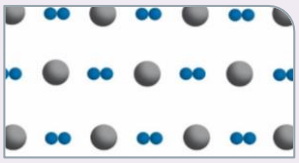
Dual-Cure Light/Moisture-Cure Conformal Coating Technology

Dymax dual-cure conformal coatings offer a green, 100% solids alternative to solvated coatings. These thin protective coatings provide environmental protection without adding excessive cost or weight to the printed circuit board (PCB). They are easily applied, typically by spray dispensing, and cure with UV/Visible light. The shape and complexity of the board, as well as the thickness of the conformal coating, will influence cure times, but typically light cure is very fast and happens in just seconds.

Dual-cure conformal coatings are also formulated with a secondary moisture-cure feature to ensure complete cure in applications where shadow areas on high-density circuit boards are a concern. Shadow areas are the areas beneath components where a conformal coating may flow, and relative to light curing, may not be exposed to the curing light from above. If this is the case, it is important to have a secondary cure mechanism.

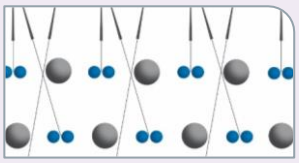
The Light-Curing Process

The light-curing process is a 4-step process:



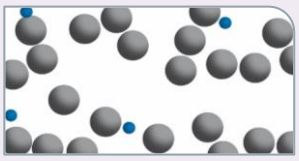
1. Liquid "unreacted" state

The light-curable material is in the unreacted state on the PCB.



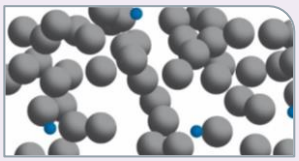
2. Photoinitiators generate free radicals

The curing process begins. This happens when the photoinitiator in the conformal coating is exposed to the energy source (light-curing lamp) of the proper spectral output and intensity. It excites and fragments photoinitiators, resulting in the generation of free radicals.



3. Polymer propagation

The free radicals begin to attach themselves to the acrylates that make up the light-curable conformal coating which results in polymeric chain radicals. This process is repeated until all radicals are attached.



4. Polymer termination

Polymer termination or basically cured material

While moisture cure typically occurs over 2-3 days at 25°C [77°F], 50% RH, actual moisture-cure time is application specific and my vary. Cure time is dependent on humidity level, amount of coating in shadow areas, and proximity of shadowed coating to humidity. Coating trapped under large components may have a prolonged cure time. Exposure to heat (typically 65° - 80°C) and higher humidity will accelerate cure. This aspect of the curing process is dependent on moisture reaching the shadow areas.

The images below show a PCB that was coated with a Dymax dual-cure conformal coating. Figure 1 shows the PCB component just after light cure. Figure 2 shows the area five minutes after light cure. The component was removed to inspect the shadow area beneath. The coating in this area was completely wet. 1 day later, as seen in Figure 3, moisture cure was in progress and the coating was soft but still wet.

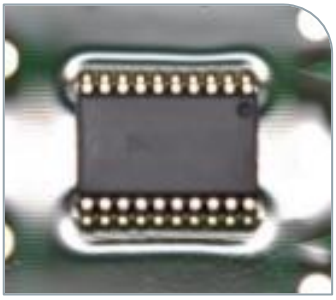


Figure 1. After UV Cure

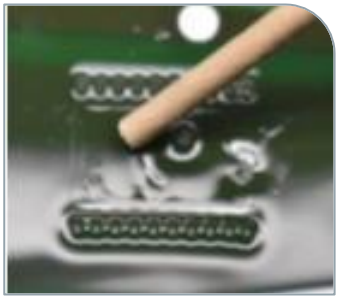


Figure 2. Control (5 minutes after cure)
Adhesive under component was completely wet



Figure 3. Day 1 at Room Temperature
Adhesive under component was soft and had a wet surface

Below are images of the moisture-cure process over 7 days at room temperature. The PCB with a component was sprayed with conformal coating and UV light cured. Each day the component was removed from the board to show the progression of the moisture-cure process. As the material cured, it became more difficult to separate the component from the coated board. The bond strength between the component and the coating increased daily.

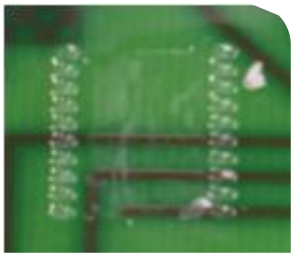


Figure 4. Day 1 at RT
Adhesive under the component was soft with a wet surface.

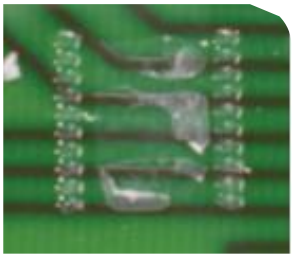


Figure 5. Day 3 at RT
Adhesive under the component was soft with a wet surface.

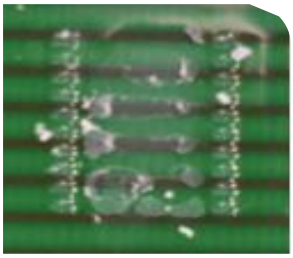


Figure 6. Day 5 at RT
Adhesive under the component was soft with a waxy surface.

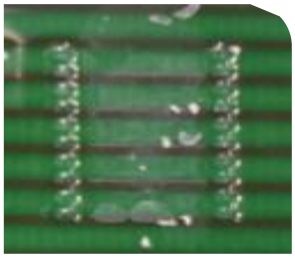
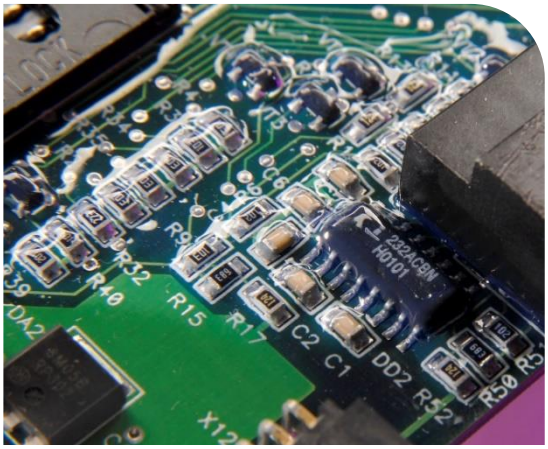


Figure 7. Day 7 at RT
Adhesive under the component was firm and tack-free.

Summary

Dymax dual-cure conformal coatings are an excellent option for manufacturers searching to replace their solvent-based process with a greener, more efficient process. These 100% solids conformal coatings cure on-demand with UV/Visible light and feature secondary ambient moisture cure, eliminating the need for a second process step and concerns of component life degradation due to temperature exposure if using heat cure. Coated PCBs can proceed to the next step of the assembly process immediately after light cure and not hold up the production process while the ambient moisture cure progresses.



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