

## Application bulletin

# DOWSIL™ Conformal Coatings in LED lighting applications

### Introduction

There has been a large amount of activity and discussion regarding protection of LEDs and their associated electronics from their application environments. Conformal coatings can be one of the protection strategies for these devices, though manufacturers recommend that the LEDs themselves not be coated. In spite of this recommendation, many LEDs are coated rather than incur the additional cost of masking them during the coating process or using an automated dispense pattern that excludes each LED. Two questions are raised as a result of this situation:

1. Do conformal coatings from Dow cause a color shift in light emitted from the LED?
2. Do conformal coatings from Dow reduce the LED's light output?

A variety of DOWSIL™ conformal coatings that contained UV indicator were tested directly over the LEDs. After coating, the LEDs were run for more than 2,000 hours and measured periodically. This report outlines those tests.

### Discussion

As the use of LEDs has expanded, the variety of environments to which they are exposed also continues to increase. This environmental exposure is not only to the LED but also to the electronics used to drive and control them. These environments are not unlike those in which electronics have had to function for years, and the same protection strategies will also, in general, work for LEDs and associated devices. This is becoming even more critical as an increasing number of LEDs and controls are packed into smaller and smaller packages.

One of the environmental protection strategies has been to conformally coat the LED board and associated electronics. Ideally, the LED itself would not be coated since this can affect the performance of the device. Anything placed over an LED has the potential for a change in light output, light scattering and color shift. From a practical standpoint, it is sometimes time prohibitive to protect every LED from being coated during the coating process. As a result, oftentimes, the entire assembly including the LEDs is conformally coated.

To quantify the effect of Dow conformal coatings over LEDs, a study was conducted comparing several coatings and the performance of the LED in use.

The specific coatings tested were:

- DOWSIL™ 1-2620 Low VOC Conformal Coating: A spray application which utilizes DOWSIL™ OS-20 Fluid as a solvent vs. the traditional organic solvent — an elastoplastic RTV coating
- DOWSIL™ 3-1953 Conformal Coating: A moisture cure solventless coating
- DOWSIL™ 1-4105 Conformal Coating: A heat cure solventless coating

It is necessary to check compatibility of any material used in the proximity of the LED. Materials that outgas or bleed certain compounds can cause the LEDs to darken and lose output in service. Manufacturers such as Cree have compiled a list of materials that may be used near the LED. DOWSIL™ conformal coatings are included on this listing. Among these are DOWSIL 1-2620 Low VOC Conformal Coating, DOWSIL 3-1953 Conformal Coating and DOWSIL 1-4105 Conformal Coating.

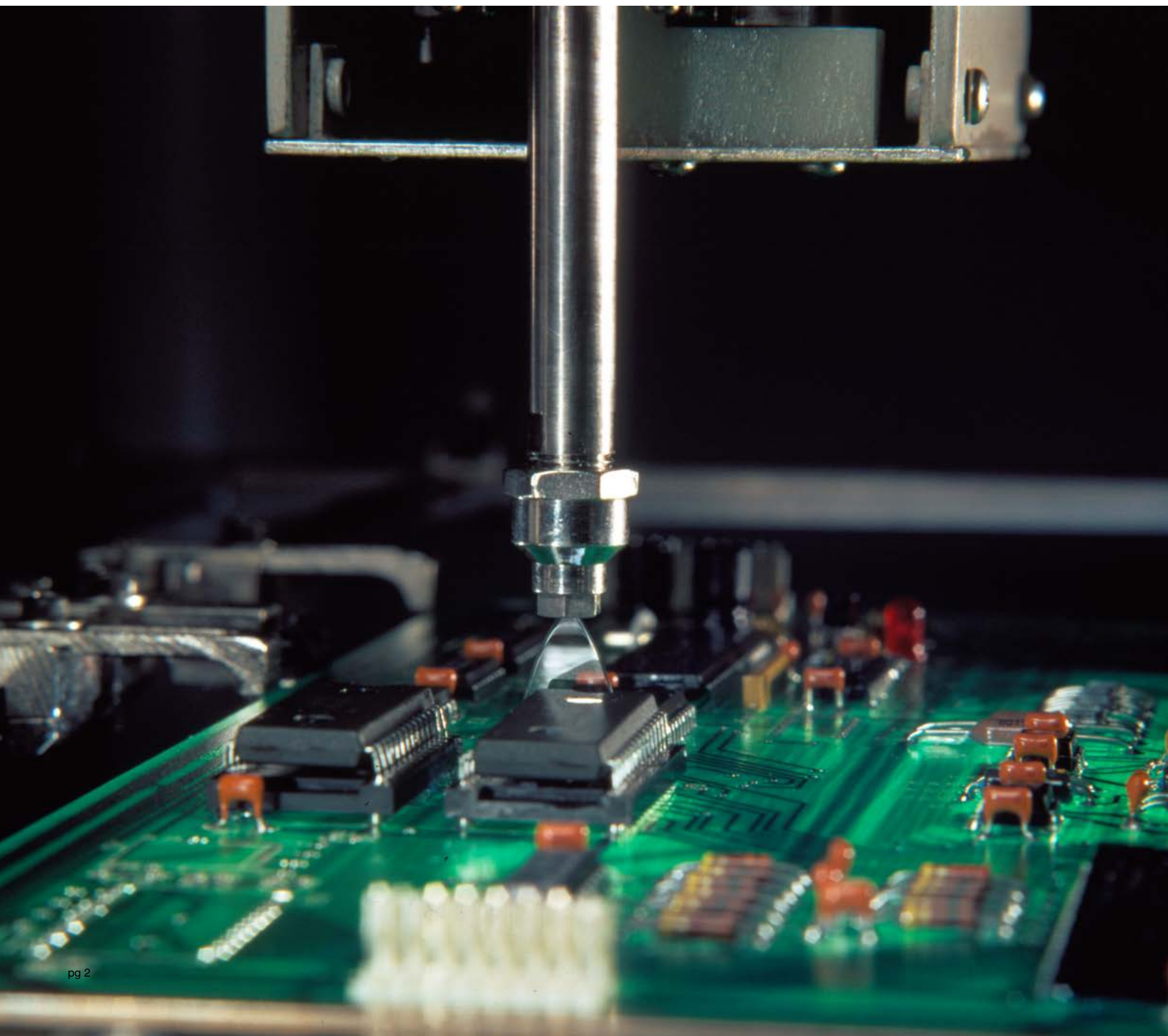


## Experimental

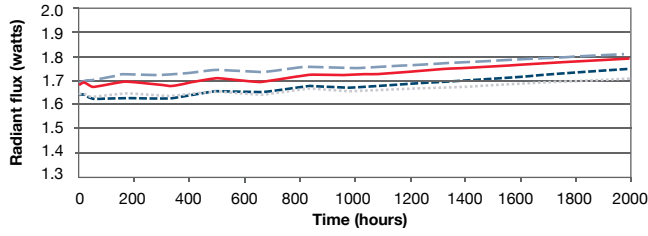
- A series of royal blue and cool white LED products were obtained and mounted to LED heat sinks with a custom made heat sink to LED adapter (aluminum) using DOWSIL™ 1-4173 Thermally Conductive Adhesive and screws to temporarily hold the boards in place while the thermal adhesive cured.
- Adhesive cure was done in a convection oven at 100°C for 1.5 hours. The screws were then removed and the boards were spray coated with between three and five mils of each of the conformal coatings. Six of each royal blue and cool white LEDs were coated with each of the conformal coatings. During burn-in, two of the royal blue LEDs failed.
- Due to undersized heat sinks and excess current, the LEDs ran at higher than normal temperatures — with nearly 100°C

measured on the face. This excess heat, in combination with the light flux, was considered to be an accelerated aging condition.

- Light output measurements were then made at 0 hours uncoated, 0, 24, 48, 168, 336, 504, 672, 840, 1,008 and 2,000 hours using a 20" Labsphere HalfMoon Integrating Sphere with Labsphere CDS-1100 Spectrometer from 350 nm to 850 nm.
- Note that most of the LEDs saw a significant increase in light output between 0 hours uncoated and the next couple of readings. It is felt this is most likely due to the burn-in period, which can sometimes be seen on LEDs. During that period, the color shifts slightly and the output can sometimes increase to its long term steady level. Overdriving the LEDs as hard as this test does may contribute to this initial burn-in increase.

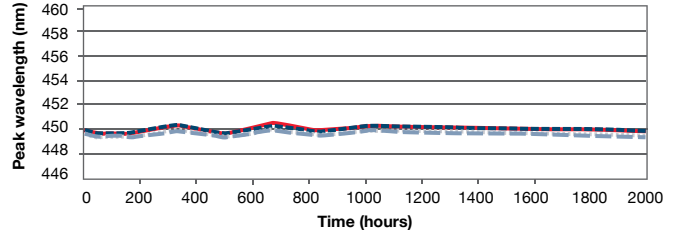


### DOWSIL™ Conformal Coatings effect on royal blue radiant flux



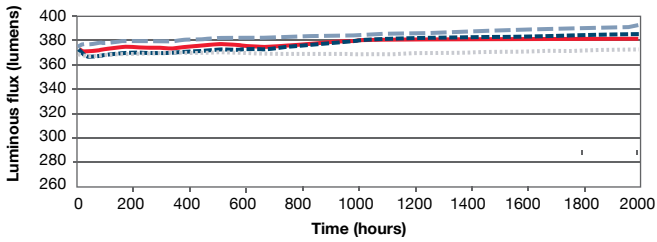
All show some increase on LOP on startup and burn-in. While there is a slight upward trend in light output with time for all coatings, it is probably within the measurement error of the equipment. None of the coatings seem to affect te blue LEDs appreciably.

### DOWSIL™ Conformal Coatings effect on peak wavelength



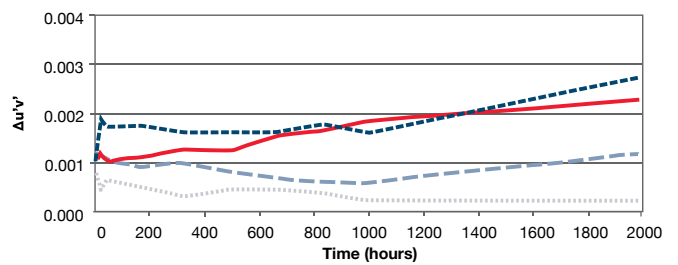
None of the coatings effect the peak emission wavelength at onset or over time.

### DOWSIL™ Conformal Coatings effect on cool white luminous flux



All show some increase in light output with burn-in and have little to no effect on total light output.

### DOWSIL™ Conformal Coatings effect on Δu'v' color shift



All, including the controls, show the burn-in color shift.

#### KEY:

- DOWSIL™ 1-2620 Low VOC Conformal Coating
- ..... DOWSIL™ 1-4105 Conformal Coating
- - - DOWSIL™ 3-1953 Conformal Coating
- · - · Control

## Summary

LEDs — with or without coatings — show minor changes in radiant and luminous flux, peak emission wavelength and color shift as a result of the burn-in period. Testing results show that DOWSIL™ conformal coatings have little or no additional effect on light output, peak emission wavelength or color shift after 2,000 hours of use.

## Learn more

We bring more than just an industry-leading portfolio of advanced silicone-based materials. As your dedicated innovation leader, we bring proven process and application expertise, a network of technical experts, a reliable global supply base and world-class customer service.

To find out how we can support your applications, visit [dow.com/lighting](https://www.dow.com/lighting).



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