



Transducer and System Dependency of Scanning Acoustic Microscope Images for Plastic Encapsulated Microelectronics

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OBJECTIVE

- Evaluation of SAM (Scanning Acoustic Microscope) as a reproducible & repeatable method for PEMs evaluation.
- Development of a “Specification” which can be used for making Accept/Reject decisions.



OUTLINE

■ SAM Technique & Issues

- Evaluation Parts
- Mfr1 SAM Images
- Mfr1 & 2 Image Comparison

SAM – IMAGING INTERFACE

■ Mechanisms:

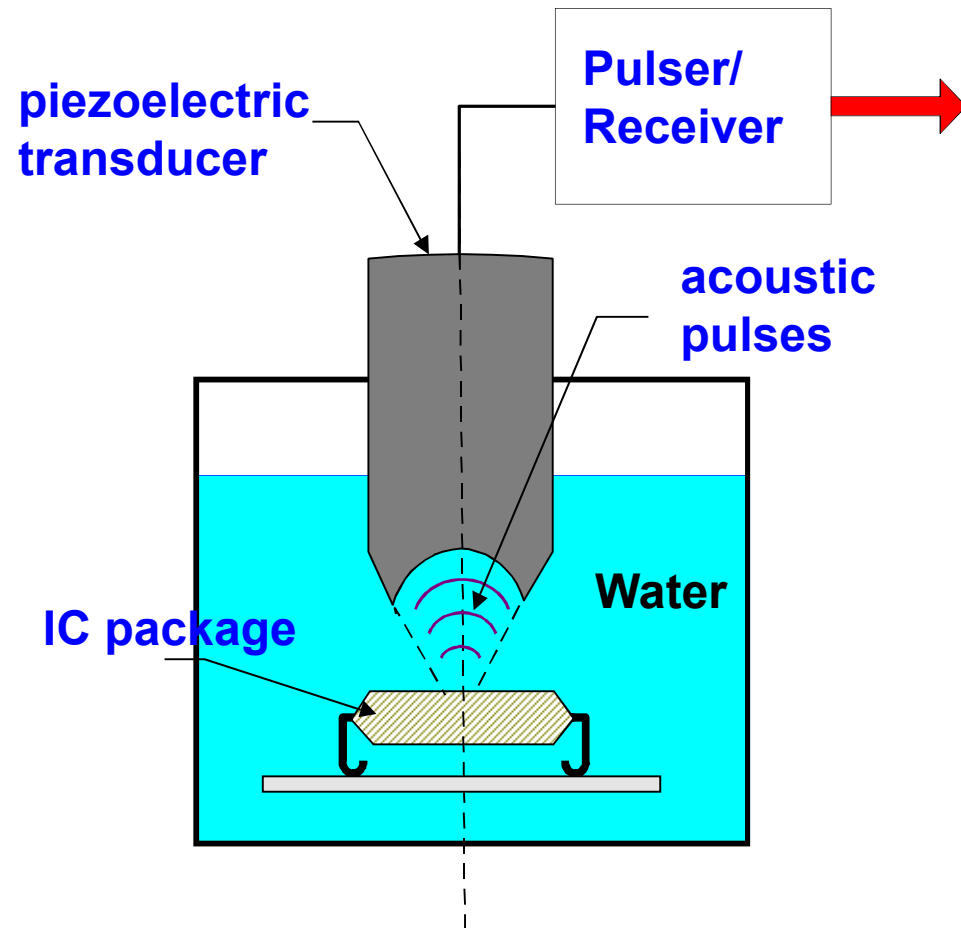
- Electromechanical energy transfers to acoustic energy.

■ Reflections occur when:

- Medium density & sound velocity change - interface

■ Reflected signal phase inversion occurs at:

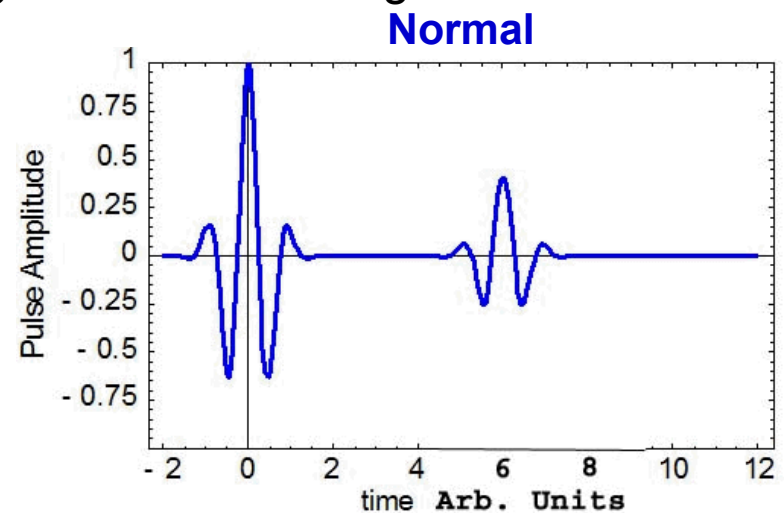
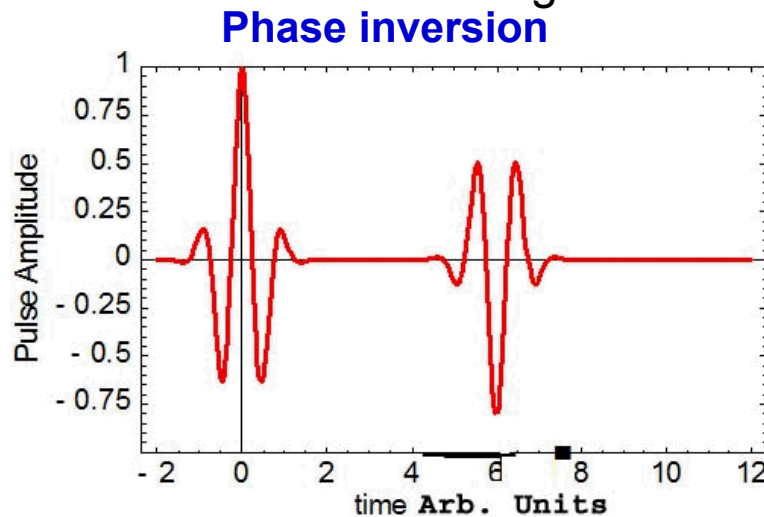
- Delamination at interface, voids, & cracks - real
- Die coating & water bubbles - false



Delamination Detection in SAM

■ Delamination detection is art & science

- Reflected signal depends on 'initial SAM setup' (focus, reflection gate, scan settings).
- Delamination detection depends on manufacturer's detection algorithm, operator, & interpretation (signal noise).
- Different transducers give different signals - select the right transducer.



=>qualify parts & make specifications



OVERVIEW

- | SAM Technique & Issues

- | Evaluation Parts

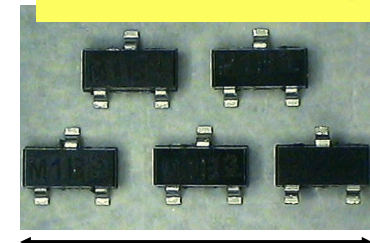
- | Mfr1 SAM Images

- | Mfr1 & 2 Image Comparison

PARTS - FUNCTIONALITY

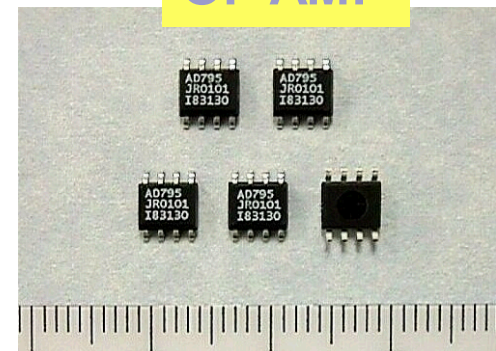
- 2222 Trans: NPN Si bipolar transistor
 - 2907 Trans: PNP Si bipolar transistor
 - Op Amp: Si operational amplifier
 - Switch: GaAs microwave switch
 - Diode: RF GaAs limiter diode
- } (same mfr)

2222 TRANS



0.3 inch

OP AMP

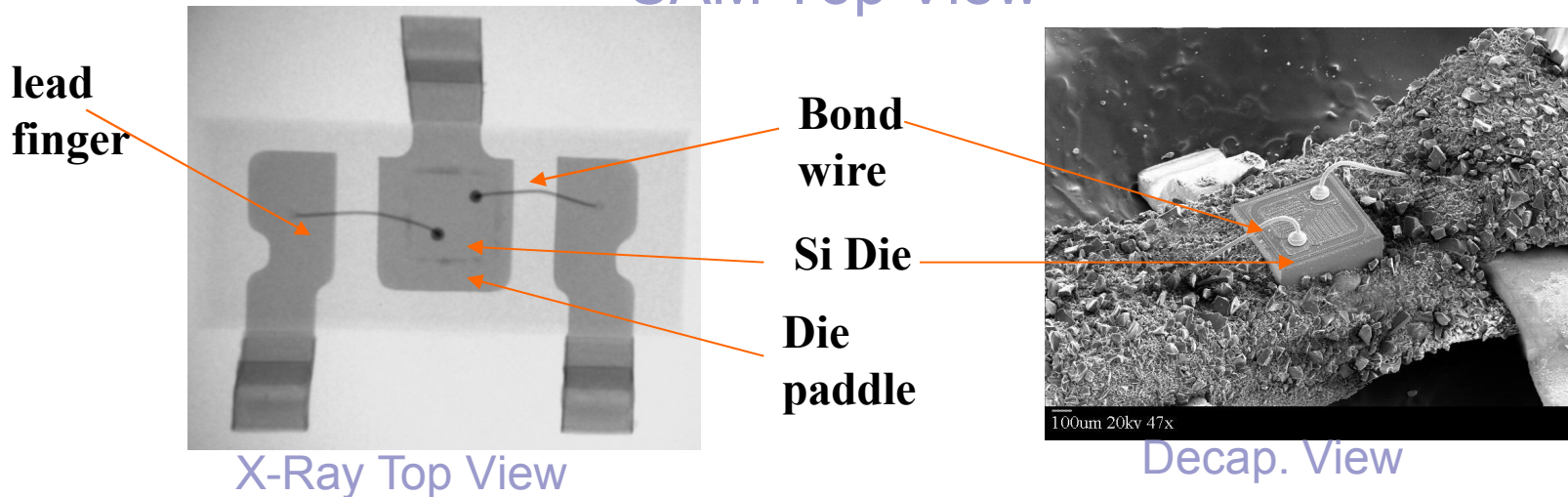
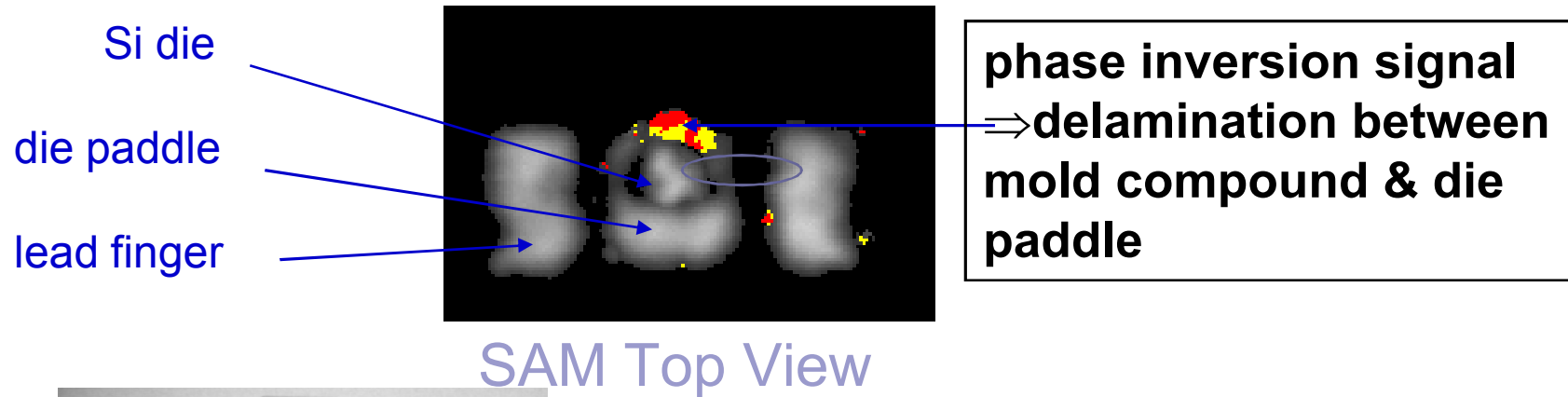


2 inch

Among five part types chosen & investigated, SAM results of two part types are presented.

2222 Transistor is chosen for the SAM evaluation because its spatial resolution is difficult. Op Amp is chosen because of existing silicon gel die coating inverting the signal.

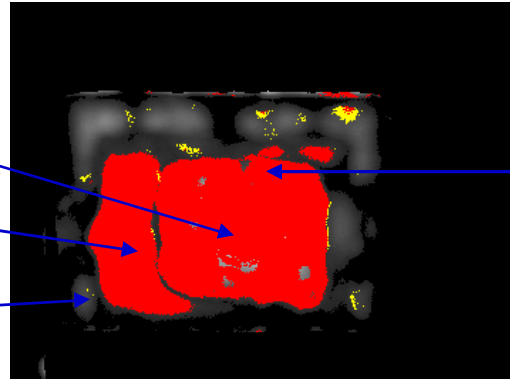
2222 TRANSISTOR



- J-STD sets the failure criterion as 10% delamination of a die surface and/or a wirebonding surface on the lead frame.
- Difficult to apply the criterion to this part type because it is very small.

OP AMP

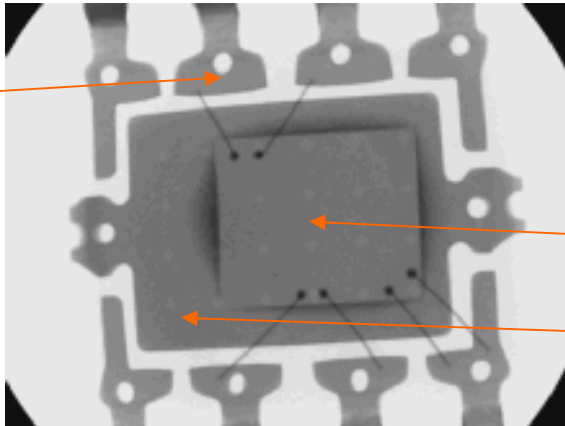
Si die
die paddle
lead finger



phase inversion signal
⇒ die coating between
mold compound & die

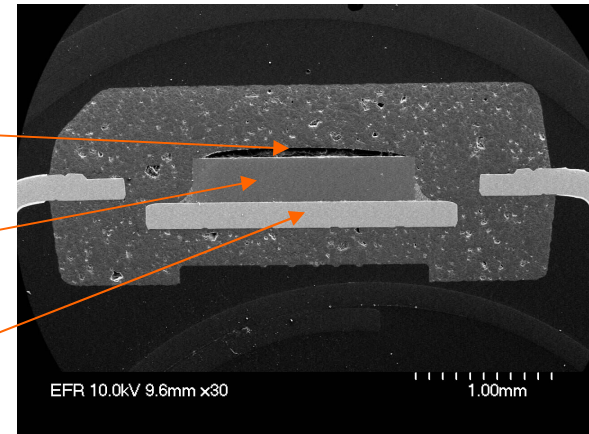
SAM Top View

lead
finger



X-Ray Top View

die
coating
Si die
die
paddle



Cross-section View

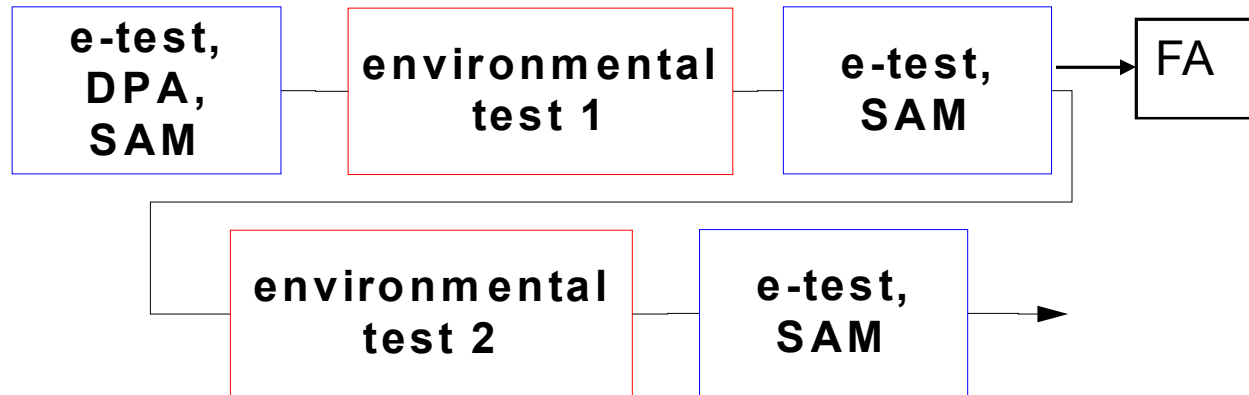
- Application of the J-STD criteria to this part is difficult.
- Die and wirebonds on the lead frame can't be imaged accurately because of existing die coating.



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- | Mfr1 SAM Images
- | Mfr1 & 2 Image Comparison

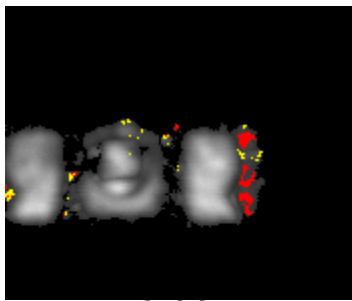
RELIABILITY TESTING



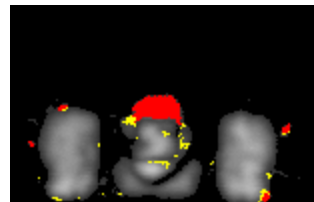
- Environmental Test: HAST, TC, TS
- HAST: 130°C/ 85% RH in 250 hrs. increment
- Temperature Cycle (TC): -65 to 150°C in 1,000 cycles
- *Thermal Shock (TS): -55 to 150°C in 100 cycles

*Fastest & most severe test

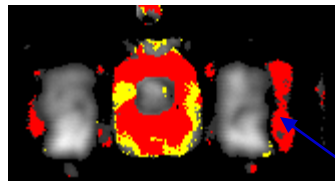
Mfr1 SAM IMAGES: TRANS



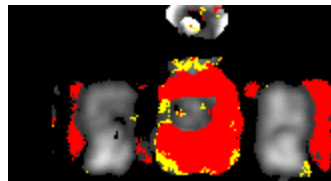
0 Hr.



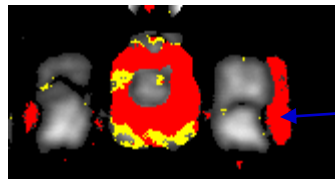
250 Hrs.



500 Hrs.



750 Hrs.



1,000 Hrs.

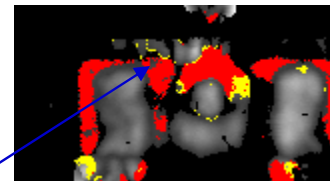
Part #44 HAST: Failed



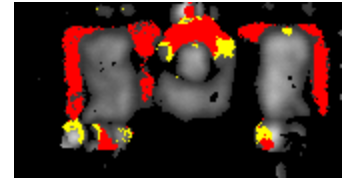
0 cycles



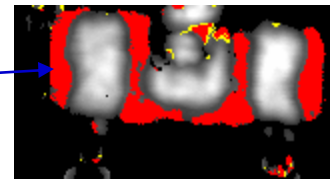
1,000 cycles



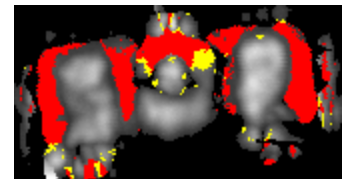
2,000 cycles



3,000 cycles



4,000 cycles

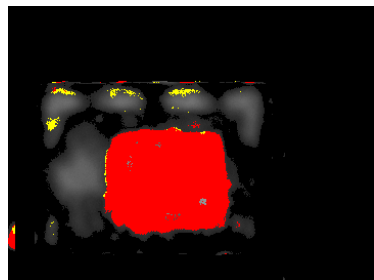


5,000 cycles

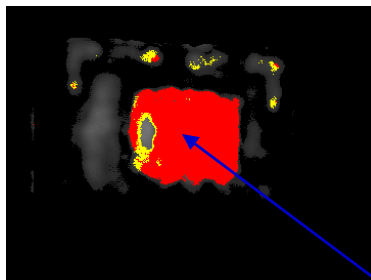
Part #109 TC: Passed

false

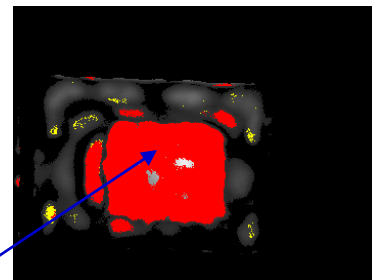
Mfr1 SAM IMAGES: OP AMP



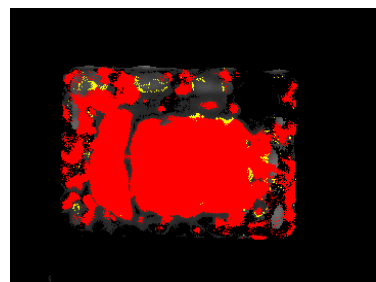
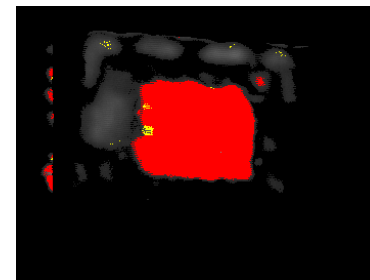
BeforeTC



false

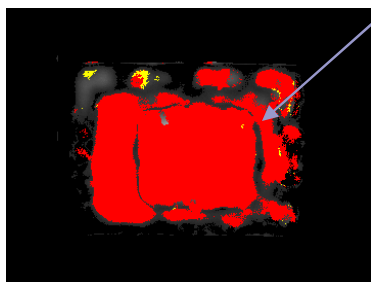


BeforeTC

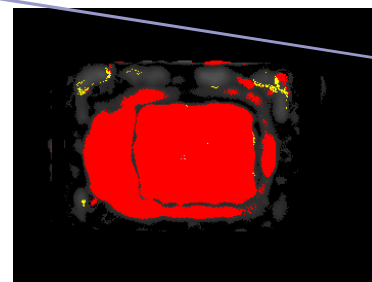


After 1,000 TC

Part #228 & 275: Failed

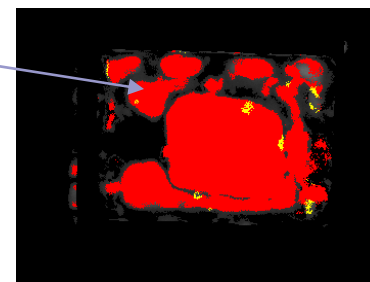


??false or real??



After 1,000 TC

Part #238 & 272: Passed



Slide 13

SW06

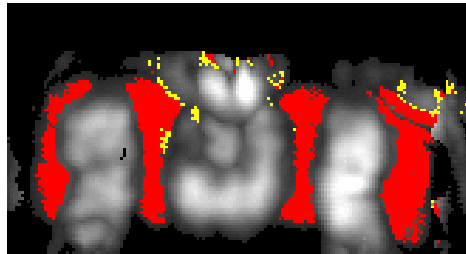
Steve Othling, 9/15/2013



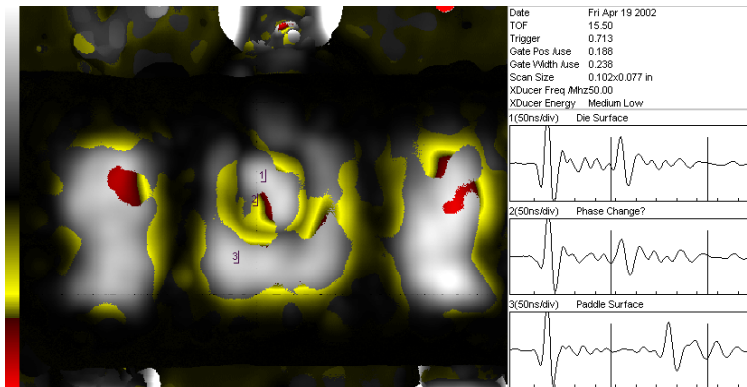
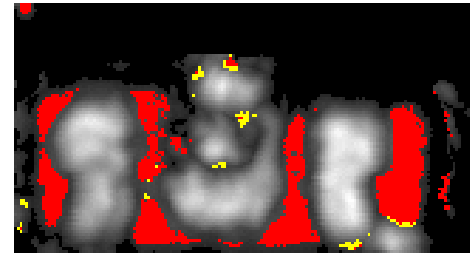
OVERVIEW

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Mfr1 & 2 IMAGE COMPARISON: TRANS I

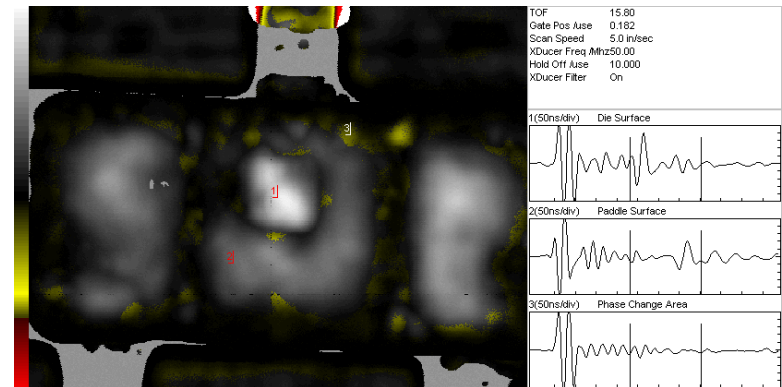


Mfr 1 w/ 50 MHz



Mfr 2 w/ 50 MHz

Part #130 500 TS

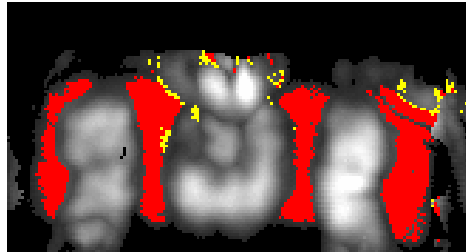


Mfr 2 w/ 50 MHz

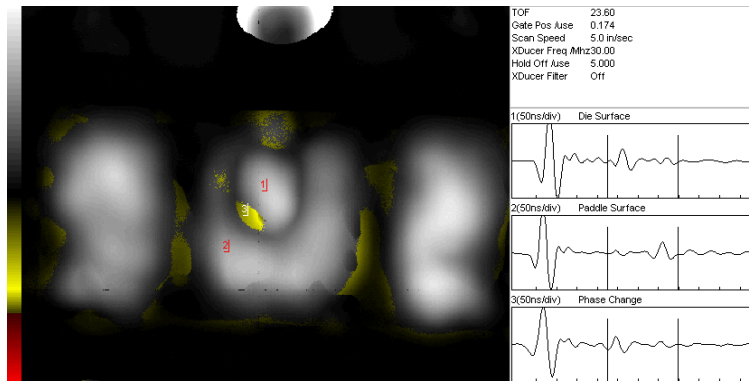
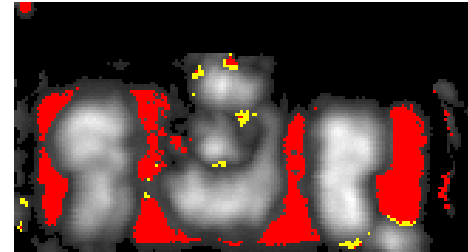
Part #135 500 TS

- Same transducers are used for both Mfr1 and Mfr2 systems.
- Both the Mfr 1 and Mfr 2 images are similar, but not the same.
- The delamination information is completely different.

Mfr1 & 2 IMAGE COMPARISON: TRANS II

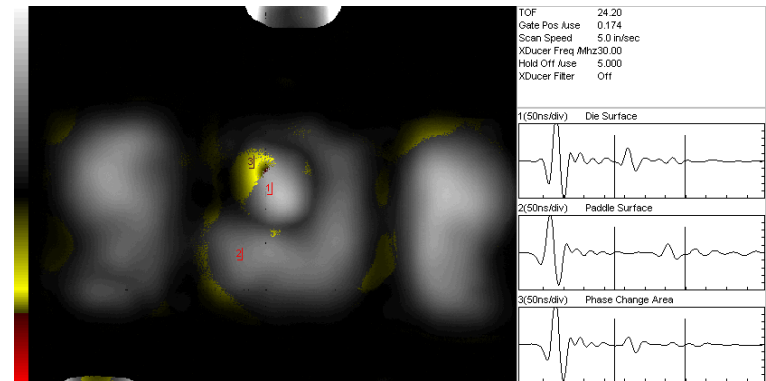


Mfr 1 w/ 50 MHz



Mfr 2 w/ 30 MHz

Part #130 500 TS

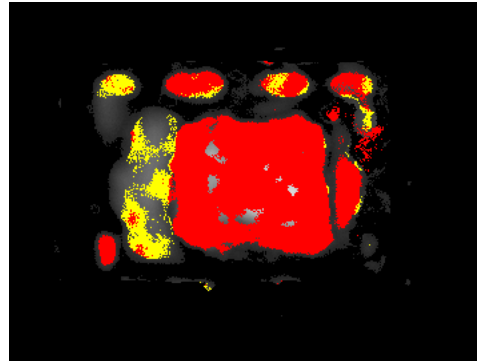


Mfr 2 w/ 30 MHz

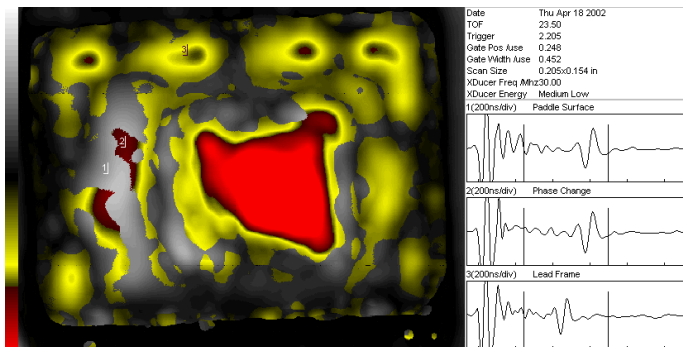
Part #135 500 TS

- The delamination information is completely different.
- J-STD recommends using the highest useable frequency transducer.
- Our preference is a 30MHz instead of 50 MHz transducer for Mfr2 system.

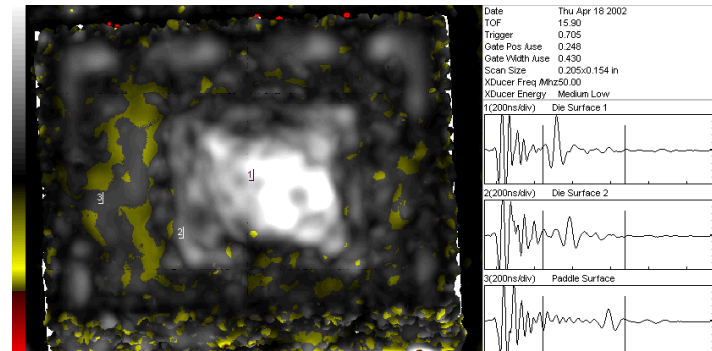
Mfr1 & 2 IMAGE COMPARISON: OP AMP



**Mfr 1 w/
25 MHz**



Mfr 2 w/ 30 MHz



Mfr 2 w/ 50 MHz

Part #302 400 TS: Passed

- The delamination information is again different among all three images.
- J-STD's recommended failure criterion and highest useable frequency transducer cannot be applied.
- Mfr2's 50MHz image doesn't pick up the phase inversion.



SUMMARY

- Similar but not exact SAM images can be made.
- Delamination info is system and transducer dependent.
- Higher frequency transducer is not necessarily better.
- Establishing universal accept/reject criteria for PEMs has not been done (if possible, very difficult) & will be **part type dependent**.



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