RAPID AND EFFECTIVE BAKE OUT FOR MOISTURE SENSITIVE DEVICES

The combination of larger chip sizes, smaller devices, newer materials and shorter development cycles are leading to a rapid increase in the number of moisture-sensitive devices (MSDs) and packages. The situation involving sensitivity to moisture for plastic integrated circuits (ICs) appears to be getting worse and people even call the rate of failure for individual MSDs to be at an intolerable level, spurred by ongoing changes in packaging technology. Moisture sensitivity of plastic encapsulated components is a critical manufacturing issue and cannot be corrected with simple "easy-to-follow" assembly procedures. A lack of control seems to exist comparable to that which prevailed with the electrostatic discharge (ESD) related problems.

Printed Circuit Boards (PCB) trap moisture and cause problems, especially, in view of the use of environment friendly lead free solder. During the high temperature solder reflow process, the moisture turns to vapors and the internal vapor pressure will cause cracking, delamination and popcorning. These defects pose several reliability concerns such as broken bonds and penetration of contamination. Perhaps the worst kind of failures caused by moisture issues are the latent failures; whereby, devices can pass QC procedures and then fail in the field.

To reduce the effects of moisture-induced stresses during soldering bake-out of moisture-sensitive devices is recommended and there are standard industry procedures, like those outlined by (Joint Electronic Device Engineering Council) JEDEC. One of the recommendations by JEDEC is to subject the parts to a 24-hour bake out at 125°C to remove all moisture. The devices then need to be placed in sealed bags containing a desiccant. If the seal of the bag has been broken or if the device has been removed and exposed to high moisture level, the device needs to be baked out again. The baking time can vary with the thickness of the device, generally the thicker the device the longer the time. Packages up to 4 mm thick may need a bake out of 70 hours at 125°C.

The electronics packaging market has a severe need for innovative approaches for moisture removal. Since it is mainly the moisture or water that causes problems, the ideal approach would be to target water molecules directly and couple energy into them for their removal.

Microwave heating of water molecules in food and plastics has been extremely popular for several decades. Water has polar molecules and they respond to the microwave by rotating in the alternating field thereby heating quite efficiently.

Microwave Drying

Microwaves have been applied to dry numerous materials. This includes, but is not limited to timber, ceramics, powders, pharmaceutical compounds, flowers, dairy products, textile products, documents and books. Anywhere one needs to remove moisture, microwave drying is a potential solution.

Naturally moisture removal from sensitive electronics devices would have come to mind to many people over the years and it is almost guaranteed that people would have tried it (using home kitchen microwave ovens), but probably given up. The process works since the moisture is removed, but the device may not work any more due to damage from non-uniformity of microwave field causing arcing with circuitry. The physics behind using microwaves to remove moisture is right, but the technology (home kitchen models) is inappropriate for electronics related drying applications

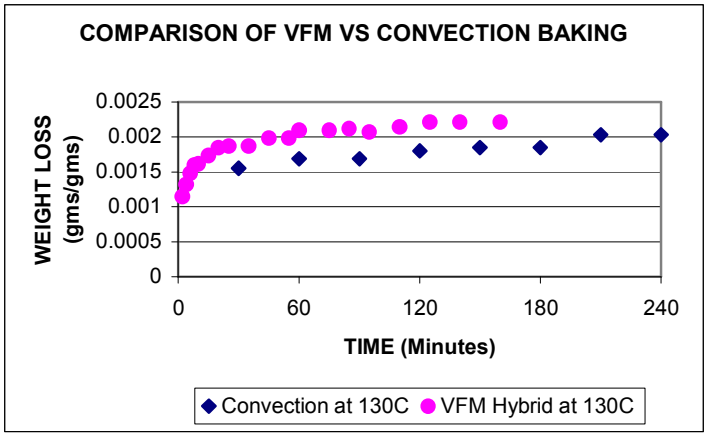
Variable Frequency Microwaves (VFM)

The Variable Frequency Microwave approach is substantially different than fixed frequency microwave because it sweeps through a bandwidth of frequencies in a fraction of a second. Each frequency has a standing wave pattern and the resident time for this pattern is in microseconds. As the frequency changes the wave pattern also changes and provides controlled and uniform distribution of microwave energy over an average time basis. In addition to the uniform energy distribution the rapid sweeping does not allow charge build up even on metallic and electronic components and hence it is possible to bake out and process delicate electronic devices without damage.

Since the interaction of VFM with water is similar to what was described above, the benefit of internal microwave heating of moisture and driving it out is obtained without any detrimental effects, as is the case in fixed frequency.

The plot below shows the comparison of VFM and convection baking processes. The internal interaction of VFM with moisture results in a higher weight loss and a shorter process time.

The VFM process is a benign process consistently used without damage for wafers, CMOS devices and various electronic packages, with functionality and reliability of the devices rigorously tested by numerous major electronic manufacturers.



The preliminary data suggests that VFM has enormous potential and opportunity to address a serious issue of bake out of moisture sensitive devices for the electronic packaging market.

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