

IEEE SW Test Workshop

Semiconductor Wafer Test Workshop



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Detecting Killer Particles to Protect Multi-DUT Probe Cards



June 8-11, 2008

San Diego, CA USA

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Contents:

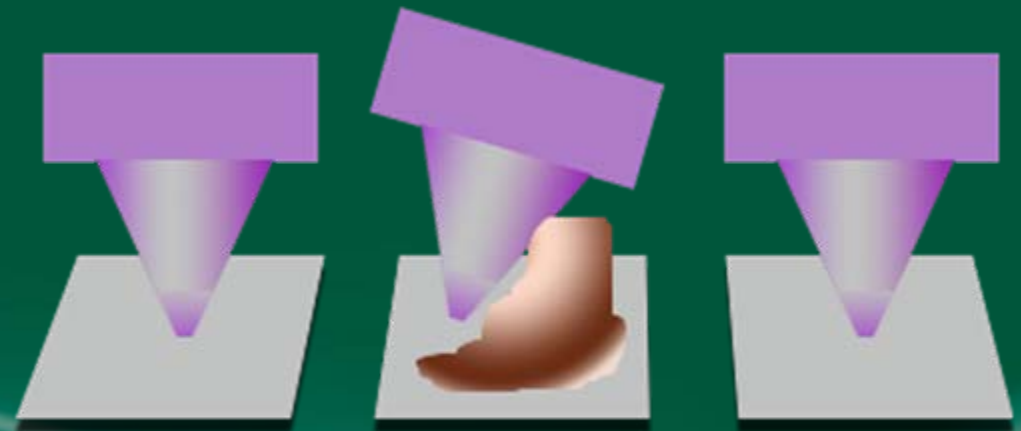
- Killer particles!?
- Different probe cards, different particles
- Economies of saving a probe card
- Couldn't regular AOI just scan the wafers?
- Study goal: Telling pebbles from stains
- Study data
- Conclusions



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Probe Card Killer Particles

- When a probe tip hits a particle, it may bend permanently
- A bent tip may not create a reliable contact
- Particles come from previous processes
- Certain probe card types are more sensitive than other
- Damage can be costly



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Cost of Damaged Card

- MEMS probe card cost ~\$150÷300K
- Time to repair at vendor / replace (usually no spare) 2÷3 weeks
- Cost to repair a damaged tip at vendor \$1÷5K
- Tips damaged per occurrence 1÷10
- Manual inspection detection rate <60%



Market Requests

- Numerous customers are buying 2D inspection systems for pre-test inspection to protect probe cards
- Particles on partial and edge die are usually not inspected by conventional 2D AOI, but still present a risk to probe card
- Other customers have requested to perform 3D scan to detect tall defects only
- Complete 3D scan is too slow
- Camtek developed the “Probe Watch™” in response to this need, a relatively fast method covering entire wafer
- This article describes the analysis of the “Probe Watch”



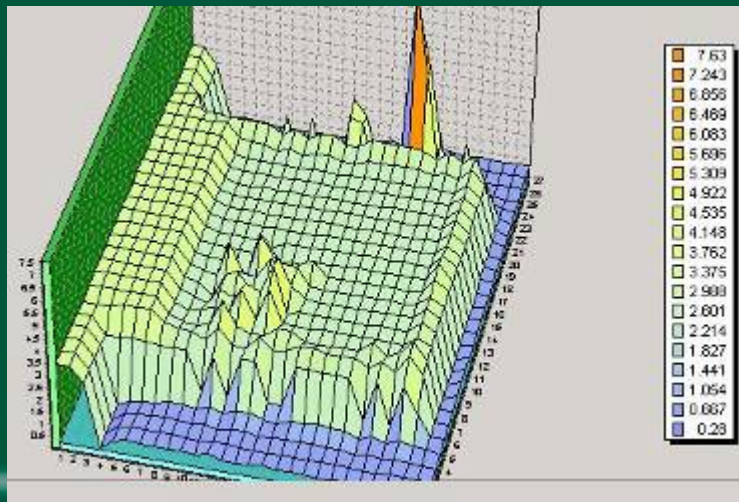
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Can't Conventional AOI Just Scan The Wafers?

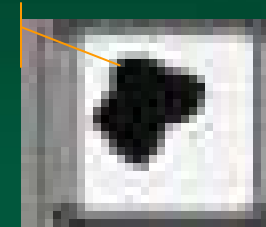
Area
22x44



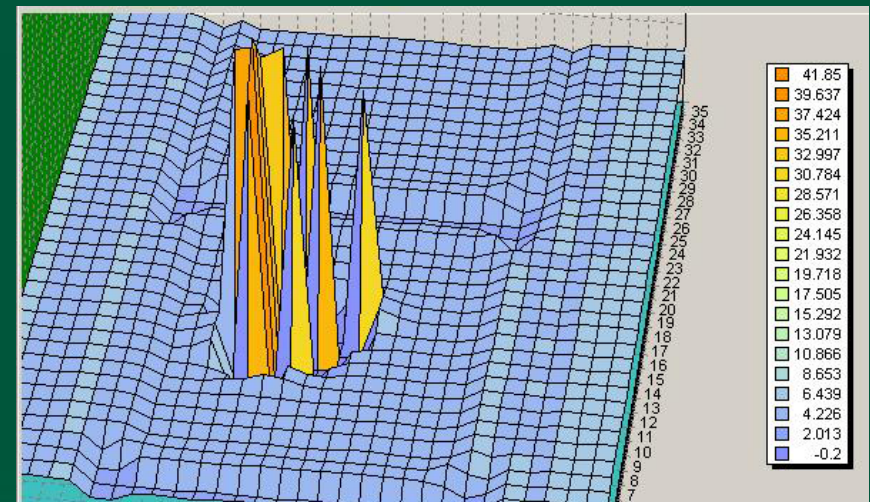
Height 2 μm



Area
35x54



Height 44 μm

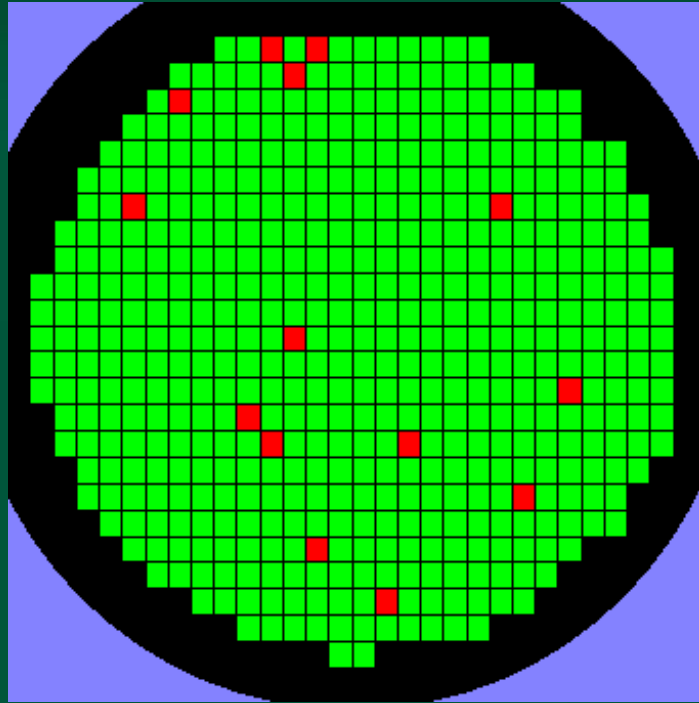


Stains and particles look alike in 2D inspection

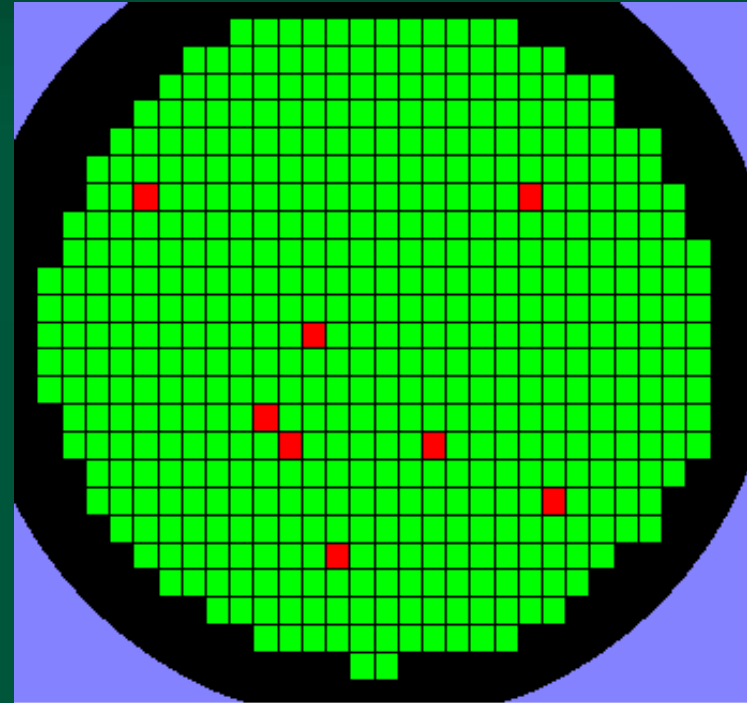


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2D Scan Limitation



2D large defects map (14)



Killer defects map (8)

Too many false calls!

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Goal: Detect Pebbles

- Automatically detect killer particles
- Classify particles by shape and location
- Avoid reporting nuisance particles (stains)
- “Killer Particle” – application dependent
- Detect particles on entire wafer area, including perimeter
- Throughput is important



Study Method

- Reference Map
 - Inspect the wafer in 2D, normal magnification
 - Mark blobs larger than 25 μm in any axis
 - Profile each blob with Camtek's Chromatic Confocal Sensor
 - Map blobs taller than 20 μm (=particles)
 - Test Map
 - Scan same wafer with new system "Probe Watch™"
 - Map signatures above criterion
 - Phase 1: Compare maps
 - Phase 2: Correlate Probe Watch signature with particle size*
-
- Size = Particle $(W \times L \times H)^{0.3}$



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Instrumentation

Falcon 830 equipped with:

- Standard 2D optics and inspection engines
- CCS (Chromatic Confocal Sensor)
- Tested new system = Probe Watch
- High resolution (x20) color review optics
- Wafers with multiple particles of various sizes and shapes to simulate extended production period

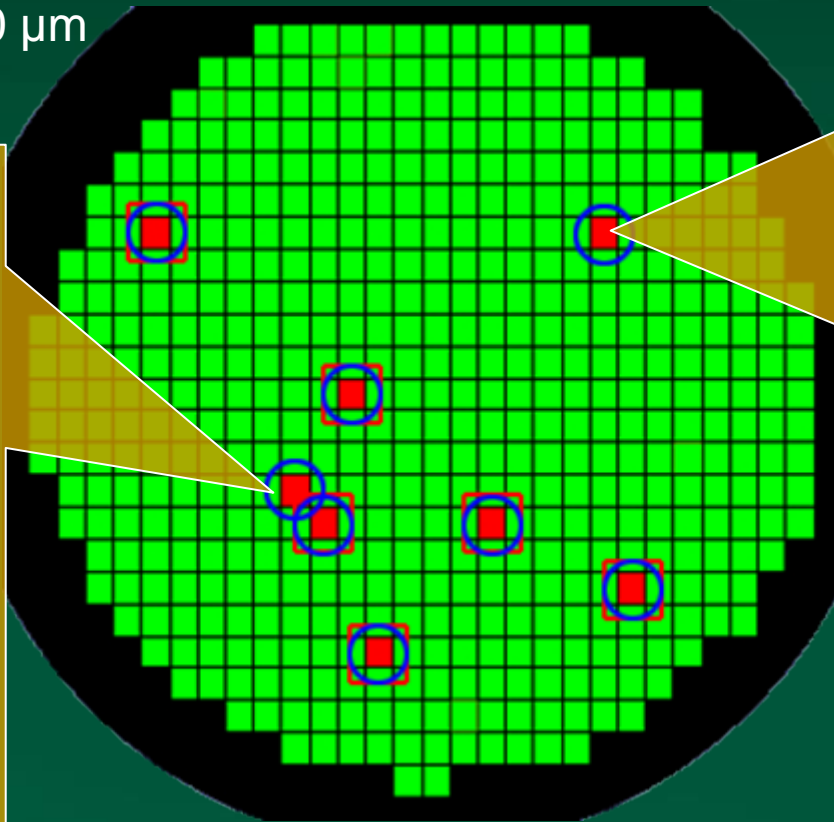
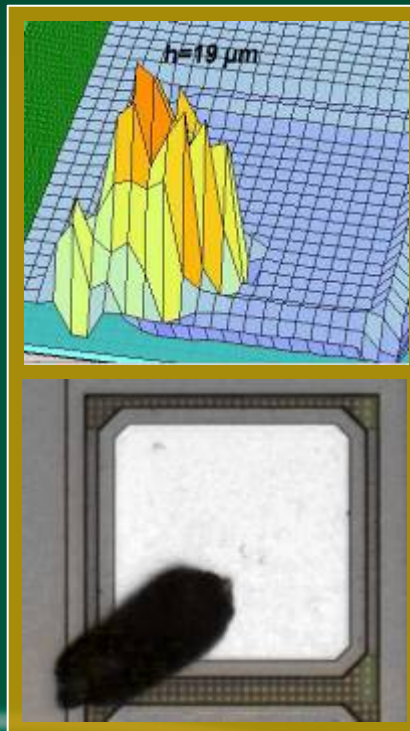


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Data Sample - Phase 1

□ Measured $>20 \mu\text{m}$

○ Signature >10



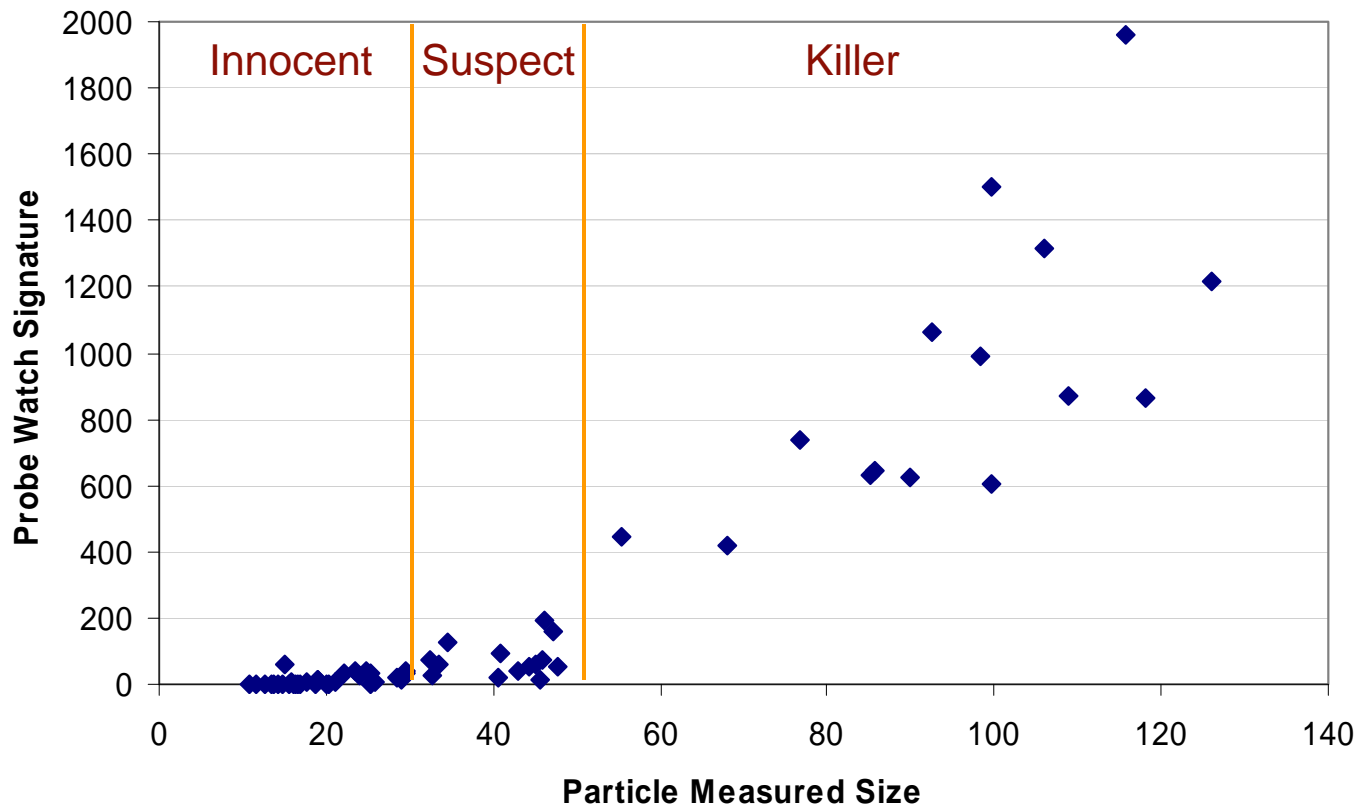
At signature 10, Probe Watch reported:

- All 6 particles marked by CCS
- Plus two particles that may be of interest



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Phase 2: Correlation



Probe Watch Test Results

Signature to size* correlation 0.90

<u>Particle Class</u>	<u>Detection Rate</u>	<u>Nuisance Rate</u>
“Killer”	100%	0%
“Innocent”	100%	3%
“Suspect”	71%	0%

Size = Particle $(W \times L \times H)^{1/3}$



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Conclusions

- “Probe Watch” was proven capable of differentiating pebbles from stains and reporting killer defects on entire wafer area
- The system’s signature correlated in the study to particle size
- Further characterization needed to adapt the new system to different probe card types and applications, as well as to user preferences
- Camtek will offer the new system as an option on its Falcon line



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The more you know

- The cost of collision between a particle and a probe tip can be significant
- Pre-test inspection can now detect killer particles and prevent such collision

Thank You for Your Attention
www.camtekusa.com



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