TECH TIP 09

EPOXY TECHNOLOGY

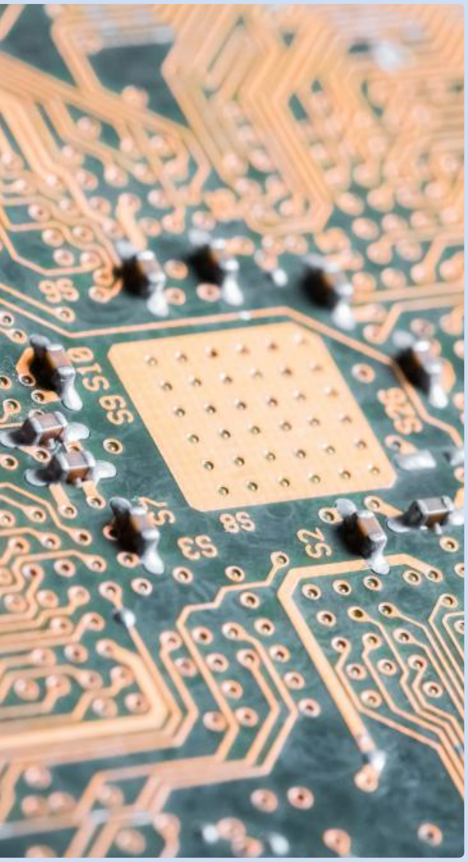
UV Cure Adhesives – Tips, Tricks & Troubleshooting

WHAT

Removing Cured Epoxy

WHY

There are several techniques which have shown to be effective tools in removing cured epoxy from substrates.



UV curing adhesives offer a convenient way to quickly cure a product in specific applications. These types of chemistries offer two fundamentally different cure mechanisms, cationic or free radical, with varying cure parameters as well as end properties.

Cationic UV Systems

For cationic UV cure products, ionic polymerization is initiated by photo generated ions and cure in minutes rather than seconds. Many are also capable of a thermal cure as well as UV cure; also called a dual-cure system. Generally they have the benefits of less shrinkage and higher adhesion over free radical cured systems, and are not adversely impacted by an oxygen rich curing environ- ment. However, they do have a few charac- teristics that are important to point out:

01 **CURE SPEED:** Complete cure of cationic systems is very dependent on thickness. The thicker the layer, the longer the required cure time will be. Warming the material before cure or curing under warm conditions (including lamps that generate large amounts of heat during cure) may increase cure speed by increasing the mobility of the molecules.

02 **SKIN-OVER:** It may be necessary to reduce the intensity of the lamp while increasing the time to cure through thick layers. If the surface of a thick layer is subjected to high intensity irradiation, it will quickly form a high crosslink density making a hard skin or barrier that prevents subsequent light from passing through to deeper layers of the bond line. Note: Moving the lamp farther away from the part is a good option to reduce the UV intensity if the lamp does not have a tunable intensity.

03 **MOISTURE SENSITIVITY:** The photo-initiators in cationic systems are acidic. As a result, both moisture and bases can neutralize them. It is not recommended that cationic systems be cured in humid environments (>70%RH). Higher irradiation energy or a higher temperature may be able to overcome the effects of humidity in some cases. An interesting note is that small amounts of moisture (30-60%) can actually increase the cure speed.

04 **MECHANICAL PROPERTIES:** The ultimate mechanical properties of cationic cured systems are generally very good. However, due to the slow nature of the cationic cure mechanism, these systems will continue crosslinking long after the UV irradiation is removed and complete. Generally, waiting 24 hours after cure to measure the full mechanical properties of cationic systems is a good rule of thumb.

05 **POST-CURE:** A thermal post-cure will often shorten the time needed for a cationic system to reach full degree of cure conversion and can often improve mechanical and physical properties of the material. In addition, a thermal post-cure can be used to cure areas of the material that were not exposed to the UV irradiation during processing (shadow areas, etc.).

06 **STRESS:** Cationic systems generally have less shrinkage and lower stress than free radical systems. Curing at lower intensities may reduce shrinkage and stress further.

Free Radical UV Systems

Free radical cure systems are most noted for their very rapid cure – seconds rather than minutes. This is made possible by the chain reaction curing mechanism set off by the decomposition of the photo-initiator into free radicals upon exposure to UV light. Here are a few characteristics that are worth highlighting:

01 **CURE SPEED:** Due to the very fast cure speed, free radical cure systems have generally reached close to their full degree of conversion/cross-linking very soon after the UV irradiation is complete. Normally there is no need to wait for the material to rest after cure before testing mechanical properties as with cationic cure systems.

02 **OXYGEN INHIBITION:** The major pitfall for free radical cure systems is oxygen inhibition. The presence of oxygen in the curing environment can actually quench both the activated photo-initiator radicals as well as the growing chains. This can lead to short chain segments, resulting in tacky surface layers and poor mechanical and physical properties. Adhesives are less prone to oxygen inhibition than coatings due to the fact that the substrates on either side of an adhesive sandwich act to isolate the adhesive from oxygen in the atmosphere. Higher cure speeds can also lessen the impact of inhibition as faster chain formation allows the polymerization to proceed to completion faster than the quenching can occur. Finally, curing in a nitrogen-rich environment can help to eliminate oxygen inhibition in the most persistent cases.

03 **POST CURE:** While a thermal post cure will not harm free radical systems, it does not benefit them either. The free radical mechanism cannot be initiated by heat. As a result, shadow curing is not possible with free radical materials.

EPOXY TECHNOLOGY INC.
14 Fortune Drive • Billerica, MA 01821
978-667-3805
techserv@epotek.com
www.epotek.com