



TECHNOLOGY ENABLING INNOVATION

APPLICATION NOTES

Moisture Absorption of Polyimide MLB's

Because polyimide materials tend to absorb moisture faster (and to a higher equilibrium point) than epoxies, we have long recommended taking particular care in removing moisture from prepreg and inner layer details prior to lamination to avoid blistering and delamination in finished boards. Over time, however, when finished bare boards are stored prior to assembly, reflow or other thermal processes, moisture will be absorbed by the boards, and may be present at a level sufficient to cause blistering or delamination during those processes. In general it has been determined that a level of about 0.22% moisture in a PWB is sufficient to cause problems during assembly or reflow. How quickly does moisture pickup occur, and what should the assembly house do about it prior to processing the boards?

Both moisture pickup, and subsequent drying are impacted by a number of variables including the particular resin system used, the board thickness, any protective coatings that may be on the board, the distance from the outer surface to the nearest ground or power plane, and the number and size of internal clearances that might permit moisture to penetrate beyond the otherwise impermeable copper power and ground layers. Naturally if finished board are dried, desiccated and kept in a well sealed vapor barrier bag, the risk of moisture incursion is dramatically lessened. Because of all these variables, no single test of moisture pickup will be completely reliable as an indicator of "how long can they sit before they have to be

dried prior to processing" but we have modeled a simple multilayer with 10 mil outer layers, solid power and ground planes, and 30 mil inners, then exposed these to room temperature 50% and 85% RH for about a week. In this test, we used three different Arlon polyimides and a multifunctional FR-4 as a control.

85N is a 250°C Tg pure polyimide (no flame retardant)

35N is a short cure time, 250°C Tg multipurpose polyimide

EP-2 is a highly filled 250°C Tg, low Z-expansion, high copper peel polyimide

45N is a 170°C Tg multifunctional epoxy system

To summarize the results:

	45N	35N	85N	EP-2
85% RH				
Equilibrium	0.28%	0.63%	0.68%	0.52%
Time to 0.22%	55 hr	9 hr	10 hr	12.5 hr
50% RH				
Equilibrium	0.29%	0.56%	0.57%	0.49%
Time to 0.22%	110 hr	20 hr	19.5 hr	33 hr

Somewhat “surprising” is that the final equilibrium levels of moisture absorbed after a week of exposure were about the same for 85% RH and 50% RH, although for the conventional unfilled polyimides they were slightly lower at 50% RH. It suggests that, like in a “bucket” only so much water can be picked up, although at the 85% RH level the rate of pickup was about double that of the 50% RH level. It is likely that at elevated temperature, additional pickup could be expected, but for purposes of this work we assumed that boards will be stored at ambient conditions, not under elevated temperature.

The individual charts of water pickup vs time are included below. The data was fit to an exponential equation that treated the data as being asymptotic to a final equilibrium level (based on an incremental increase over the level attained at 168 hours) and time to 0.22% was calculated using the best fit to an equation of the form:

$$y = ke(1 - at)$$

where

k is the empirically determined equilibrium moisture level

a is a form factor that fits the rate of rise of the graph (shape of the curve) to the plotted data.

In all cases the fits were excellent with R² (correlation coefficient) values of 0.97 to 0.99.

Drying Polyimide MLB Boards Prior to Assembly

So how long does it take to dry the boards after they have absorbed water? In all cases drying is much faster than moisture pickup because it is done at 125°C (250°F) but a simple rate of drying graph is deceptive,

because it does not take into account the time it takes to remove water that has gone down through clearance holes or that has bled in at edges and diffused into layers below the solid copper power and ground layers.

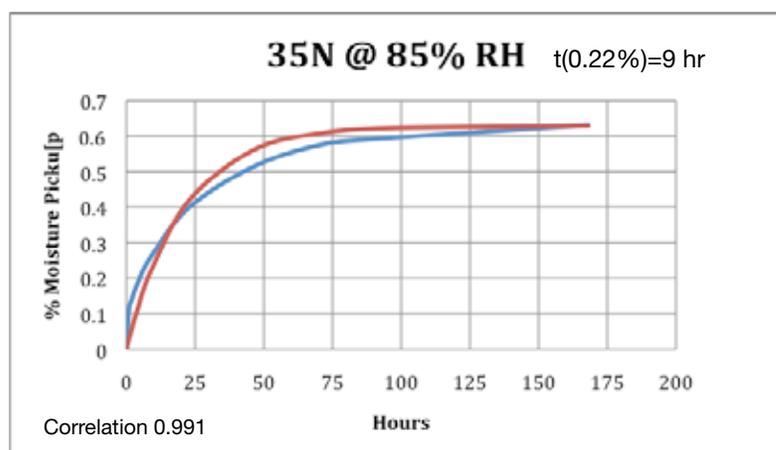
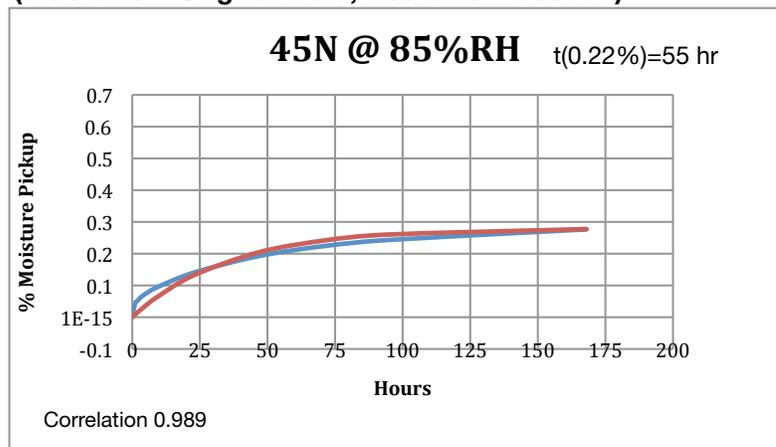
Our experience has been that it takes 4-6 hours at 125°C in a circulating hot air oven to adequately dry a PWB that has been exposed to humidity long enough to absorb more than about 0.2% moisture.

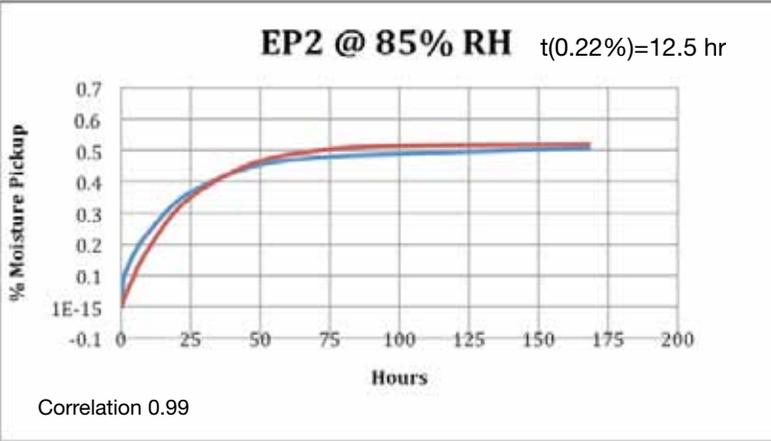
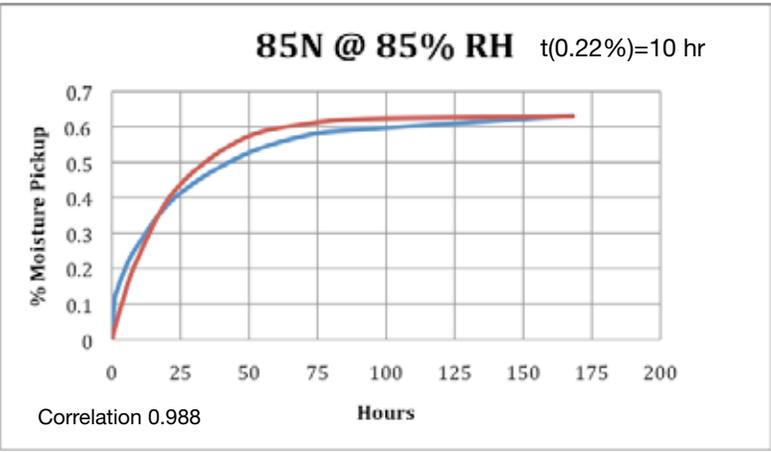
Removal of water from a polyimide PWB involves breaking of hydrogen bonds as well as the diffusion of free water out of the board. While it may be true that if it has absorbed less water, it may take less time to dry, but unless we can know how much

it absorbed and how the geometry of the board will impact the rate of drying, it is risky to use less time than recommended.

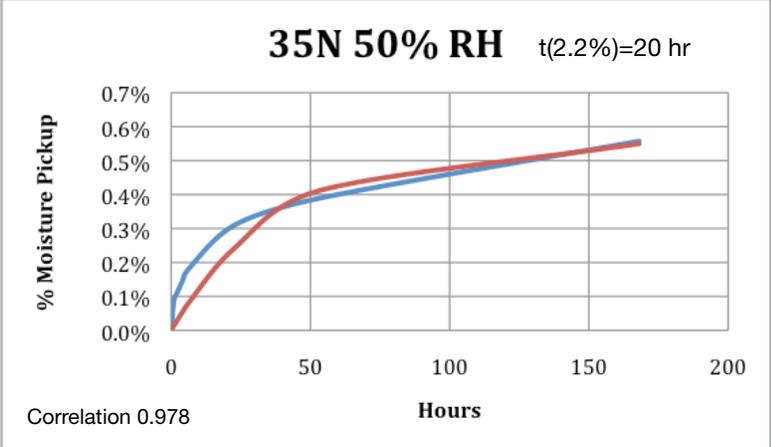
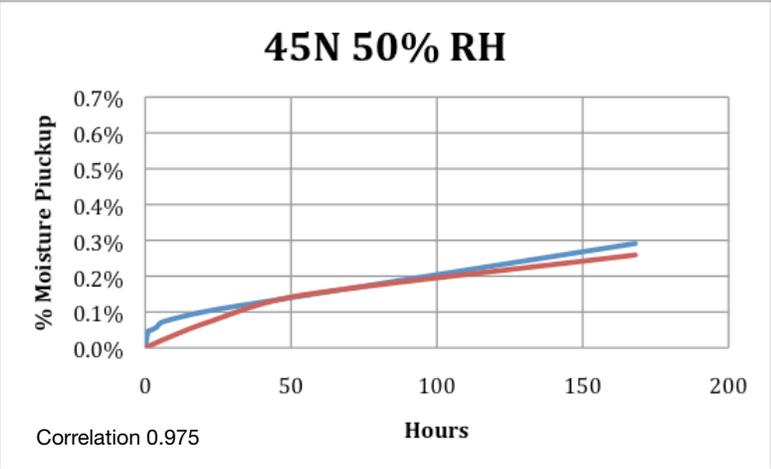
And regardless of the drying cycle selected, it is of paramount importance that dried samples be run through the process to verify that adequate drying has taken place before the whole batch is processed. Be especially cognizant of possible blowouts of plated copper and possible blistering and delamination adjacent to internal clearance holes or near board edges where moisture might be getting in between the solid copper planes.

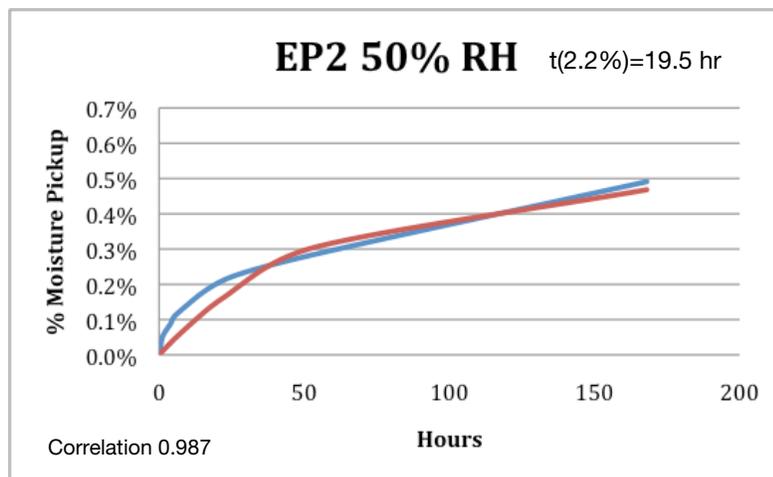
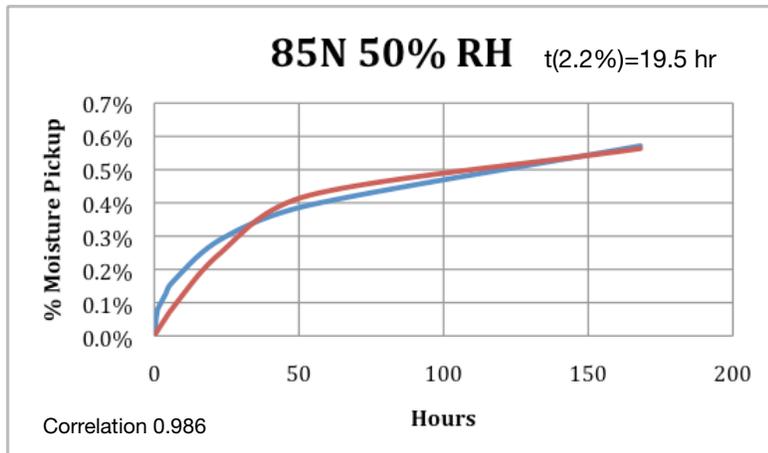
Moisture Pickup – 85% RH, 25°C
(Blue Line = Original Data, Red Line = Best Fit)





Moisture Pickup – 85% RH, 25°C (Blue Line = Original Data, Red Line = Best Fit)





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