

Non-destructive evaluation of a memory module from incident CEN20FA093

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Overview

- One module received for analysis
 - Incident id: CEN20FA093
 - The memory module could not be read
 - Sent to Binghamton to evaluate the chip
- Non-destructive evaluation techniques:
 - Initial inspection with optical stereo microscope
 - 2D X-ray Imaging with Phoenix Nanome|x
 - Acoustic microscopy using 100 MHz transducer.
- Results
 - Optical inspection revealed multiple cracks on the back side and a long thin crack on the front side of the module.
 - Side view showed one of the cracks to have propagated along the package thickness, and that the package is slightly bent.
 - X-ray imaging revealed that the memory module consists of a wire-bonded, rectangular die with a leadframe.
 - Package cracks could be easily discerned in the x-ray images. They also revealed possible cracks in the die. No anomalies were detected in any wire bonds. There were inhomogeneities in the die-attach.
 - X-ray images from the side showed a slight bowing of the package
 - Acoustic images show cracks in the silicon die, mold as well as the leadframe. Voids and delaminations were detected in the die attach.
- Conclusion: No data recovery is possible due to cracks in the Silicon die. This module can not be repaired.

OPTICAL INSPECTION

Front-side of the module



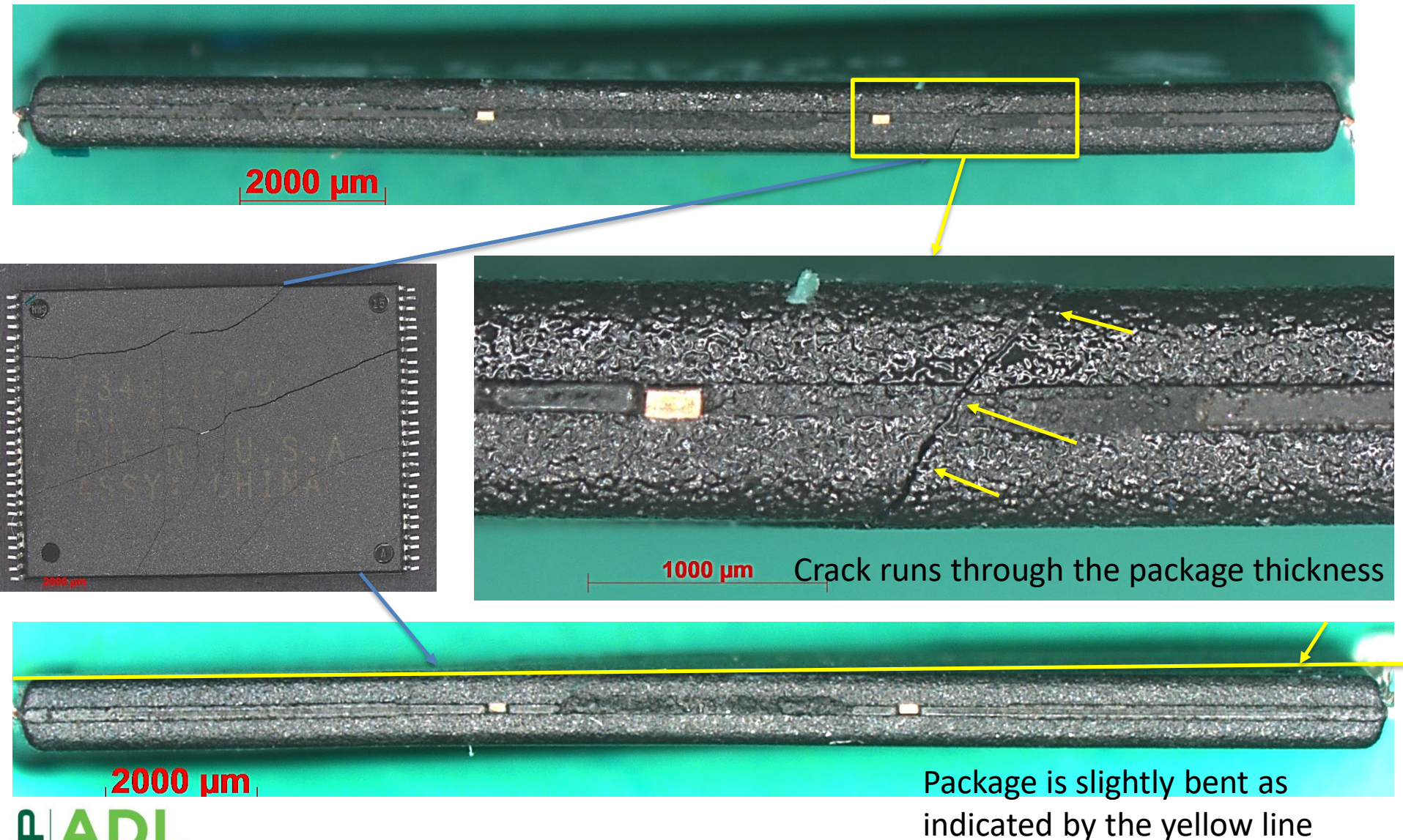
Module has a long thin crack in its front side

Backside of the module



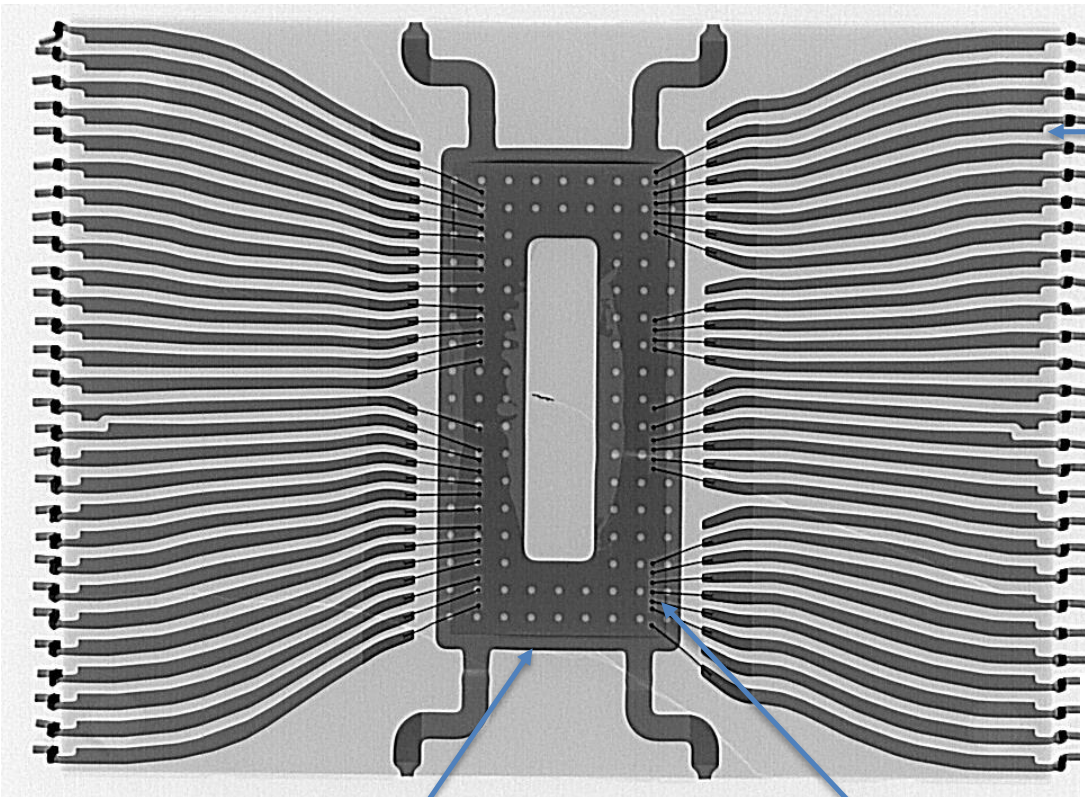
Package is severely cracked from its back side

Side views of the module



X-RAY INSPECTION

X-ray image of the module

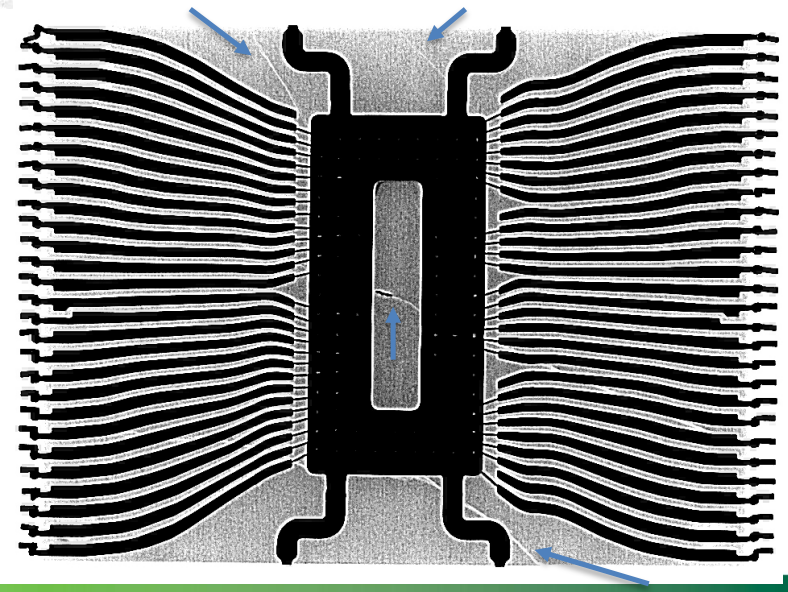


Leadframe

Lead frame
with die paddle

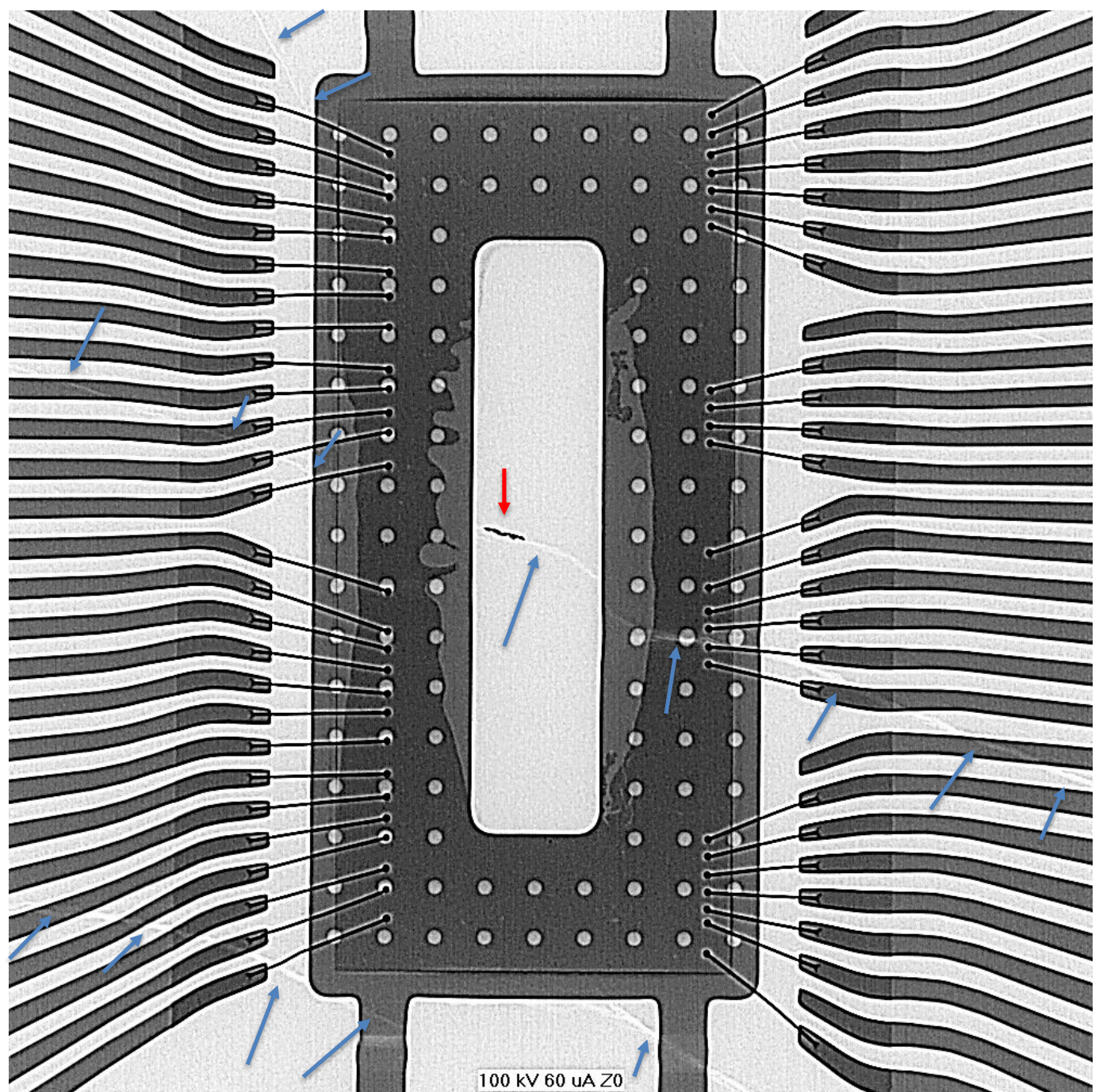
Die with
wirebonds

The image below with adjusted
contrast shows package cracks



The package has a die with
wirebonds on two sides

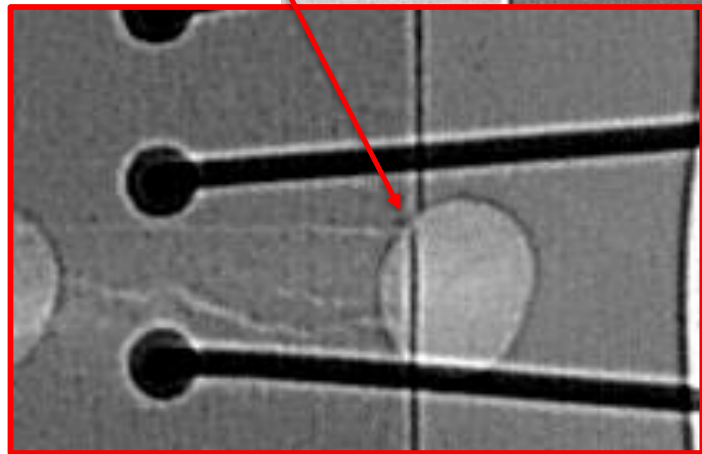
- Multiple cracks in package shown with blue arrows
- Some cracks pass through the die area
- The die attach shows inhomogeneities such as voids
- Some kind of metal debris is trapped in the crack in the middle (red arrow)



Wire bonds look OK

Blue arrows pointing to
cracks in the package

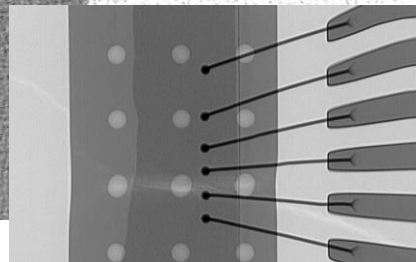
Possible cracks in the die as
indicated by shift in its edge



Wire bonds look OK

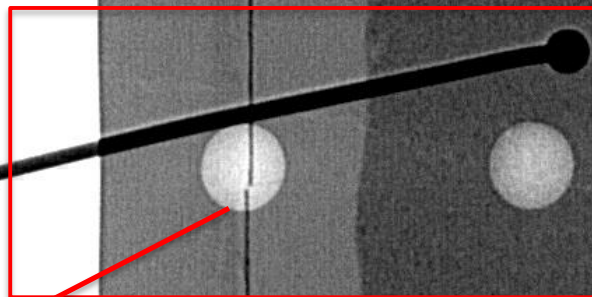
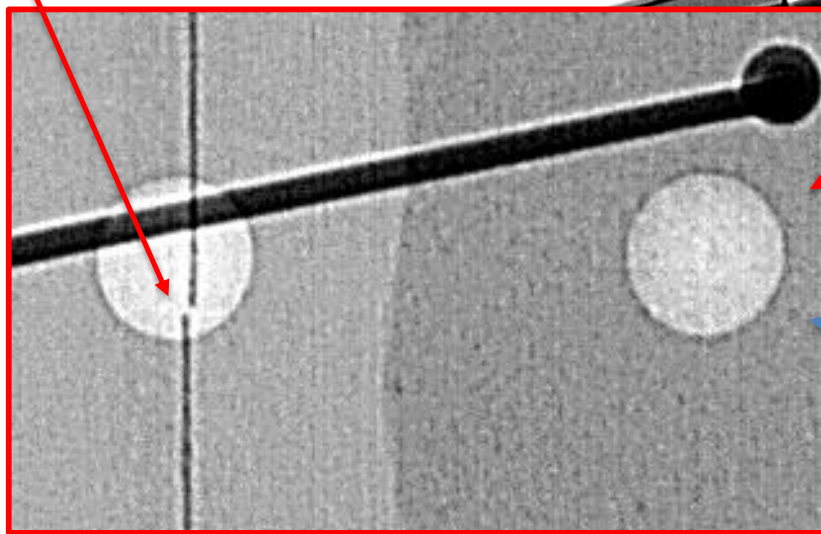
Possible cracks in the die as indicated by shift in its edge

Oblique view of the area in the inset



wire bonds looks OK

Possible cracks in the die as indicated by shift in its edge



100 kV 60 uA Z0

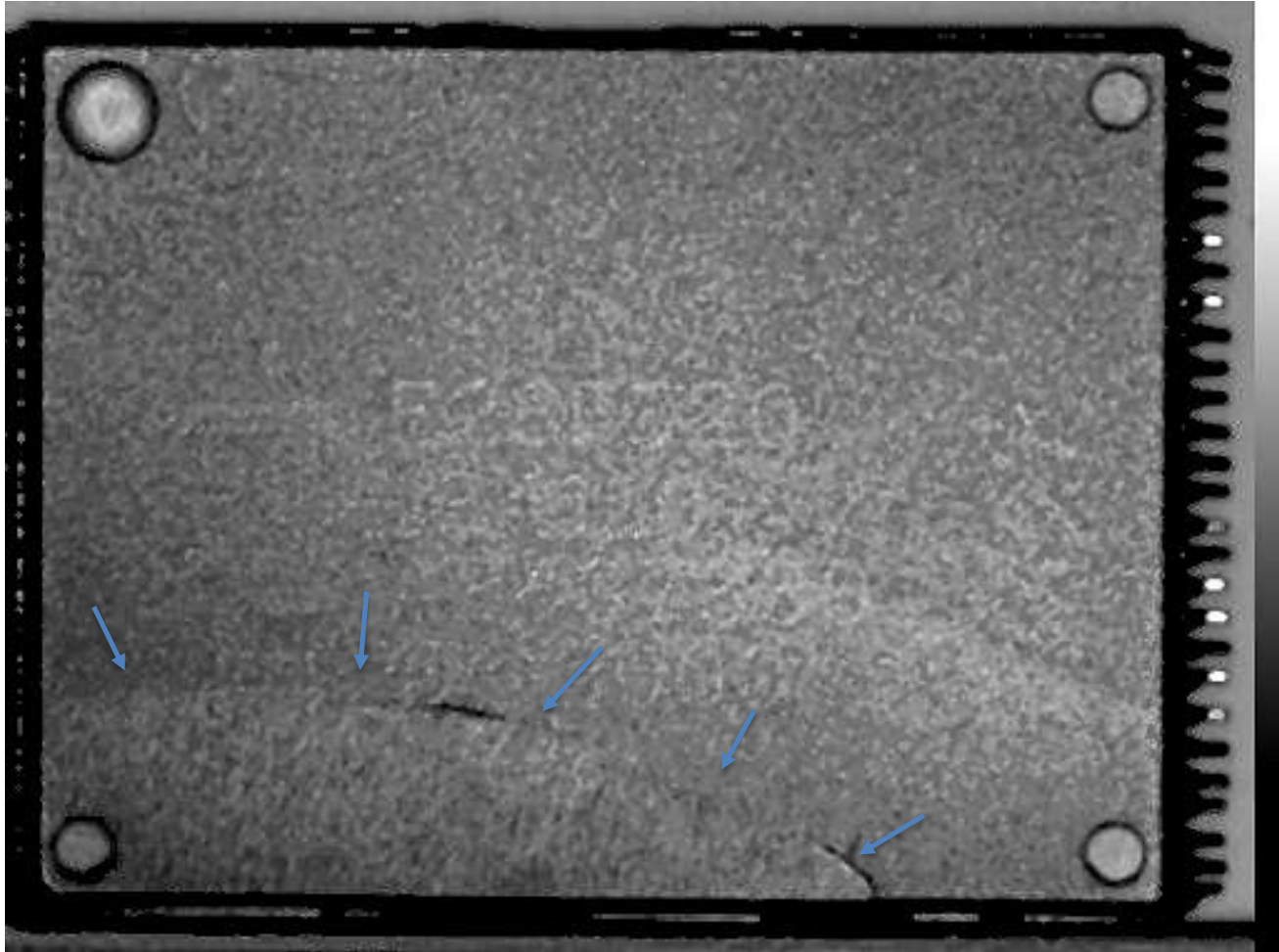
Side view of the module



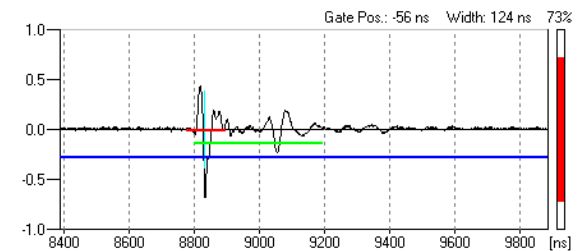
Side view of the package shows that it is bent.

ACOUSTIC MICROSCOPY (C-SAM) IMAGES

Top surface of the module



C-SAM image from the top surface shows a long crack in the mold surface

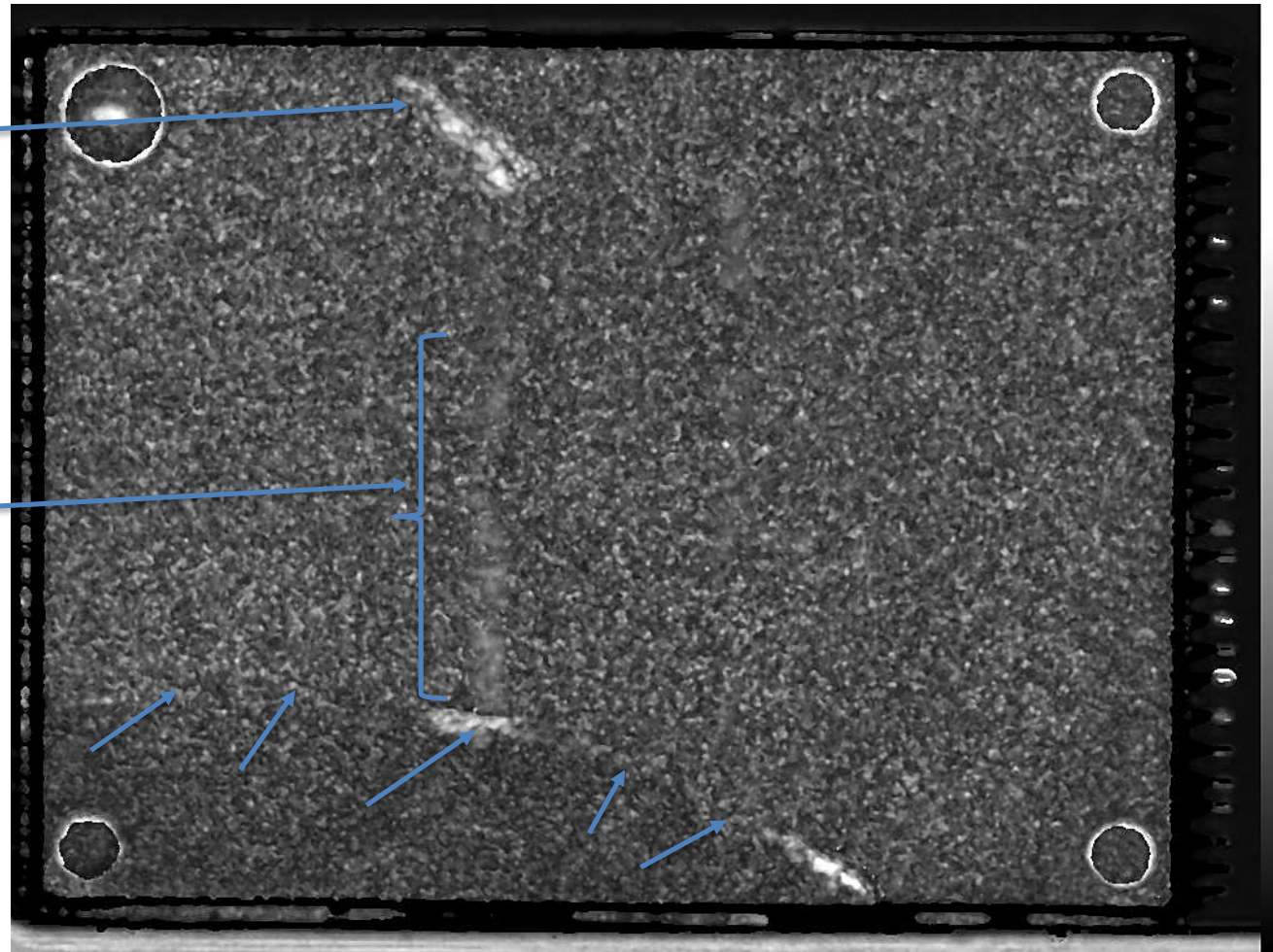


C-SAM image from the mold compound

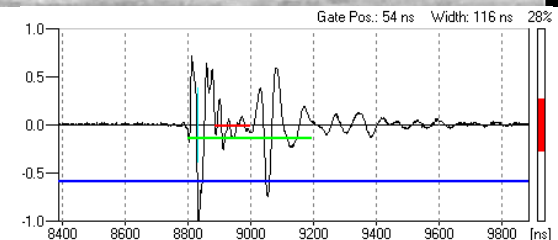
Crack in the mold

Die wire bonds
within the mold

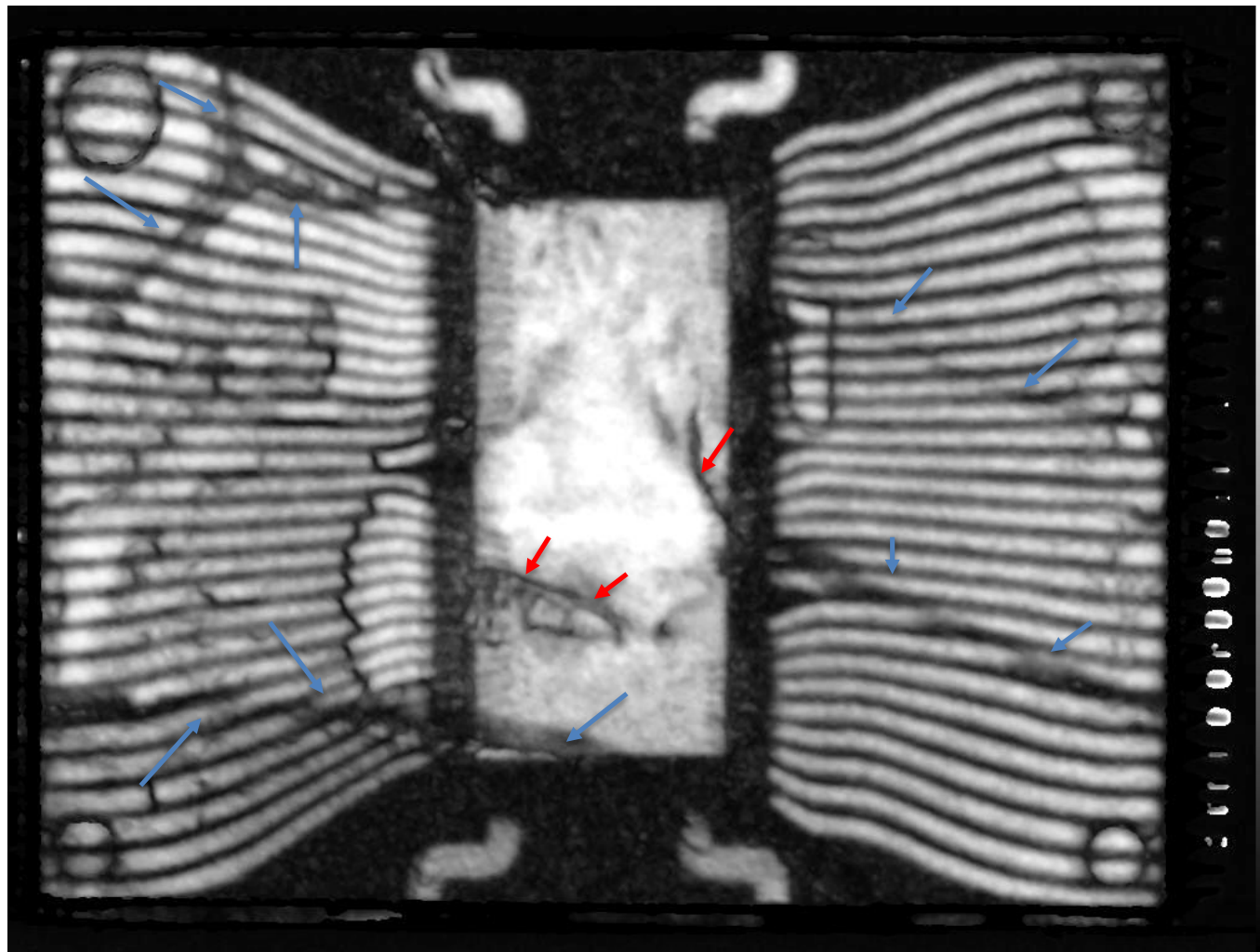
Shadow/propagation of
the mold surface crack



There are cracks on the top package surface as
well as within the mold

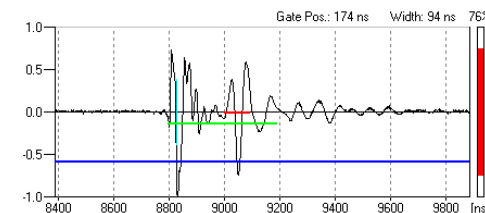


C-SAM image from die top and leadframe

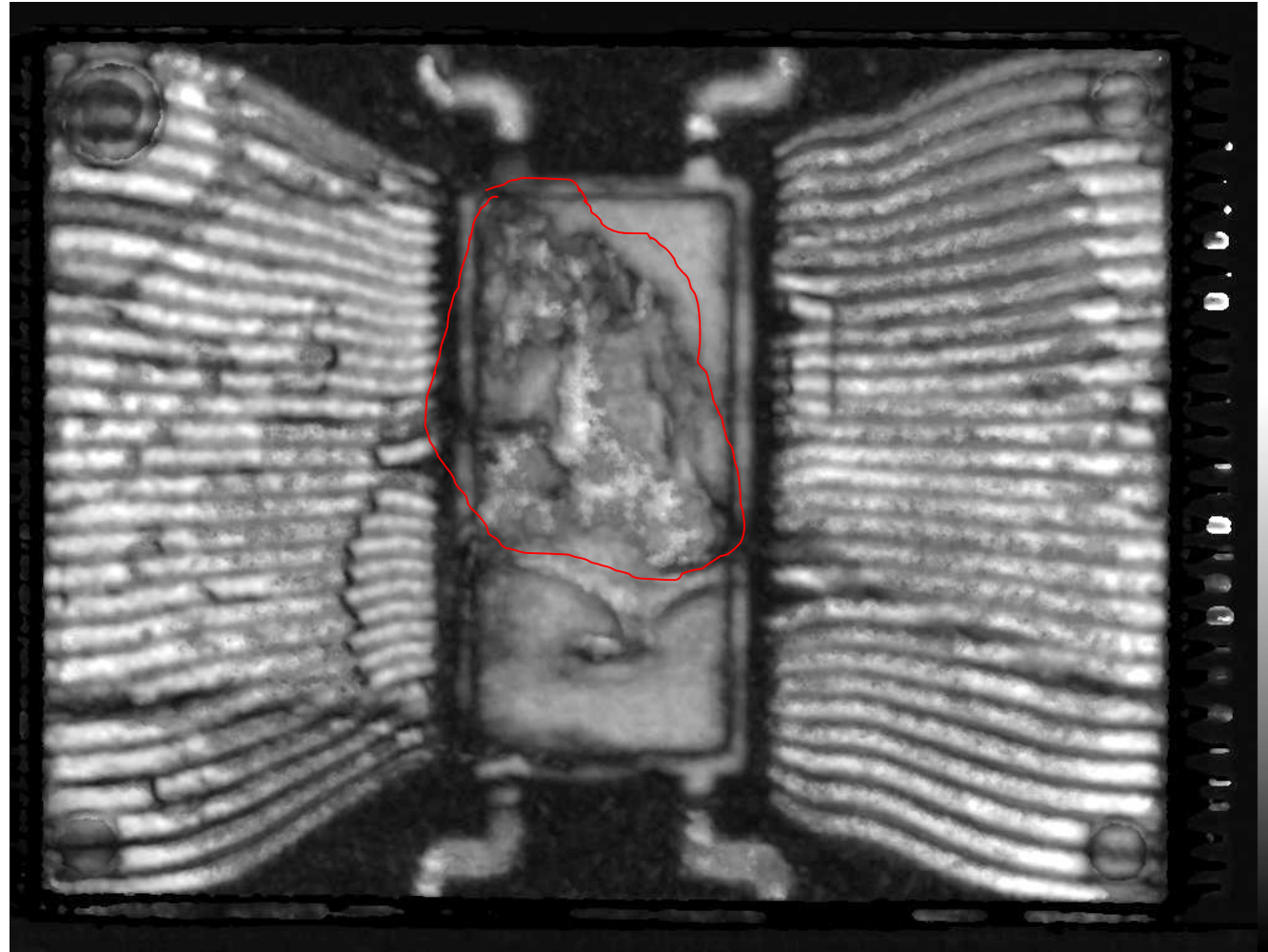


- Die cracks pointed with red arrows
- Leadframe cracks pointed with blue arrows

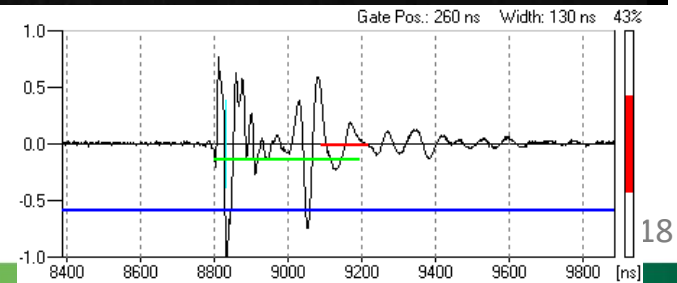
C-SAM images show that there are cracks in the die.



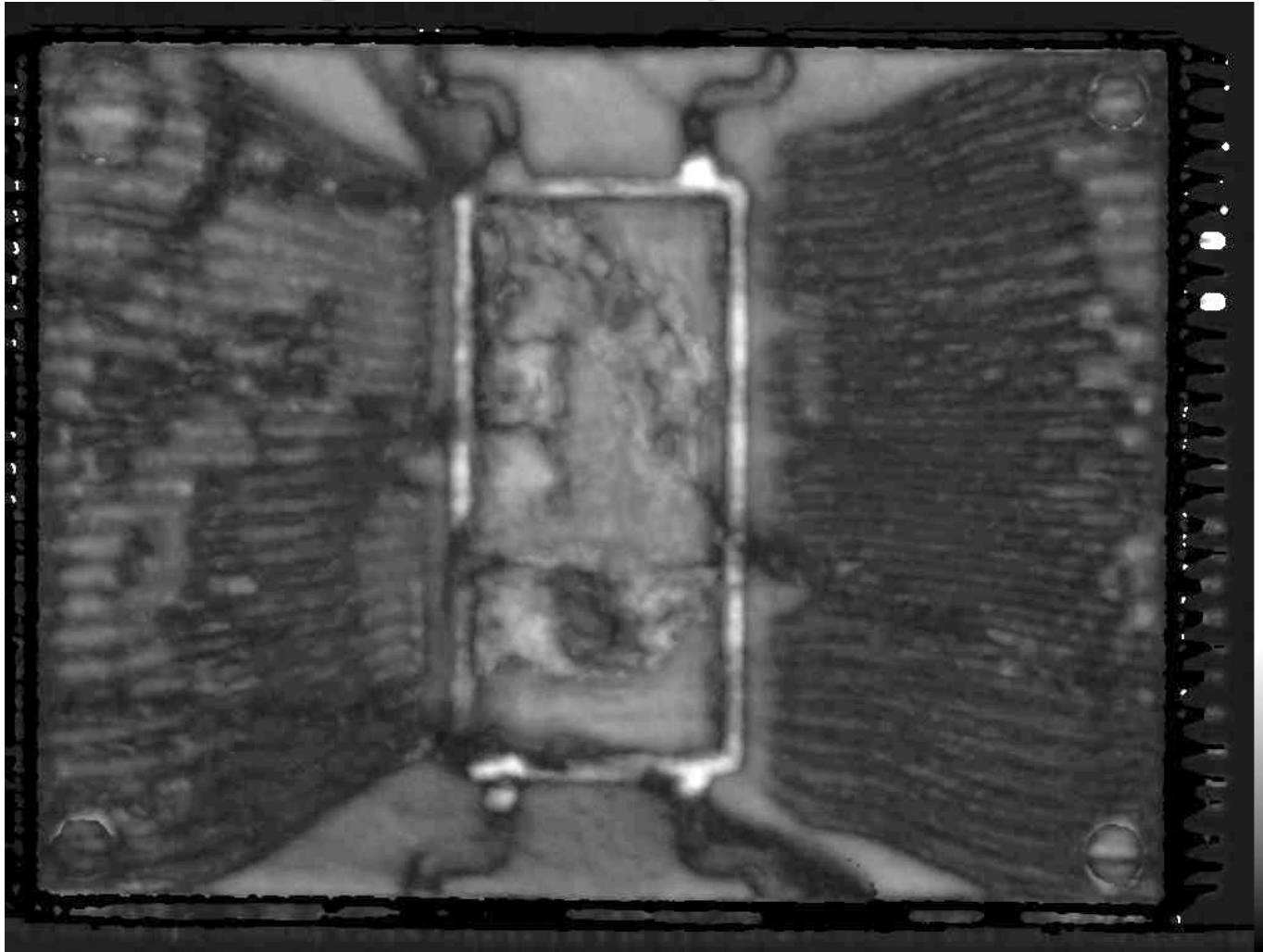
C-SAM image from the die attach



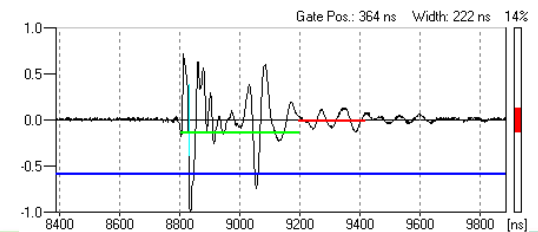
C-SAM images show delaminations and voids in the die attach.



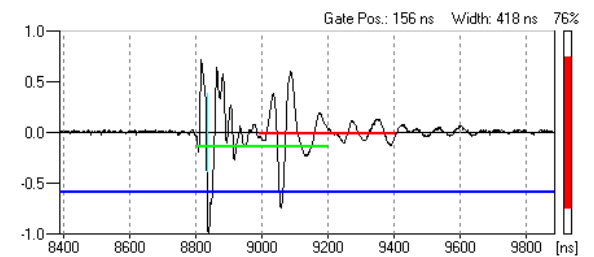
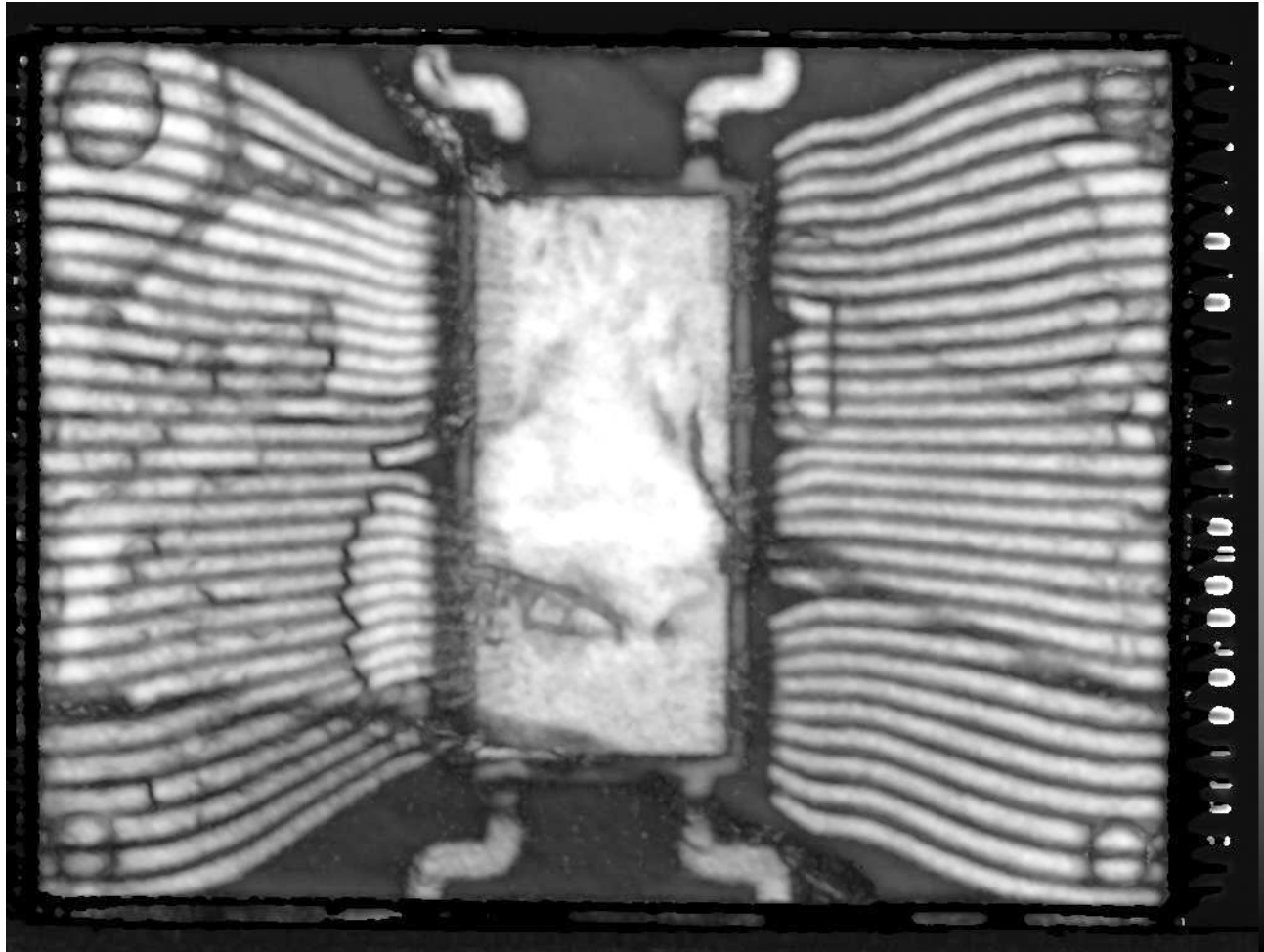
C-SAM image from the die paddle and leadframe



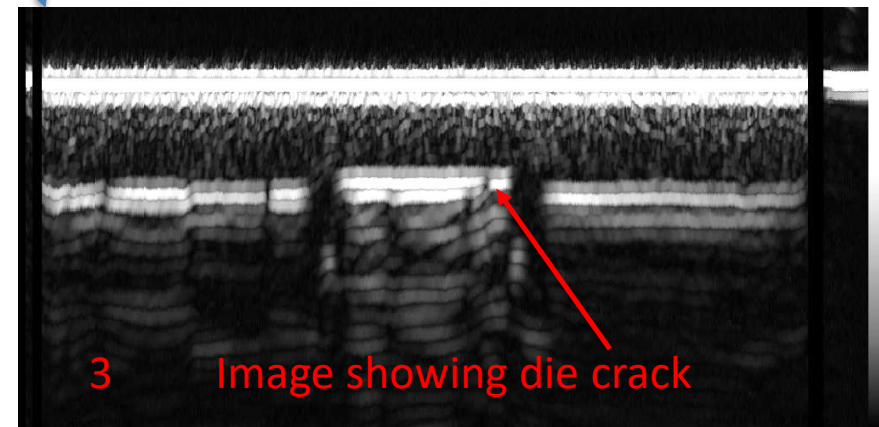
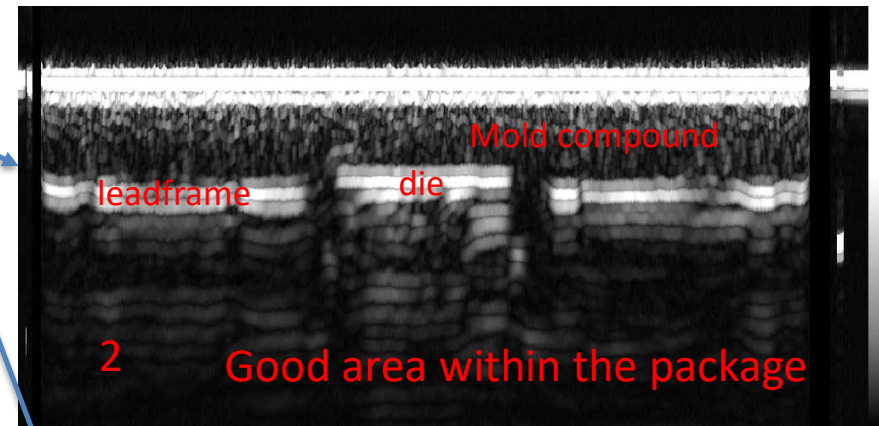
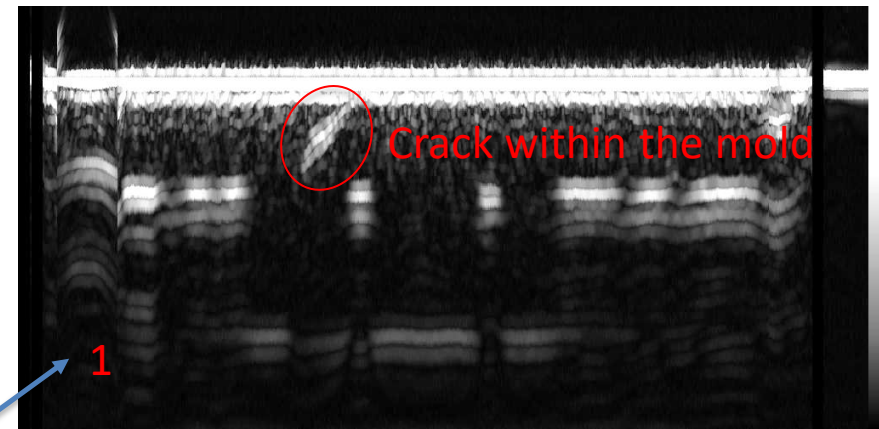
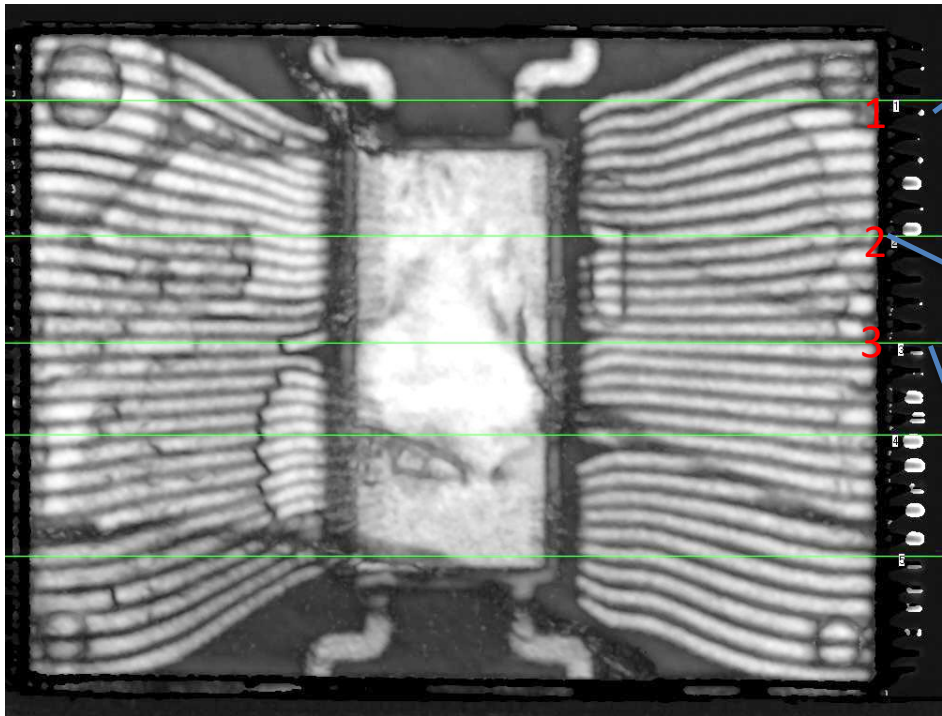
The image shows package cracks and their shadows.



Composite C-SAM image

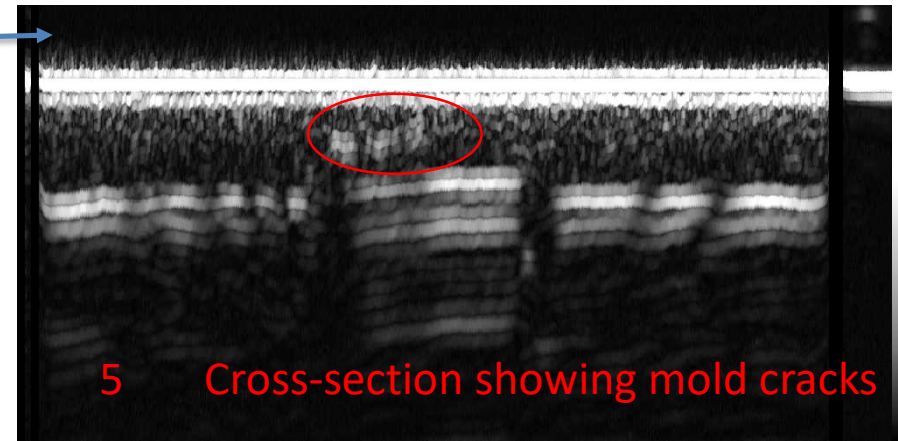
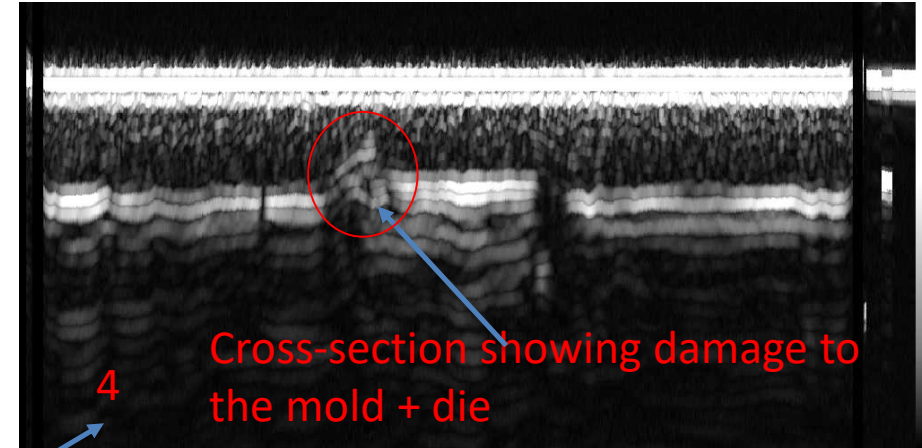
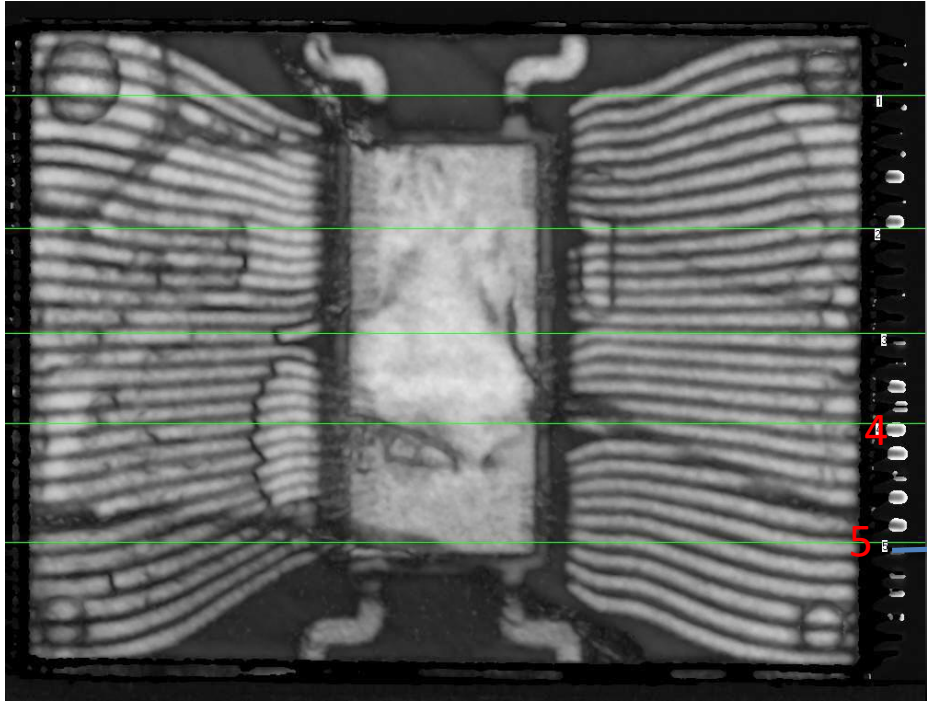


B-scan (virtual cross-section) images



Green lines showing virtual cross-section locations (1 through 3).

B-scan (virtual cross-section) images



Green lines showing virtual cross-section locations (4, 5).