

# Failure Analysis of LEDs

Paper Prepared by: SEM Lab, Inc.

425.335.4400 [info@semlab.com](mailto:info@semlab.com)

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A significant number of intermittent LEDs have been analyzed in this laboratory.

The figures on the following pages illustrate various failure modes that resulted in the intermittent conditions. These conditions include die attach failure, die cracking, wedge bond failure and ball bond failure. In most cases, these failures are induced by mechanical or thermo-mechanical stresses.

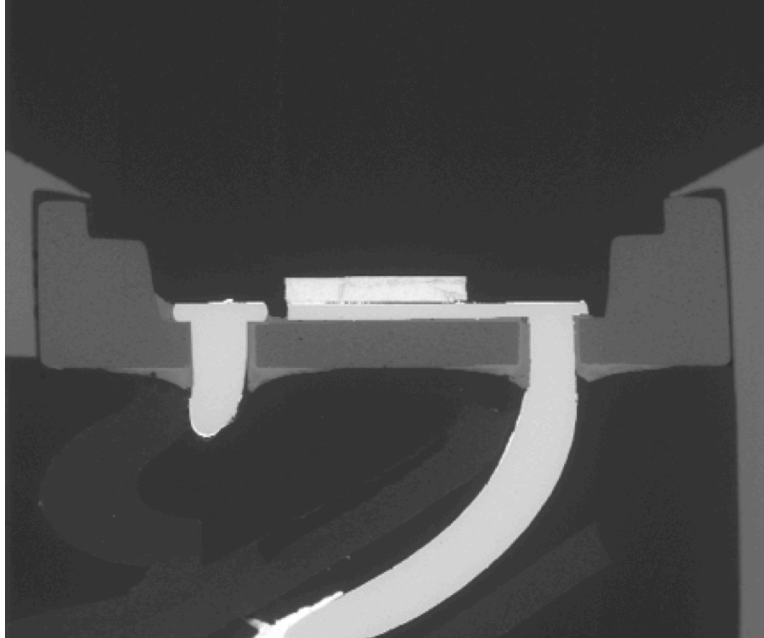


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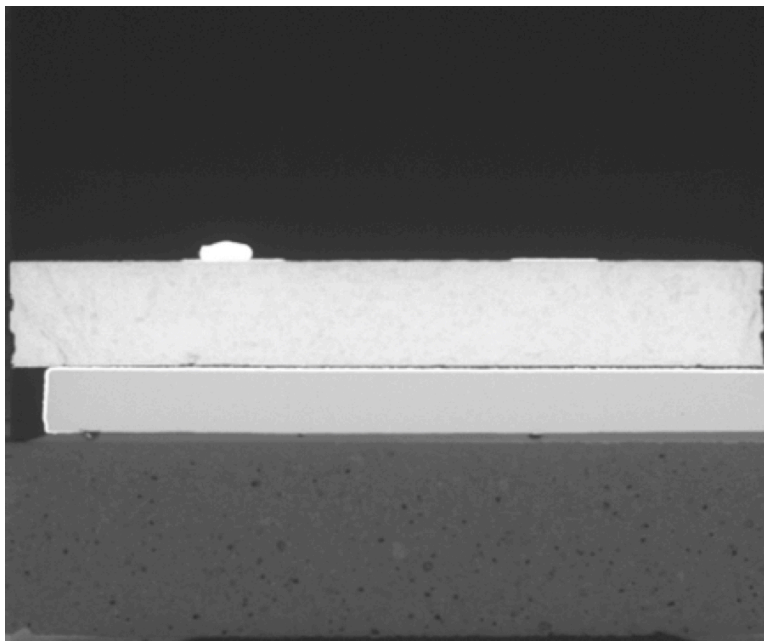
Edward Hare, PhD

[ehare@semlab.com](mailto:ehare@semlab.com)

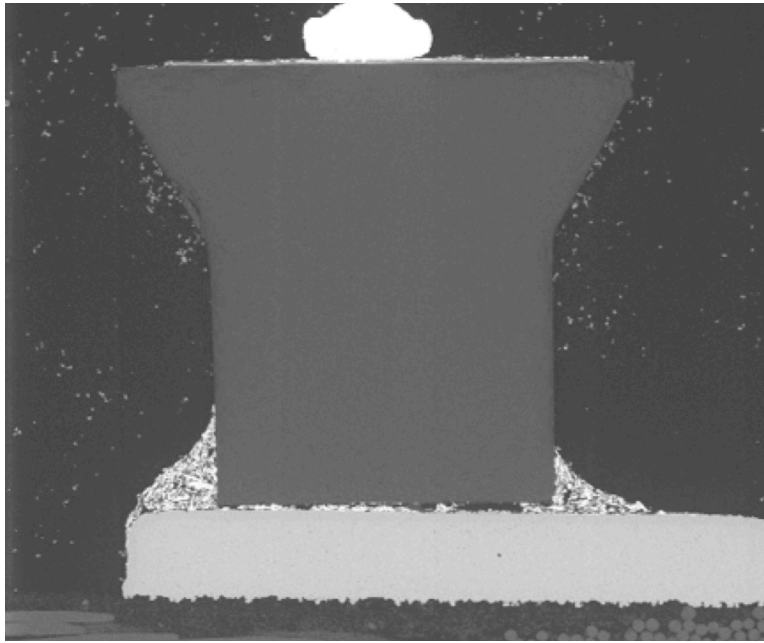
425.335.4400



*Figure 1: This is a custom LED package. There is significant lead (bending) strain and associated damage to the glass feed-through seals. This caused the die attach to fail. [12X, ref. 926A\_7]*



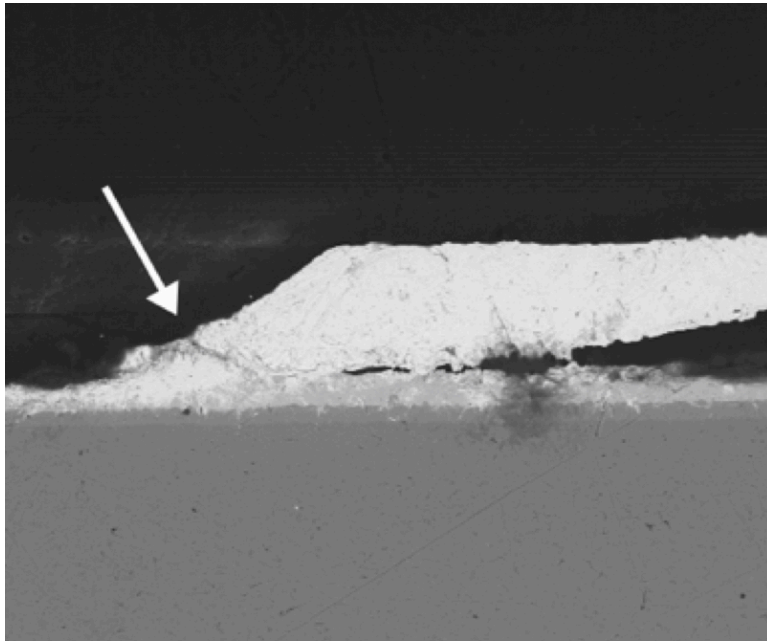
*Figure 2: The die attach failed due to mechanical stress caused by a lead bending operation. [45X ref. 926A\_2]*



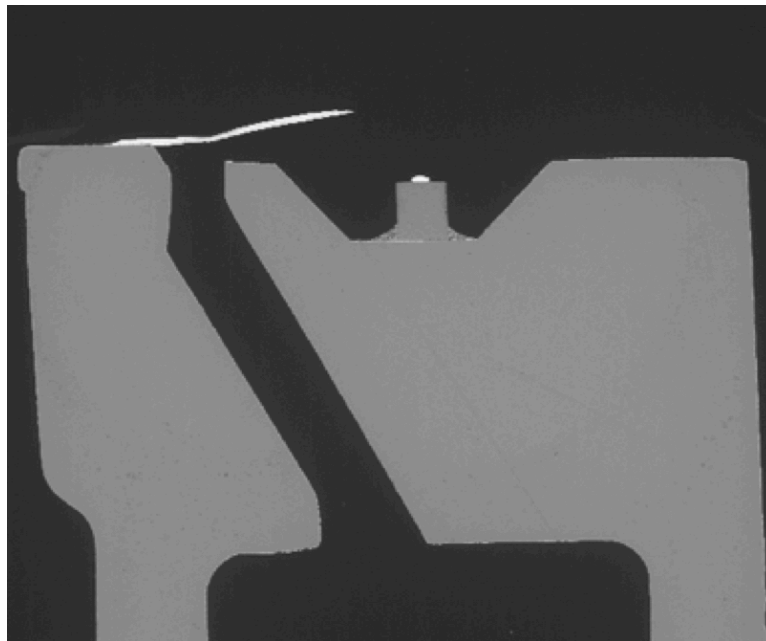
*Figure 3: This LED exhibited degraded brightness after humidity and rapid decompression testing. It shows damage to the die/die-attach interface. [ref. IFN 736B\_5]*



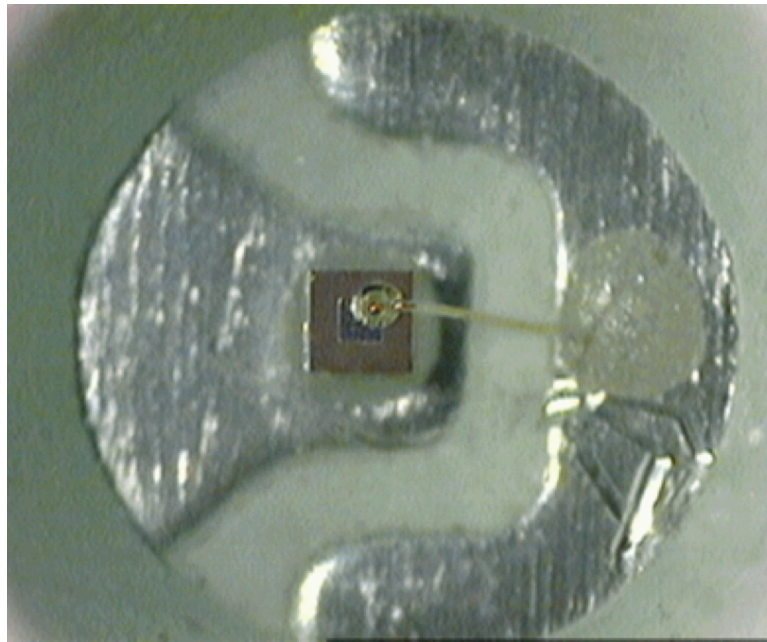
*Figure 4: This is a bright-field optical image showing a broken bond wire at the wedge bond. [96X ref. 245AO\_6]*



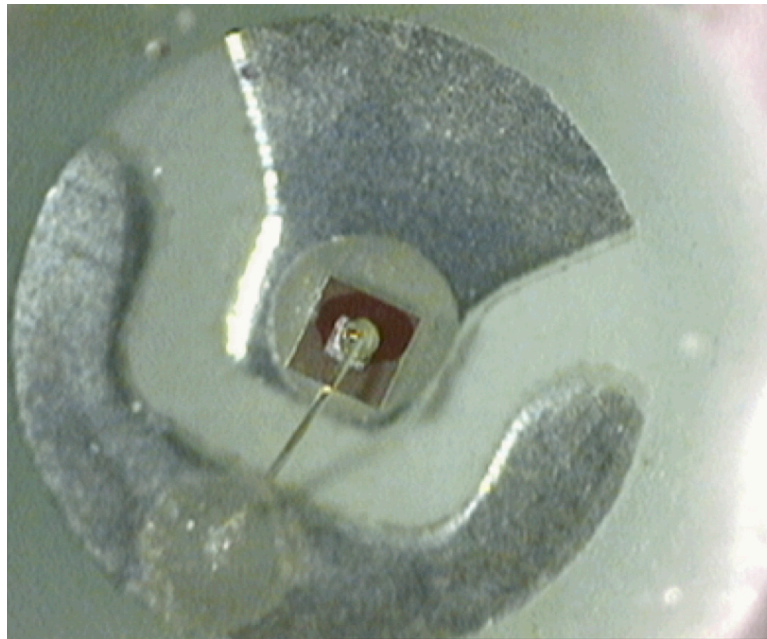
*Figure 5: The wire bond apparently failed in shear at the heel of the wedge bond. The crack is very fine and is held together by the lens material. This explains the intermittent nature of the failure. [405X ref. 140\_2]*



*Figure 6: This BSE SEM image shows the LED construction including the geometry of the die, die cup and post. [21X ref. 140\_5]*

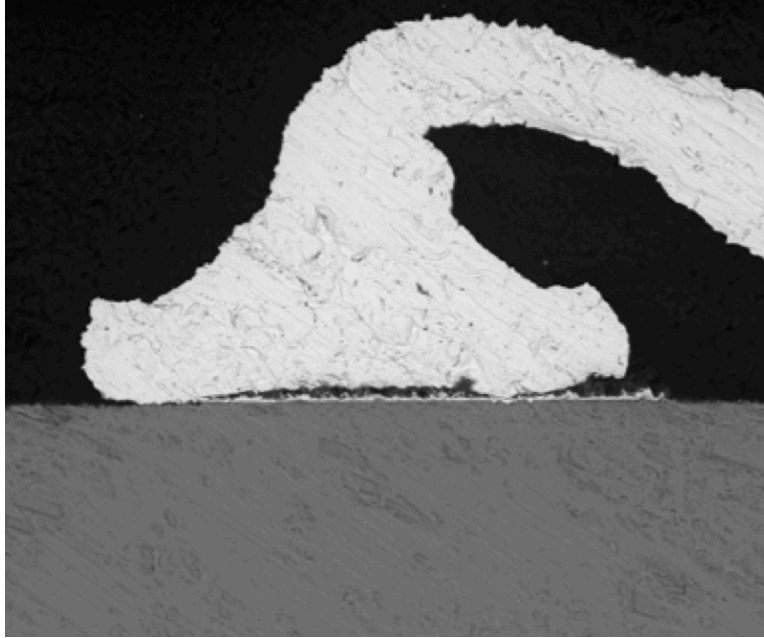


*Figure 7: Here the bond alignment to the pad is poor. The probe marks on the post (right) suggest that a problem was identified prior to encapsulation. [28X ref. 186O\_3]*

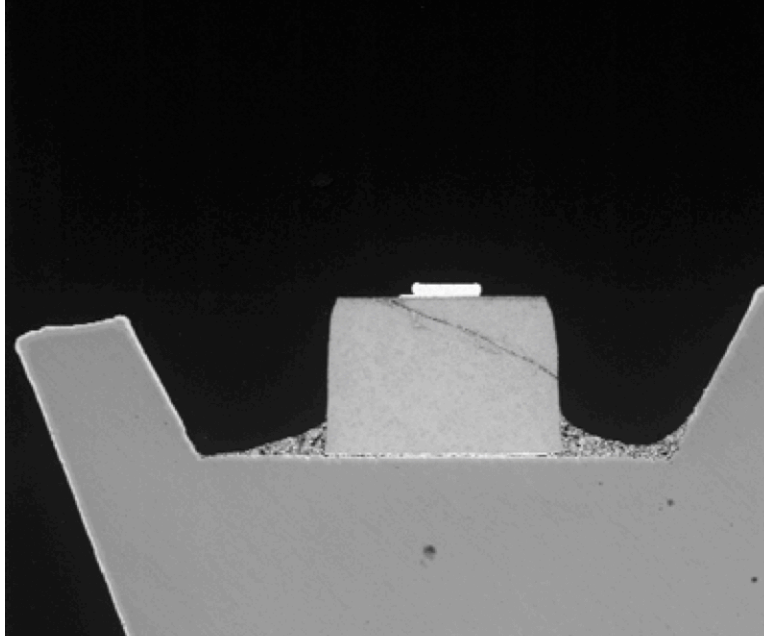


*Figure 8: This LED was verified as dim on the test fixture. The dark area on the die surface is an area of delamination of the encapsulant from the die. The delamination is evidence of displacement and is likely related to a high resistance bond. [28X ref. 186O\_4]*

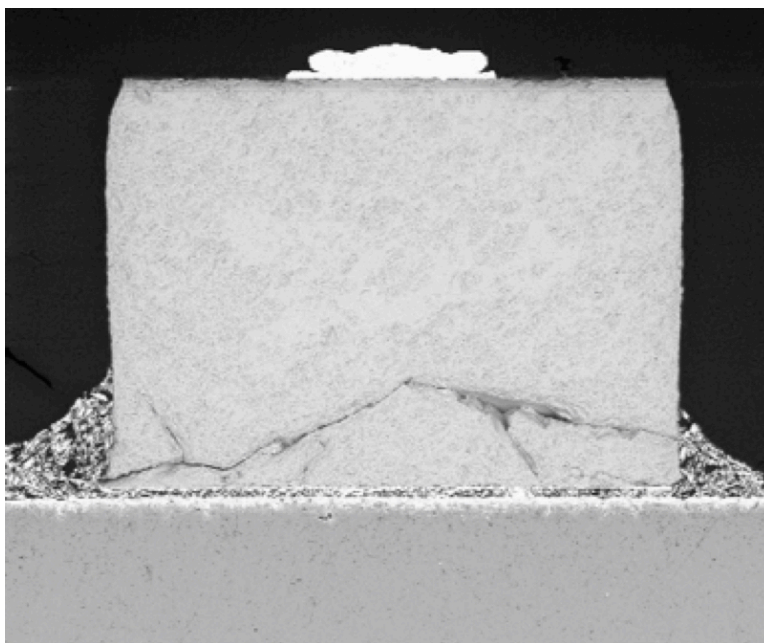




*Figure 9: This is a high magnification view of a ball bond failure caused by delamination of the encapsulant from the die surface. [405X ref. 201C\_1]*



*Figure 10: This is a SEM image of the sectioned LED. A large die crack was the cause of this intermittent failure. [65X ref. 220B\_1]*



*Figure 11: These die cracks are the cause of the intermittent LED failure. [162X ref. 305A\_2]*