# Solutions for Long-term Storage of Electronic Components and Compositions

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The storage of moisture sensitive electronic components and materials is problematic, and manufacturers with long term storage requirements face additional obstacles.

Requirements for long-term storage are increasing. Why?

### 1. Component Obsolescence

Due to rapid changes in packaging design and material, companies find themselves forced to purchase additional quantities of components in order to guard against the impact of component obsolescence on their final product designs. This in turn creates an issue of long-term inventory storage.

### 2. Short Product Lifecycles

Product lifecycles have become very short with new models being released sooner than ever before. However, many manufacturers in industries including automobiles, aviation and avionics, military and railway must guarantee the availability of replacement parts including PCBs for ten or even twenty years. This demands the advance purchase and extended storage of components and materials. Further complicating the problem is that most components cannot be stored for more than a few years without very special handling procedures.

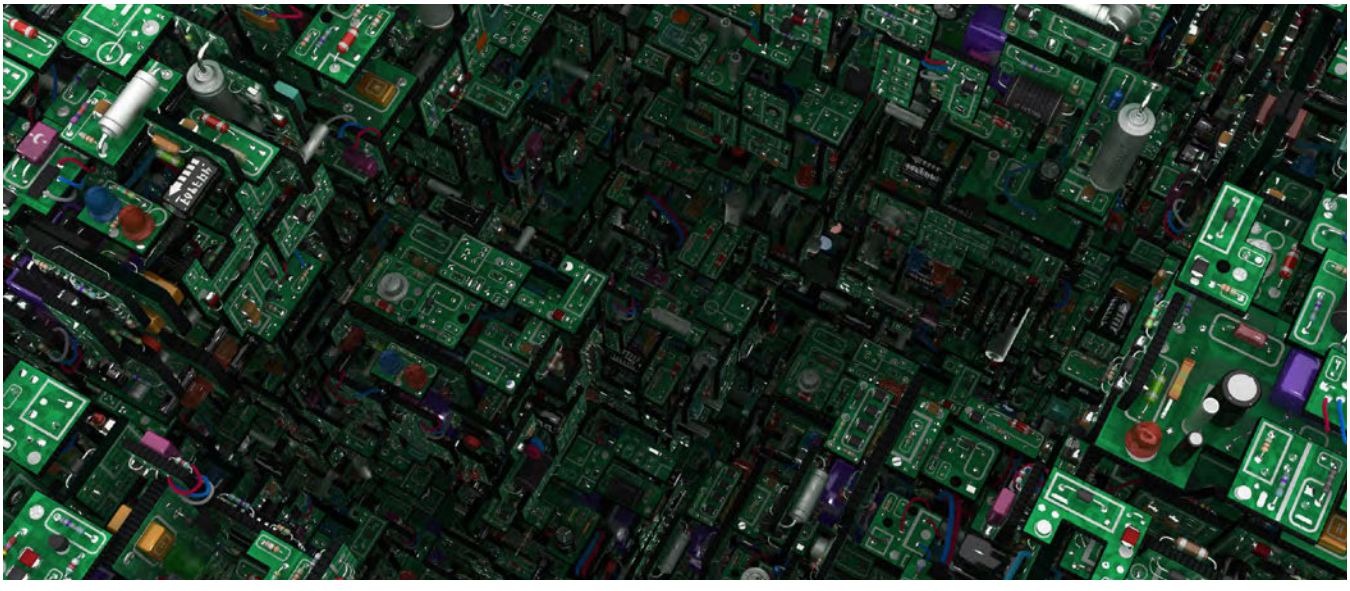
### Risks

The biggest danger posed is humidity. It is the cause of two of the biggest defect causes: oxidation and diffusion.

Because of surface oxidation, components and PCBs can suffer from reduced solderablity, which often results in complete failure. Diffusion of vapor and noxious substances in the inner structure of the components or PCBs can result in long-term disintegration of conductor paths and insulation layers. Both risks can be avoided by correct handling and dry storage.

### The Oxidation Process—Contact Corrosion

In an ultra-dry atmosphere, there is no corrosion. For corrosion to occur, two demands must be met: there must be a means of oxidation and a watery solution, which works as an electrolyte.



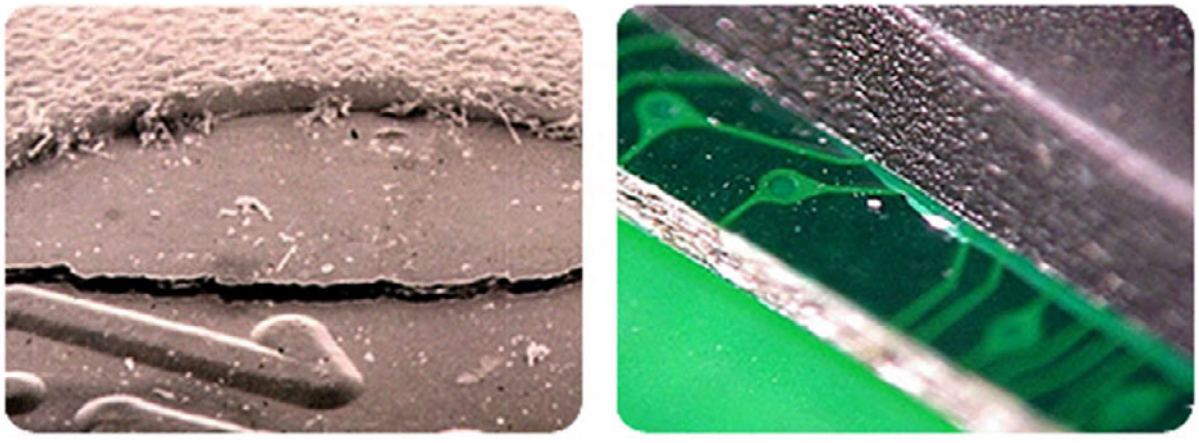


Figure 1: Component micro-cracking resulting from the absorption and rapid release of moisture.

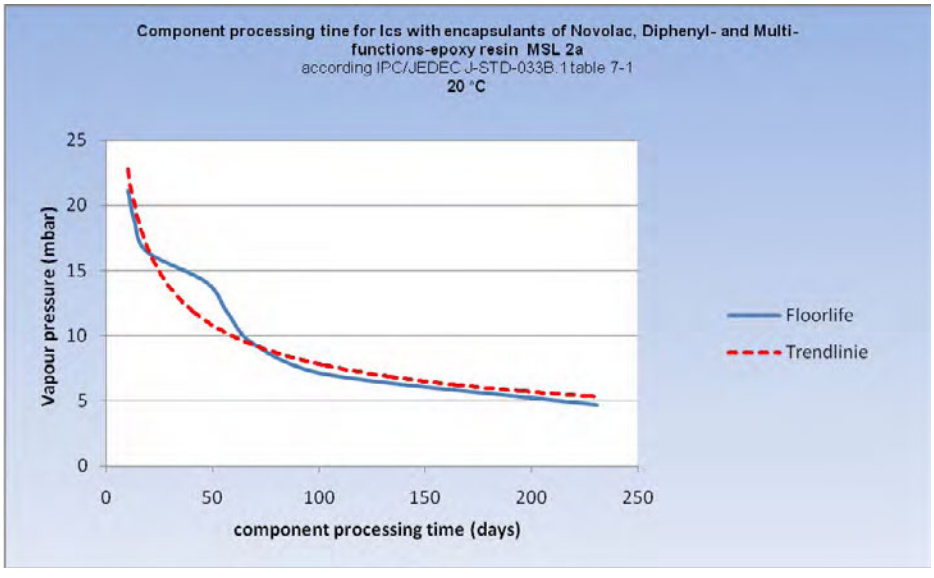



Figure 2: Component processing time.

The oxygen in the air forms the means of oxidation, the vapor (humidity) the electrolyte.

The critical limit at which oxidation with oxygen takes place lies in accordance with the metal or alloy at between 40–70% RH. This means that more than eight grams of vapor per cubic meter must be present.

## The Diffusion Process

The vapor in the atmosphere diffuses into hygroscopic materials. The cause of this is the so-called vapor pressure—this means the partial pressure of the vapor which is present in the air. The higher the vapor pressure, the faster the components or PCB's absorb humidity and with this the permissible processing time decreases.

All components classes 2a to 5a in accordance with the classification of IPC/JEDEC J-STD020D absorb no moisture with a vapor pressure of < 2.82. At this level, they can be stored and processed indefinitely. (IPC/JEDEC-STD033C table 7-1).

Storage cabinets should maintain, over 24 hours, on average a vapor pressure of <0.95 mbar. In a humidity protection bag with a rest pressure of <6 mbar the vapor pressure is <0.15 mbar.

Both systems, dry storage cabinet and hu-

midity protection (a.k.a. moisture barrier) bag, reliably and effectively protect from moisture diffusion.

For storage periods of more than five years, a combination of the two systems is recommended. The storage in humidity protection bags with nitrogen present within a simple dry storage cabinet with 5% RH.

Critical to the effectiveness of the bags, however, is that the construction is mechanically stable and exhibits a very low percentage of diffusion. The IPC/JEDEC-STD033C demands a Moisture Vapor Transmission Rate (MVTR) of less than 0.002 g/100 in² in 24 hours at 40°C. This demand is only met by bags which have a thickness of 150 µm; 90 µm-bags have a substantially higher diffusion percentage and are therefore not suitable. Moisture barrier bags are available that remain significantly below the maximum value as laid down in the IPC standard with an MVTR of 0.0006 g/100 in².

The bags must of course also be ESD-safe; they must be marked as receptive to humidity and be provided with a label upon which the moisture-sensitivity-level and the packing date are clear.

Procedures such as those outlined above have been successfully utilized to eliminate the oxidation and diffusion hazards of long term storage. However, another risk of long term storage must also be considered.

**Intermetallics**

Intermetallic compounds form when two unlike metals diffuse into one another creating species materials which are combinations of the two materials. Intermetallic growth is the result of the diffusion of one material into another via crystal vacancies made available by defects, contamination, impurities, grain boundaries and mechanical stress. There are a number of locations within the electronic package where these dissimilar metals are joined. These include die level interconnects and wire bonds, plating finishes on lead frames, solder joints, flip chip interconnects, etc. Growth of intermetallics during the storage period can occur and reduce the strength.

Intermetallic growth rate is strongly temperature-dependent and doubles for each 10°C temperature increase. This aging process can be slowed by appropriate cooling. However, the risk of whisker formation of tin alloys increases with decreasing temperature. Studies and practice have shown that a storage temperature of 12°C is optimal in order to best mitigate both risks. **SMT**

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