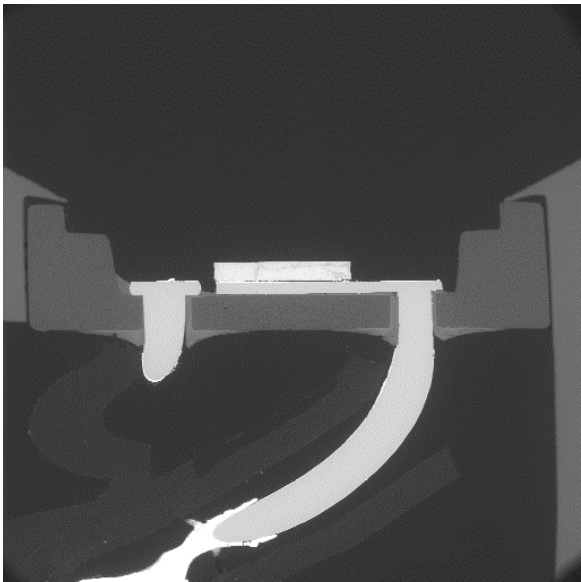


## Failure Analysis of LEDs

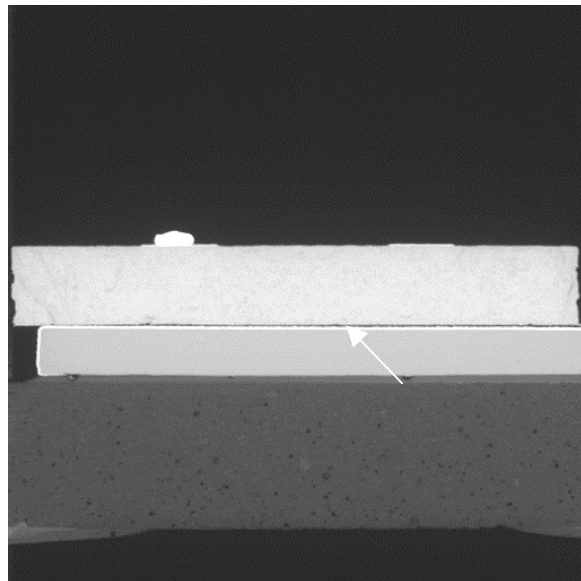
Ed Hare, Ph.D.  
October 15, 2004

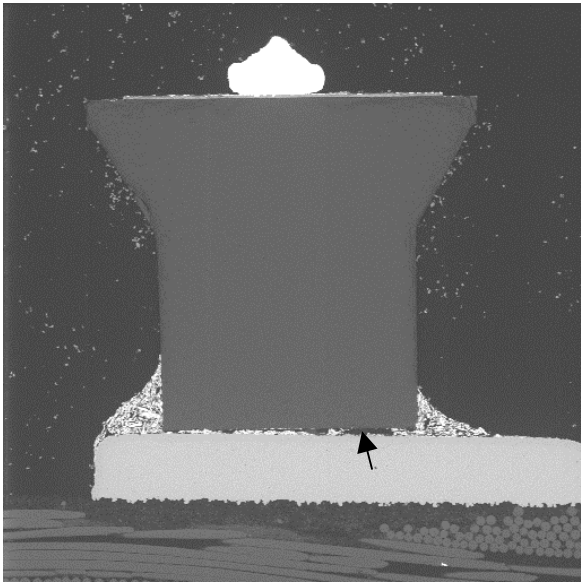
A significant number of intermittent LEDs have been analyzed in this laboratory. The following figures illustrate various failure modes that resulted in the intermittent conditions. These conditions include die attach failure, die cracking, wedge bond failure and ball bond failure. In most cases, these failures are induced by mechanical or thermal-mechanical stresses.



[12X, ref. 926A\_7] 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.

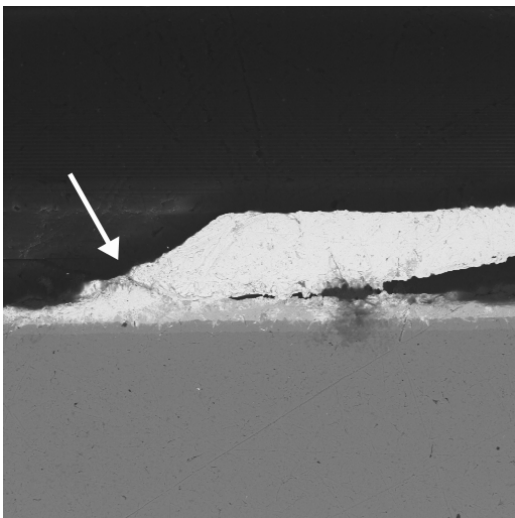
[45X ref. 926A\_2] The die attach failed due to mechanical stress caused by a lead bending operation.





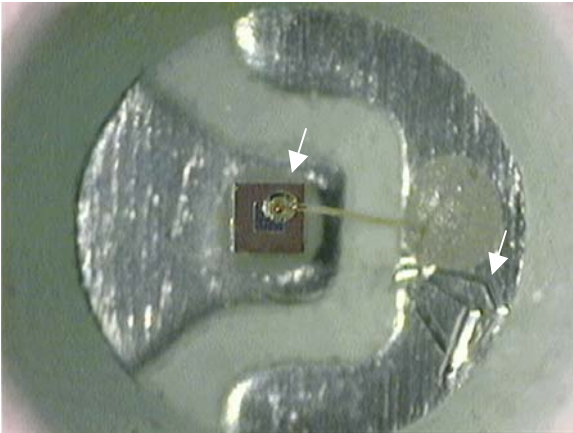
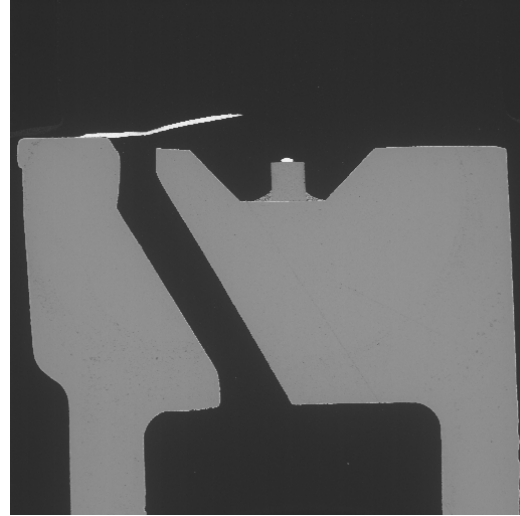
[ref. IFN 736B\_5] This LED exhibited degraded brightness after humidity and rapid decompression testing. It shows damage to the die/die-attach interface.

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



[405X ref. 140\_2] 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.

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

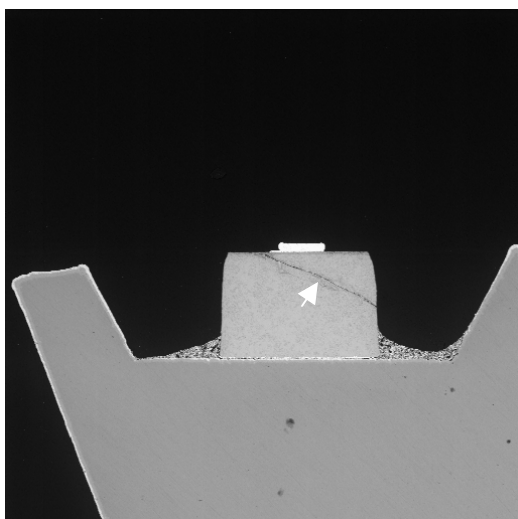
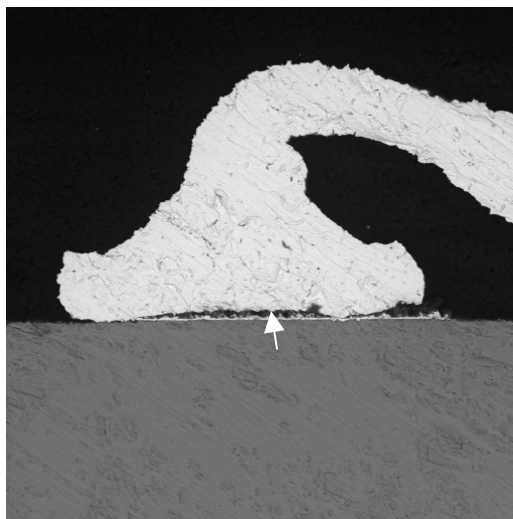


[28X ref. 186O\_3] Here the bond alignment to the pad is poor. The probe marks on the post (right) suggest that a problem was identified prior to encapsulation.

[28X ref. 186O\_4] 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.



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



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

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

