EPOXY TECHNOLOGY

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Re-working, Removing, and "Decapsulating" Cured Epoxy

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"Epoxy adhesives ..... form strong bonds with high tensile strengths and resist solvents... can be highly rigid..."
- William E. Broxerman, Adhesives and Sealants Industry, Oct./Nov. 1996.

"Epoxies are usually noted for their chemical ... resistance. They are also rigid adhesives .... and tend to have higher temperature resistance ... than other organic adhesives."
- Roger J. Lohman, Adhesives and Sealants Industry, June/July. 1996.

The advantages which an epoxy provides in an adhesive application, can also act as its limitation in the sense of reworking, removing, or "decapsulating" the cured epoxy. This document lists several techniques which have shown to be effective in the process.

1. Chlorinated solvents will most aggressively attack the cured epoxy. They do require a good soaking to dissolve the material. We have had the best success with methylene chloride (di-chloro-methane). Our Applications Lab uses a product from the Miller Stephenson Chemical Co. (800-992-2424 Danbury, CT USA) called MS-111, which is about 85% by volume methylene chloride. Tri-chloro-ethane has also shown to be effective. Also, Dynaloy, Inc. (800-669-5709 Indianapolis, IN USA) offers unique chemical solutions, when encountering some very difficult situations where removal of cured epoxies is needed.

2. A warm solution of sulfuric acid dissolves the cured epoxy. This, like the chlorinated solvents, requires a good soaking. We have also seen groups decapsulating plastic packages by repeatedly dropping the acid on the top surface of the molding compound.

3. Other chemicals which have shown to be effective: toluene, NMP (n-methly-pyrollidone) and MEK (methyl-ethyl-ketone).

4 Combination of heat and pressure; Since epoxies are thermosetting resins, they have softening points (called glass transition temperature Tg) and not melting temperatures. By heating above the Tg, the material will soften, and its cohesive shear strength will significantly decline; allowing the epoxy to be de-bonded or pried away with some ease. The tip of a soldering iron can be used as the heating mechanism. It can be applied directly on the epoxy, or at the bond-line. When the adhesive becomes soft and "gummy", de-bonding can occur. Heating of the substrate using a hot plate is another common technique, as well as a box curing oven.

5 Temperature degradation of the epoxy; Most epoxies will simply decompose and turn to carbon ash at temperatures of 400°C. By heating the unit above the degradation temperature (Tdeg), the epoxy adhesive simply burns away.

6. Boiling water. "The limitations of epoxies usually include sensitivity to humidity with subsequent moisture absorption. (Roger J. Lohman, Adhesives and Sealants Industry, June/July. 1996.)" We have found that the epoxy, when exposed to boiling water for an hour or so, simply lifts away from the surfaces. Some prying action is needed, and this technique can vary widely depending on epoxy and bonding surfaces.

7. Thermal shock. Differences in expansion rates between the substrate, adhesive, and component can create joint separation and bond-line lift. Thus, by imposing severe thermal fatigue on the adhesive joint, de-bonding can be accomplished simply by the thermal-mechanical differences of adhesive and substrate.

Additional Notes

Where rework is necessary, special properties inherent in epoxies can be a big advantage over other adhesive methods. Most epoxies become quite plastic, and shear strength decreases drastically over 200°C. With any heated tool an X-Y stage (available with any eutectic die attach station), die can be removed easily without heating the entire substrate. With substrate temperatures of 60 to 70°C and tool temperatures of 250 to 300°C, the die may be sheared off with little physical force and no damage to the other hybrid circuit components. With modified epoxy dispensing station, we are able to remove a reject die, dispense epoxy and a place a new die in a single operation. If the need arises, substrates can be removed from a package with proper application of heat and shear force. The substrate can then be inserted into a new package with all the integrity of the original build. When documentation permits, die may be epoxied on top of a reject die and wired into the circuit facilitating rework without die removal. This method will greatly expedite the rework processes and will not degrade circuit integrity.

We realize that several of the techniques listed are destructive in nature, and can be suicidal in terms of re-usable parts for manufacturing. This document makes no attempt to suggest how manufactured parts can be saved or reclaimed. Its intention is to provide means of solving erroneously placed epoxy or components, and failure analysis.

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