Further to this we are interested in the change of dew condensation after an increased number of cycles, we used the visual inspection setup and got the results as shown:

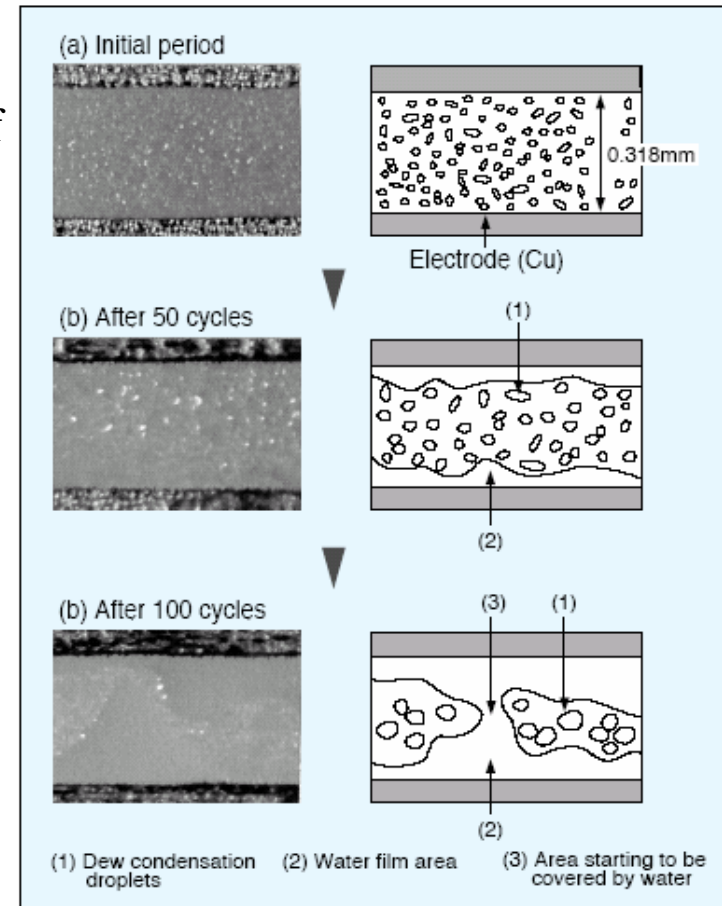
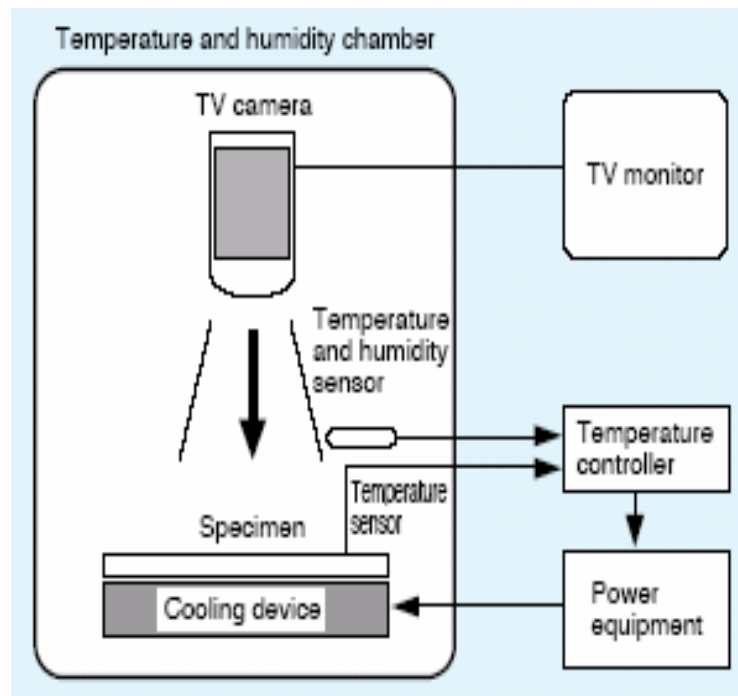


Photo 3 Changes in dew condensing conditions during testing

Dew cycle test

Research: (continued...)

the process of migration caused by dew condensation is shown as follows:

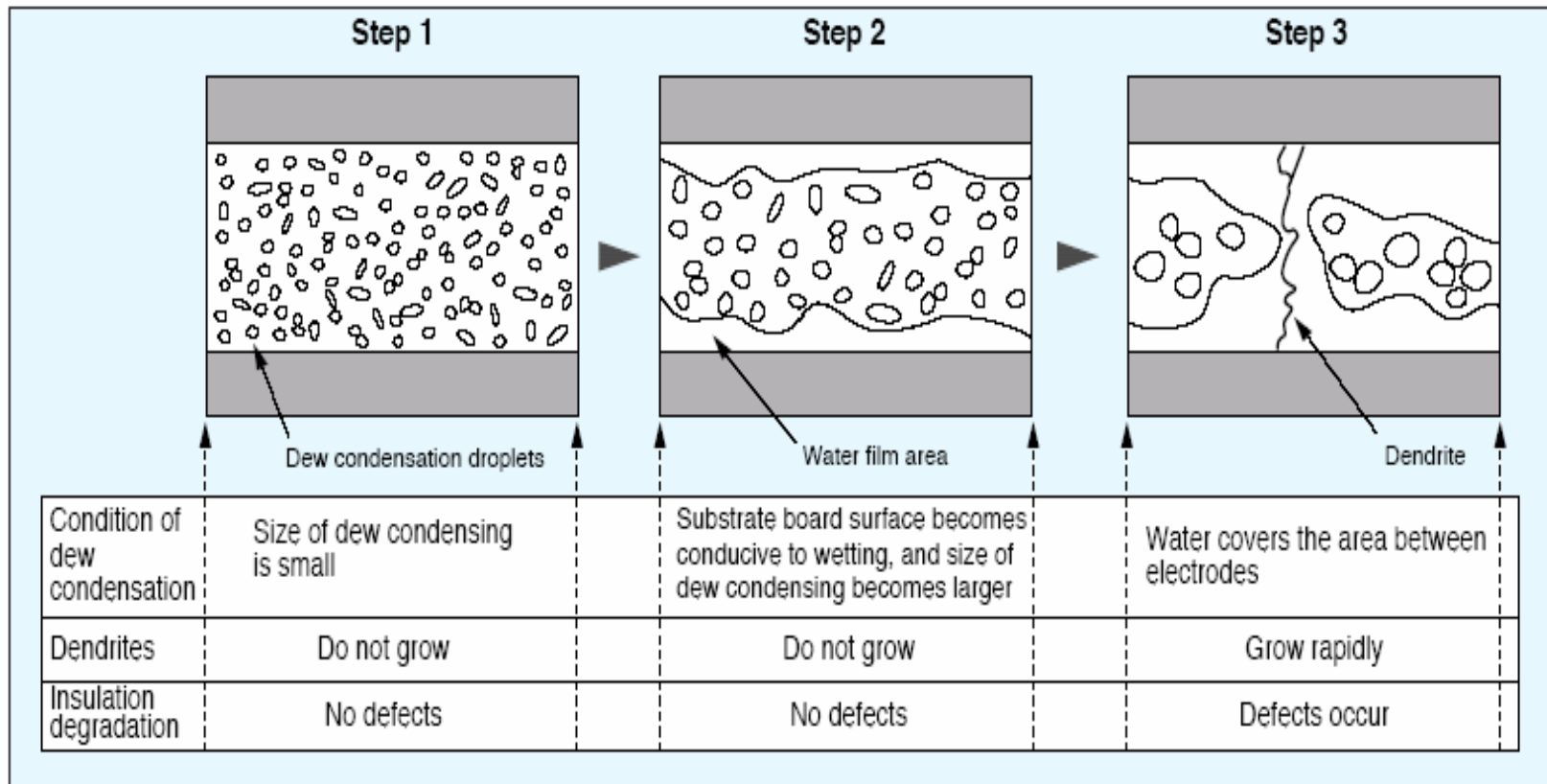


Fig. 9 Process of insulation degradation in the dew cycle test

Dew cycle test

Research: (continued...)

Migration has a direct relation to the amount of dew condensation.

Repeated dew condensation is affecting the wettability of the substrate board surface, more and more water is absorbed and allows migration to grow between the patterns.

A dew condensation test must guarantee for a reproducible amount of dew condensation on the sample to stimulate migration.

Choosing reselectable environmental conditions (temperature and humidity) in 2 zones creates a reproducible amount of dew condensation.

Dew cycle test

Research: (continued...)

summary:

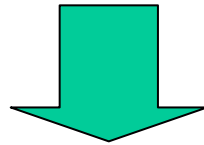
- Increased temperature difference in a cycle increased the amount of dew condensation, T (20, 25, 30, 35, 40, 45K, proven by leakage current measurement)
- Temperature cycles in high temperature areas with fixed temperature difference ($T = 20K$) increases the amount of dew condensation. (proven by leakage current measurement, humidity: 90%r.H.)
- A reproducible dew condensing time exists for identical test settings.
- High wind speed at the sample reduces dew condensing time.

Dew cycle test

Results:

to get a designated amount of dew condensation.....

- the temperature and humidity difference can be varied:
T und r.H.
- the temperature range can be varied



by measuring the dew condensation time the amount of dew condensation can be verified:

- the dew condensing time is related to the amount of dew condensation and wind speed → therefore the amount of dew condensation can be verified by measuring the dew condensation time.

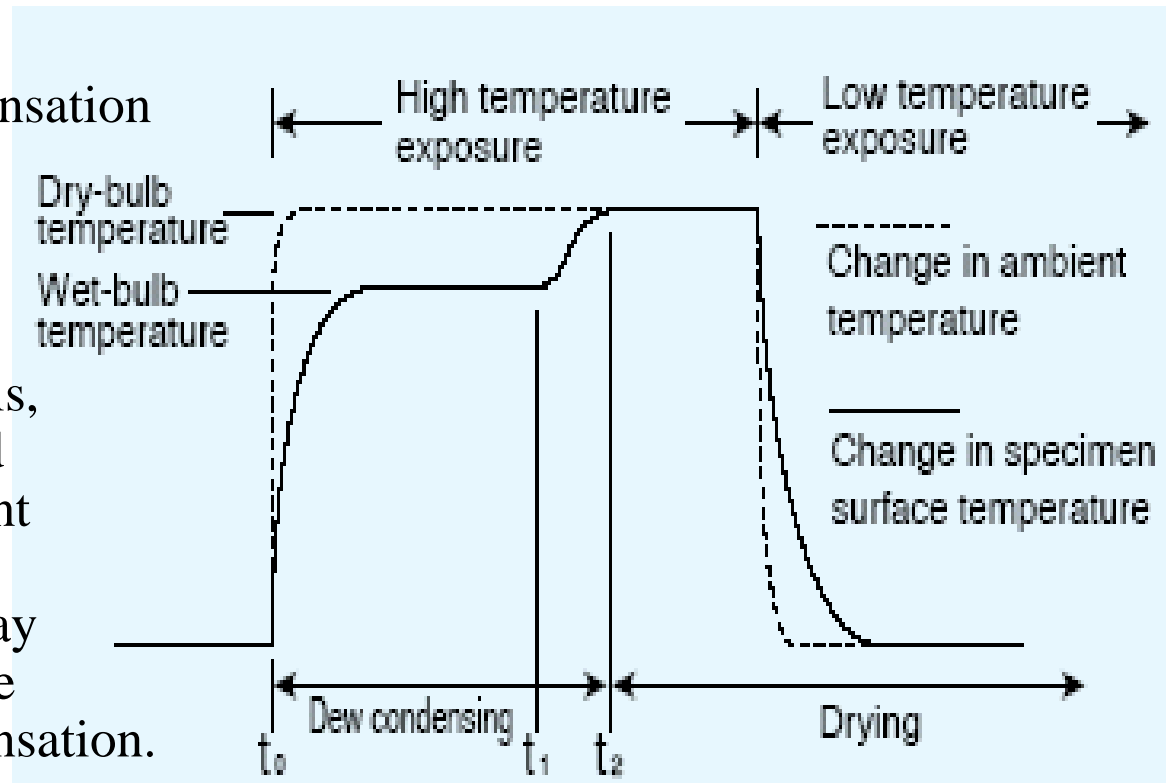
ESPEC is using the „Pachinkoball“-Method to measure dew condensation time.

Dew cycle test

Pachinkoball-Method:

Temperature is measured at a defined steel-ball.

At the time of dew condensation the temperature at the steel-ball increases slower than at the sample because of the thermal mass, after this, dew is evaporated and temperature adjustment at the steel-ball starts, as longer the time delay ($t_0 - t_1$) as higher is the amount of dew condensation.



Dew cycle test

Test-Methods:

- JASO Test:

-5 ° (2 hrs.) \leftrightarrow +35 ° / 85% r.H. (10 min.)
(T: 40K)

Temperature change shall be as quick as possible,
best is to move the sample from one room to another.

A functional test is done when the unit is in the +35 ° condition.

Dew cycle test

Test-Methods:

	automotive	mobile devices	paint, coatings
temperature (° C)	-30 ↔ +25 (+35) T: 55K (65K)	5 ↔ 25 T: 20K	-5 ↔ 35 T: 40K
humidity (% r.H)	- ↔ 90	60 ↔ 90	- ↔ 90
duration (soak)	60 min	20 min	60 min
cycles (lifetime)	50 10 years	100 5 years	200
equipment	TSA101D dew - shock	DCTH temperature cycle	DCTH temperature cycle

Dew cycle test

equipment:

DCTH:

temperature cycle chamber
with fixed test area, volume 70,
100 or 200 ltr.

Used in combination with Ion
Migration Evaluation System,
AMI, to monitor Isolation
resistance.

In use by Matsushita, Sony,
Sharp, Sanyo etc.



Dew cycle test

equipment:

TSA101D:

temperature(humidity)-shock-
system with fixed test area,
volume 100 ltr.

This equipment is capable for
standard thermal-shock and for
dew-shock.

in use by Toyota, Denso etc.

