

EFI POLYMERS

FORMULATED SOLUTIONS WORLDWIDE

Engineering Reliability with Epoxies and Urethanes

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AGENDA

Why Potting/Encapsulation over Conformal Coating?

Environmental protection

Thermal Management

- What makes this important?
- Fillers

Cured Performance

- What are key properties?
- Effects on the Board

Processing

- Why it's important
- Best Practices

Material Recommendation and applications

WHY POT OR ENCAPSULATE?

Environmental Protection

Thermal ManagementImproved Lifespan

Chemical Resistances

Safety

Electrical Properties







ENVIRONMENTAL PROTECTION

- The best argument for potting or encapsulation over traditional conformal coatings, is for the vast increase in environmental protection
- Allows for a more robust design
- Eliminate the threat of contamination by dirt, water, and debris.

THERMAL MANAGEMENT



Potting Epoxies and Polyurethanes allow for a greater rate of heat dissipation, due to an increase in thermal conductivities.



This allows for longer component lifespan, more efficient operation, greater power density. Studies on LED bulbs show that using materials with rough 1 w/m*K can overcome a temperature increase of 15%.

FILLERS AND EFFECTS

- Silica
- Mineral Fillers
- Viscosity increase
- Possible
 Abrasiveness



MODIFYING PERFORMANCE WITH FILLED POTTING/ENCAPSULANTS

Pros

- Increase flame resistance
- Increase moisture & chemical resistance
- Increase mechanical strength
- Increase thermal conductivities
- Reduce expansion rate Lower CTE
- Decrease exotherm and shrinkage

Cons

- Increase viscosity, air entrapment
- Possible abrasion of metering and mixing machines
- Storage filler settling

CURED PROPERTIES

- CTE What is it and how it effects the board
- Glass Transition Temperature Tg
- Shore Hardness
- Electrical properties

- Flammability
- Adhesion

ABOVE OR BELOW TG

- Above Tg
 - High expansion, flexible polymer
 - Less stress on components due to lower resistance

Below Tg

- Lower expansion, rigid polymer
- Aim to align expansion rate with other
- components to reduce stress



A look at the Polymer and how it moves... Tg & CTE

When the temperature is below the Tg of the material, the polymer is in a rigid/glassy state. Above the Tg, the polymer is in a flexible, elastomeric state.

CTE represents the expansion rate of the polymer. The expansion rate is 2 to 3 times higher above the Tg, compared to below the Tg. In applications that require extreme thermal shock or thermal cycling performance, the cured polymer will perform best if the Tg is outside the thermal operating temperature range

Epoxy systems can provide Tg's above the operating temperature range

Urethane & Silicones can provide Tg's below the operating temperature range In all cases filler in the polymer will decrease the expansion rate below and above the Tg. In many sensitive electronics, where a hard polymer is needed, it is best practice to use a material with a low CTE, to match well with the parts being potted.

PROCESSING

- Processing is an often-overlooked component of a successful potting system
- When not optimized for the material and application, improper processing can lead even the best formulated products to failure.
- Handling, mixing, pre-heating, dispensing, de-aeration, and cure temperature are keys to success

✓ Homogeneous mix ✓ Proper ratios \checkmark Cure schedule o Gel Time ○Viscosity ○ Filler content ○ Shrinkage



METER MIX MACHINES



Property	Ероху	Urethane	Silicone
ADHESION	XXX	XX-XXX	Х
PHYSICAL STRENGTH	XXX	XX	Х
ELASTOMERIC/RE-ENT	Х	XX	XXX
ABRASION RESIST	XX	XXX	Х
HIGH Tg	XXX	XX	Х
HIGH OPERATING TEMP	XX-XXX	Х	XXX
LOW OPERATING TEMP	Х	XX-XXX	XXX
CHEMICAL RESISTANCE	XXX	XX	Х
EXOTHERM	XXX	XX	Х
CONTROL CURE SPEED	Х	XXX	XX
COST	XX	X-XX	XXX

HOW THE THREE CHEMISTRIES DIFFER

X-LOW OR POOR XX-MODERATE XXX-HIGH OR GOOD

APPLICATION EXAMPLE: POTTING STRESS SENSITIVE ELECTRONICS

Performance Requirements	Ероху	Urethane	Silicone
Low temp4oc.			
Adhesion			
Flameout			
Heat & humidity			
Stress sensitive electronics			
Cost			

SUCCESSFUL MATERIAL: URETHANE

-LOW TG WITH IMPROVED HEAT & HUMIDITY PERFORMANCE -ADHESION OUTPERFORMED SILICONE

SUMMARY

Urethane Systems

- Suitable for many applications ranging from ultra soft, low Tg systems, to rigid +100c Tg systems.
- Able to fine tune cure speed in a thin layer or thick casting
- Good for low temperature, thermal cycle performance, and moisture resistance applications
- Cannot compete with silicones where high temp applications are continuously above 13oc.

<u>Epoxy Systems</u>

- Suitable for many industrial applications requiring high strength and/or chemical resistance and in physically demanding electrical applications
- Can formulate systems with low expansion and high Tg
- <u>Both</u>
- Formulate to resist UV degradation, meet UL, FDA, and strict regulatory compliance