New Urethane Technology for Potting and Encapsulation in Electronics

Electronic design engineers find it difficult to protect today's components and assemblies from constant moisture, thermal shock, and stress at very low and high temperatures. A new class of polyurethane products provides a solution.

Problem

Many electronic components and assemblies require a potting compound for protection against moisture, thermal shock, vibration and very low temperatures. Most of the potting & encapsulating compounds available to designers are unable to give adequate protection over a wide temperature range. Epoxies are generally hard and tough materials. They provide excellent mechanical properties, good chemical resistance and good adhesion. However, they do not protect delicate components during thermal cycling and may provide stress during the exothermic cure. Silicones are excellent for high operating temperatures (185º C) and provide a low durometer. Unfortunately, they are expensive and do not provide good adhesion. Conventional polyurethanes can be formulated to be flexible or rigid and have a low peak exothermic temperature during cure. But, these conventional polyether and polyester urethanes can be penetrated by water, especially at high temperatures.

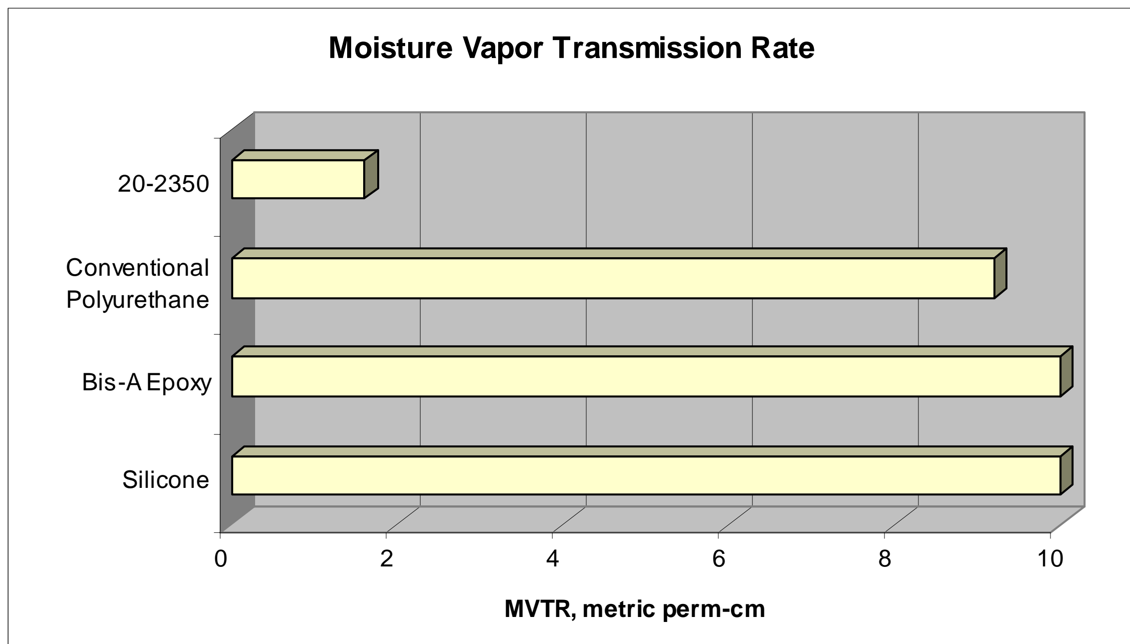
The new generation of polyurethanes developed by Epoxies, Etc… provide a unique combination of properties:

- Excellent Hydrolytic Stability
- Low Temperature Performance
- Elastomeric
- Fast Cure with low Exotherm & low Shrinkage

Hydrolytic Stability

Epoxies, Etc… 20-2350 Polyurethane is one of the new polyurethane products that provide outstanding moisture resistance. The hydrocarbon backbone in this resin imparts hydrolylitic stability and low moisture permeability, surpassing that of any other urethane. There are no ester or ether linkages to hydrolyze in these formulations. Electronic insulation and integrity is maintained in the presence of moisture, even at elevated temperatures.

Measuring moisture vapor transmission rates (MTVR) is one method of determining the permeability of a material. The graph below is representative of the MVTR of common potting and encapsulating materials.



These polyurethane formulations far exceed the 28-day requirement of the Naval Avionics test. By measuring hardness versus time at 100º C and 95% relative humidity, it is demonstrated that these products are virtually unaffected by moisture at high temperature. Some conventional urethanes have been shown to actually revert back to a liquid under these conditions.

Flexibility at Low Temperatures

The 20-2350, and other similar formulations, maintain their flexibility over a wide temperature range. This feature provides low stress on sensitive electronic components even at very low temperatures. The 20-2350 does not become brittle until -70º F. These polyurethane products also have an elongation of 130% at -20º F. The table below shows a fairly consistent elongation from -20º F to 140º F.

Temperature º F	Elongation %	Tensile Strength
-20	130	6100
0	125	5100
77	122	3300
140	117	2100

This feature of maintaining flexibility at low temperatures allows encapsulation of delicate electronic components in a stress free environment.

The potting material creates a cushioning medium for the components and their connections. Due to this property the thermal cycling characteristics are excellent.

Low Exotherm and Low Shrinkage

The cure speed and pot life of this new class of polyurethanes can be easily tailored to suit customer requirements. The cure speed at room temperature can be accelerated for faster process times and less work in progress. With epoxy potting and encapsulating compounds this acceleration of the cure speed results in a very high exotherm and also greater shrinkage. The 20-2350, and its faster curing versions, exhibit little to no shrinkage and very low exotherm.

The faster curing formulations have a low peak exothermic temperature of 30º - 60º F in a 300 gram mass. This is an attractive feature for large potting applications and/or high volume production where processing speed is important. Other materials are known to generate a lot of heat during the curing process in large masses or when formulated to be fast curing.

Conclusion

With the new polyurethane technology utilized in the 20-2350 and similar formulations, electronic design engineers now have a solution for demanding environments. These products will outperform most conventional polyurethanes, epoxies, and silicones when consistent elongation over a wide temperature range is important for protection of electronic components. There is simply no better potting and encapsulating material for exposure to wet environments. The ability to maintain electrical integrity in a wet, hot environment is reassuring. The faster curing versions of the 20-2350 will improve productivity. They will not generate a high exothermic temperature during curing and the shrinkage will be minimal.

This new class of polyurethanes are quickly replacing many conventional potting and encapsulating compounds. Their pricing is less expensive than silicones and comparable to conventional urethanes and epoxies.

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