Semiconductor
Technologies &
Instruments

PRESENTS

Using AVI
(AUTOMATIC VISUAL INSPECTION)
for Probe Mark Inspection
and
Implementing AVI
into the
Test Floor Production Process

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Mike Clay   STI, Inc.

June 12, 2000

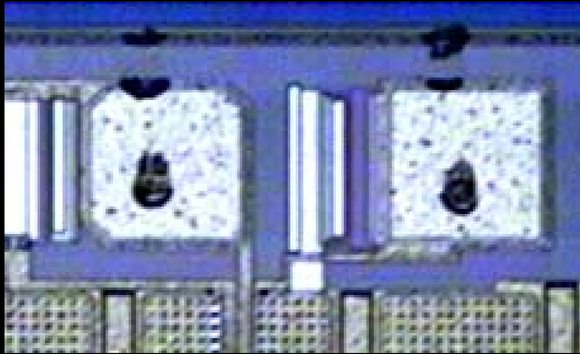
Part One:

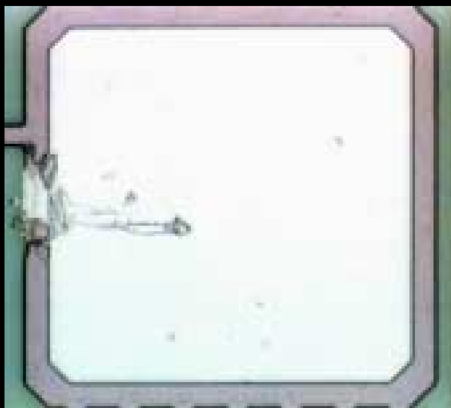
Using AVI for Probe Mark Inspection

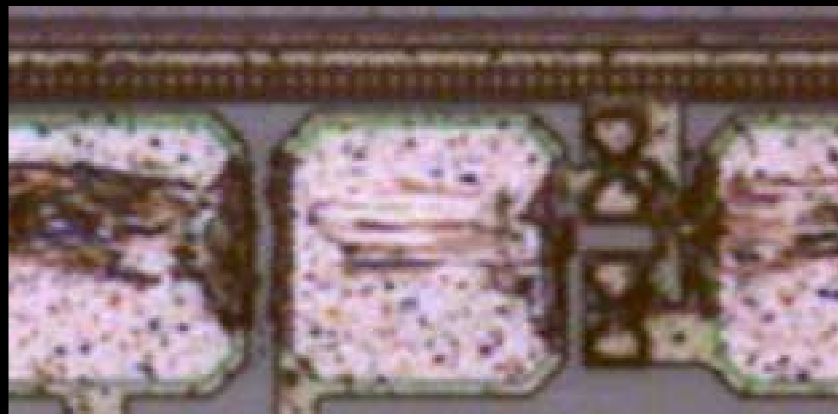
OUTLINE

- Probe Mark Defects Detectable
- Bond Pad Damage Detection as qualified at CM I
  - capture rate and range
- Bond Pad Damage Detection as quantified at T I
  - accuracy correlation

Probe Mark Defects Detectable with AVI: Edge Excursion

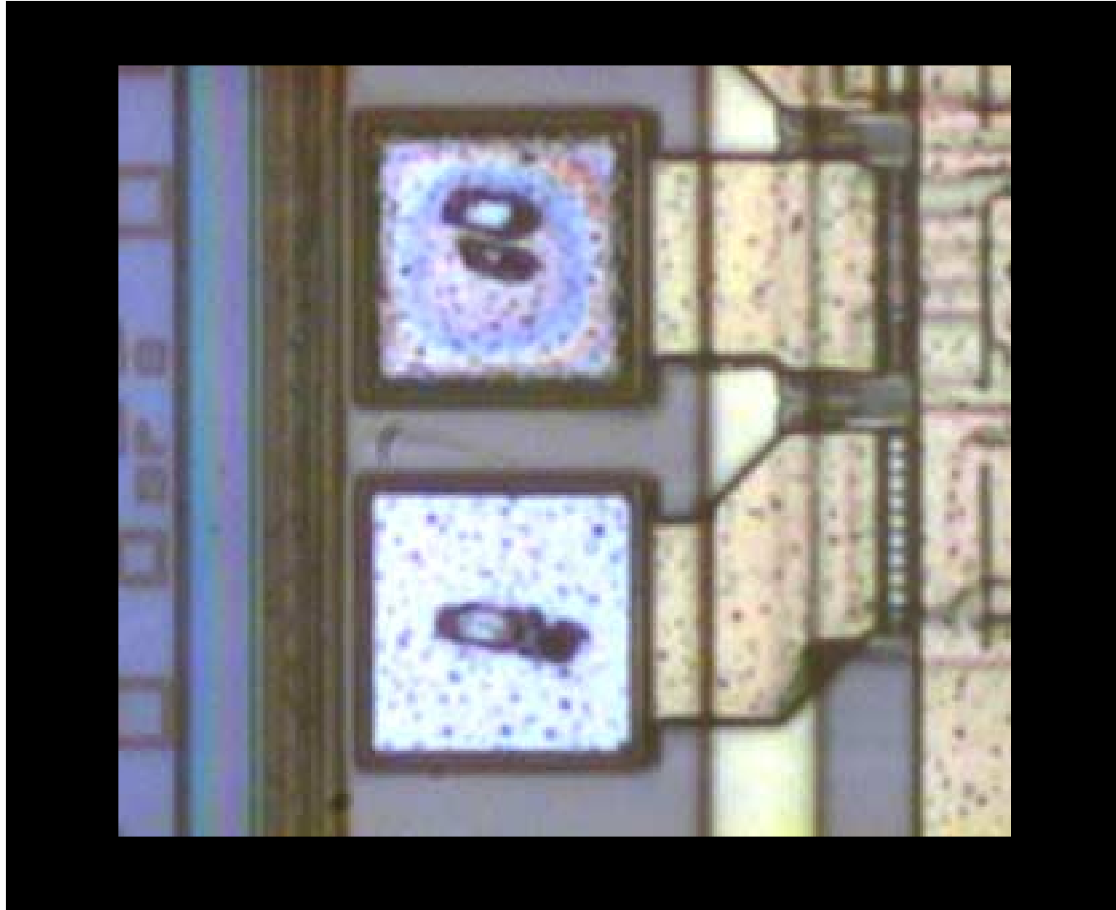






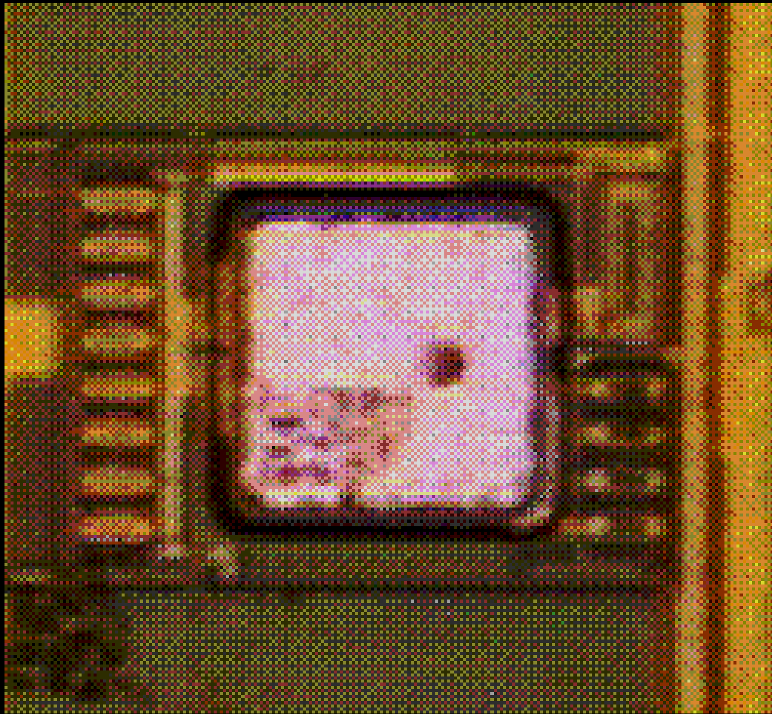
STI

Probe Mark Defects Detectable with AVI: Pad Discoloration



STI

Probe Mark Defects Detectable with AVI: Pad Damage



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Bond Pad Damage Detection: As Qualified at Cypress Semiconductor, Minnesota

Accuracy and Repeatability for Percentage of Pad Damage:

Capture Rate and Range

Sample= 289 die

Max area pass/fail setting		Manual count	AVI Count	Fail to capture	False defects	% fail to capture	% false capture	
30%		39	39	0	0	0%	0.00%	
29%		39	39	0	0	0%	0.00%	
28%		39	39	0	0	0%	0.00%	
27%		39	39	0	0	0%	0.00%	
26%		39	39	0	0	0%	0.00%	
25%		39	39	0	0	0%	0.00%	
	NOTE: DIE LEVEL INSPECTION							

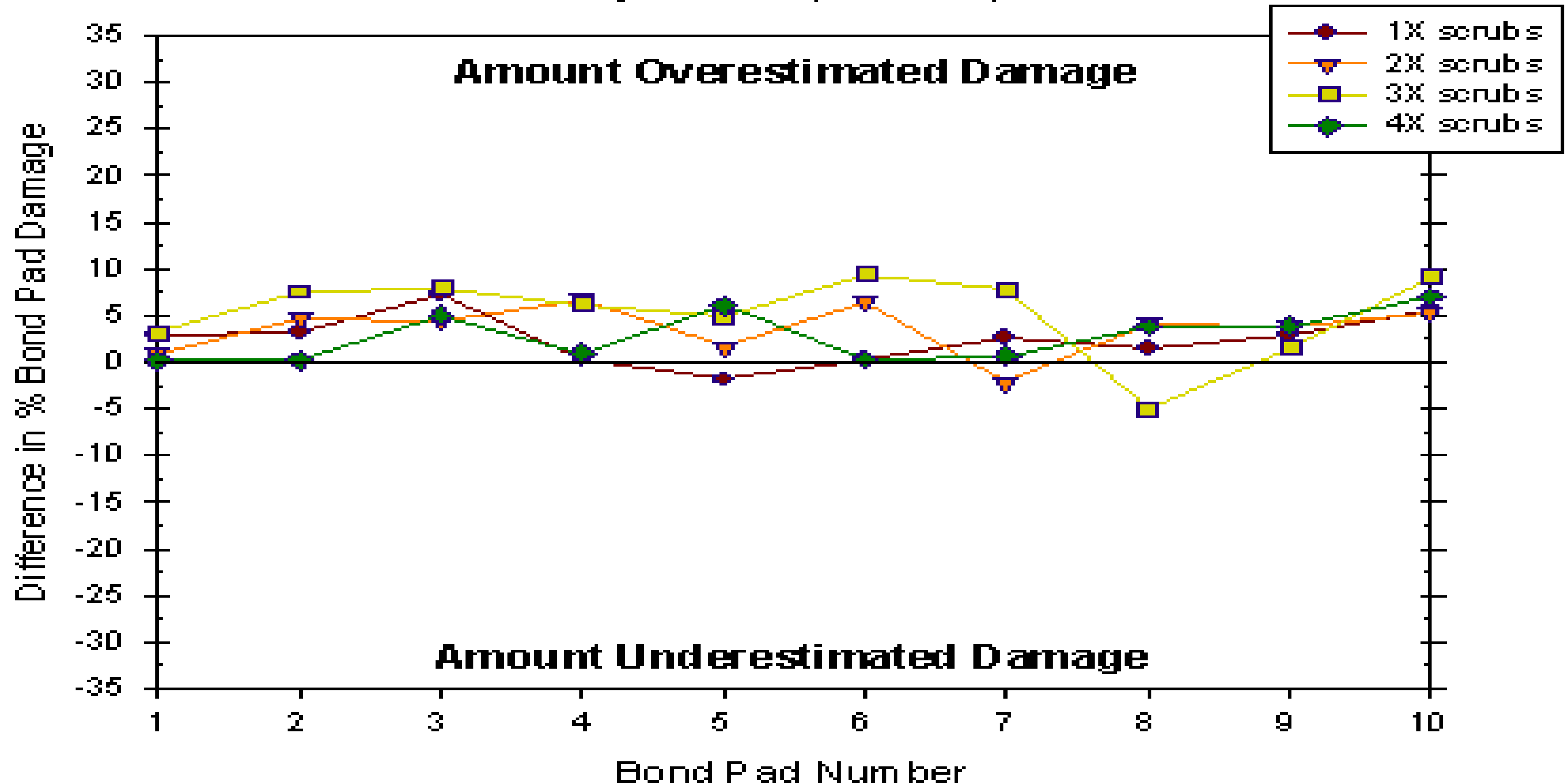
** Bond pad level probe mark area inspection accuracy is 2.3%. Range determined by testing one borderline bond pad (56 pixels = 25% area probed) 100 times.

Low	24.6	
High	26.9	
Range	2.3	%

[These data provided by Dane Christian, Cypress Semiconductor]

Bond Pad Damage Detection: As Quantified at Texas Instruments, Dallas

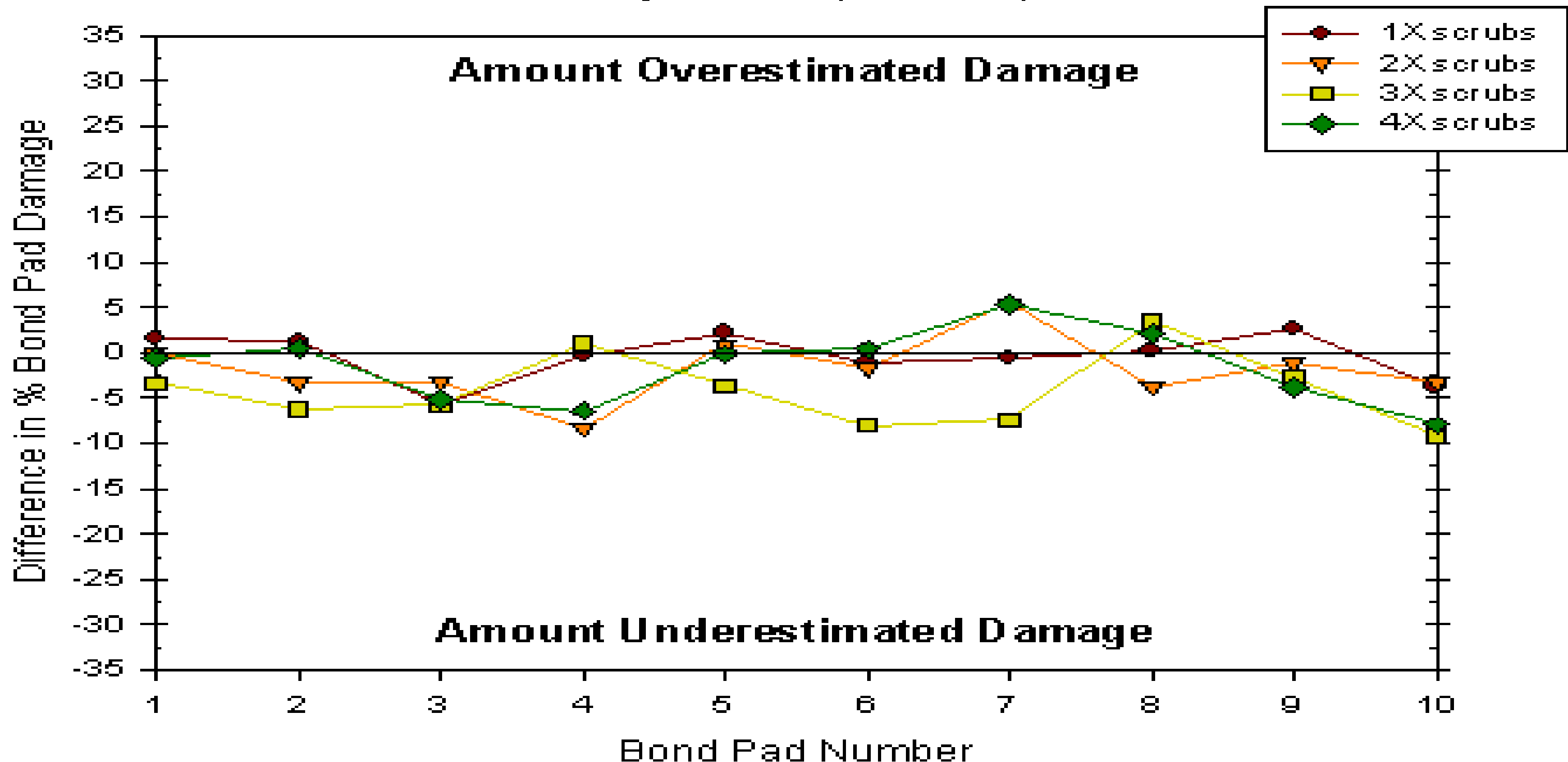
Accuracy Correlation: AVI, Dallas Wafer Test Site and Off-Shore Assembly Site



[These data provided by Jerry Broz, Texas Instruments - Dallas]

Bond Pad Damage Detection: As Quantified at Texas Instruments, Dallas

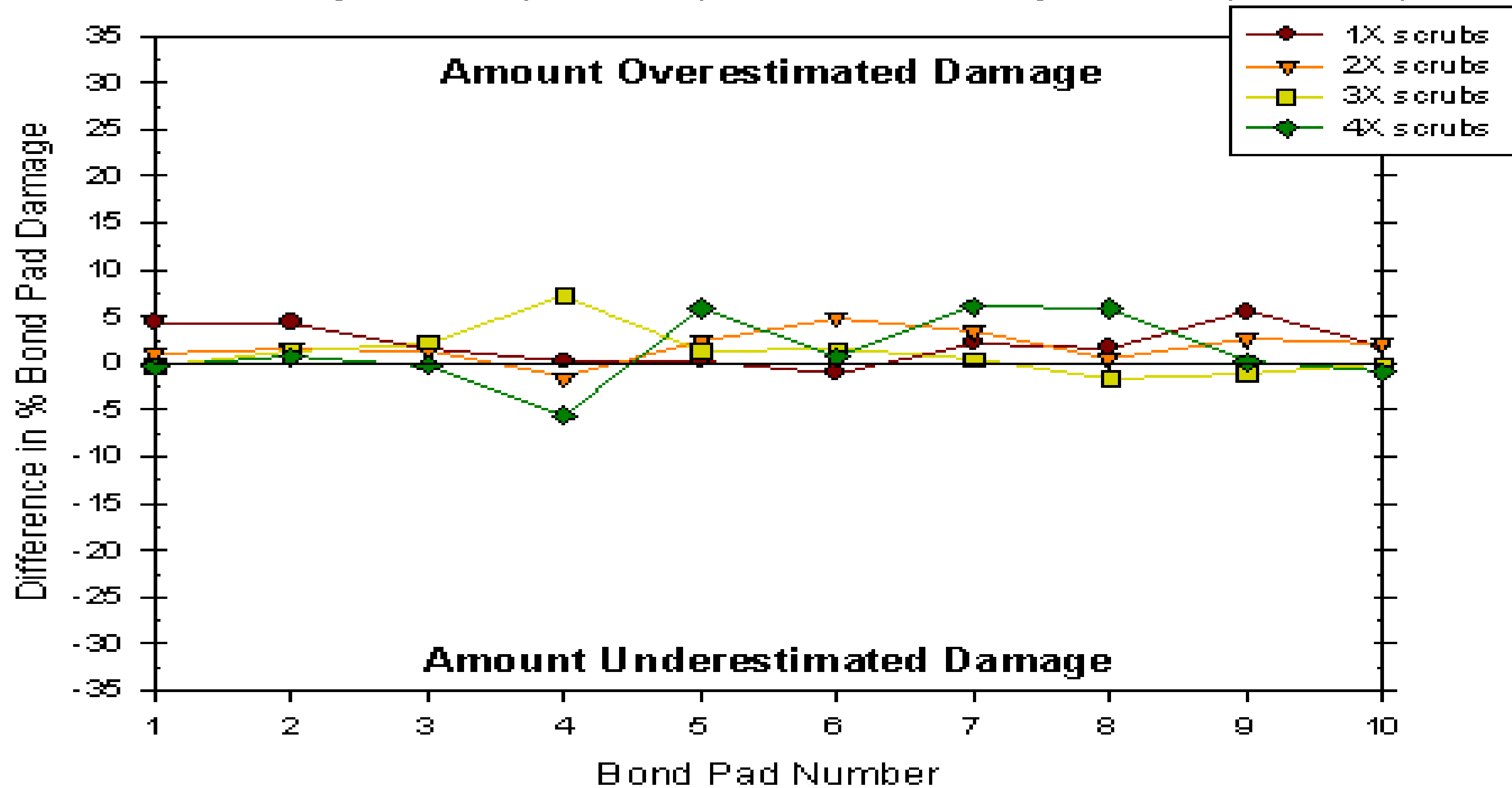
Accuracy Correlation: AVI, Dallas Wafer Test Site and Off-Shore Assembly Site



[These data provided by Jerry Broz, Texas Instruments - Dallas]

Bond Pad Damage Detection: As Quantified at Texas Instruments, Dallas

Accuracy Correlation: AVI, Dallas Wafer Test Site and Off-Shore Assembly Site



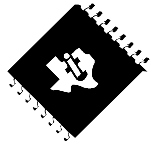
[These data provided by Jerry Broz, Texas Instruments - Dallas]

Part Two:

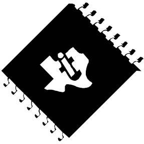
Implementing AVI

into the

Test Floor Production Process

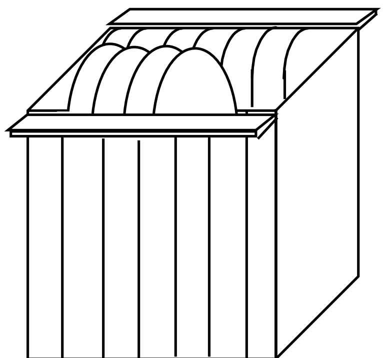


AVI System WAV-1000

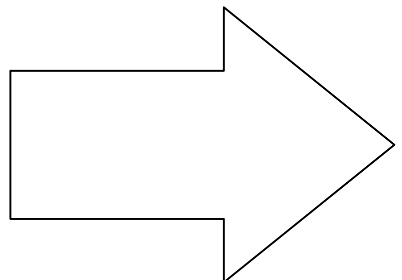


PURPOSE TO IMPLEMENT AVI

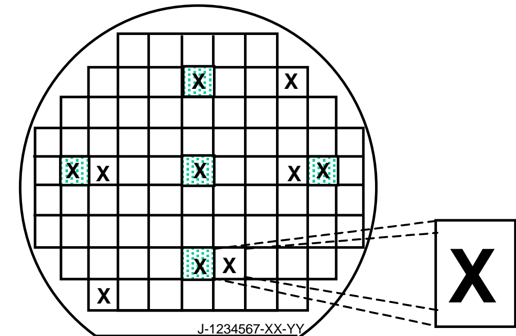
- To provide AVI(Automated Visual Inspection) system within TIJ Hiji to detect accurately visual anomalies defect on patterned wafer with reasonable price.
- Brake through Visual Quality Lot assurance concept on FAB. Products. (Wafer level ➡ Chip level assurance)
- Productivity improvement compared with human inspection with metal microscope.
- Short operator training period.
- Full time operate possibility.(24Hr./Day)



Lot Level Assurance



Wafer Assurance



Chip Assurance

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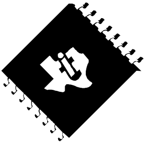


TIJ Hiji Wafer AVI System

Case study : Defects escape VS Crime

100%

Lot Pass rate

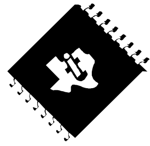
QC Pass Lot

Crime number

Crime

Defect % in Lot

Large



TIJ Hiji Wafer AVI System

From Assembly line Defect Analysis

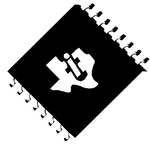
High

Defect Q'ty

Can be detected over 90% defect, if we screening more than targeted size defects.

Defect size (um)

Large

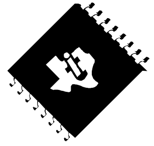


TIJ Hiji AVI System

SYSTEM DESCRIPTION/DESIGN

- Automated Wafer Handling Platform. (Load/Unload, Align, Index or Position)
- Accurate repeatability. (Over 90%)
- Speedy inspection time. (Approx. 3 Min./6"Wafer 100% Inspect.)
- Minimum 10um defect size detect.
- Automatic Defect Categorization is future concept.

As of 04/25/00 MM



Hiji AVI Current Methodology -1/2

- **Capability**

Function

- Defect detection 4 ~ 5um or more >90% repeatability.(Use Sub-Pixel test)
- High speed visual inspection. (Approx. 90s /6” W, (225s/6”W with Load/UnLoad))
- Multi dies(x2, x3 or xN) and Sub dies(1/2, 1/3 or 1/N) inspect function.
- 100% chips/Wafer inspection, random sampling inspection with set AQL level.
- Wafer handling size from 5” to 8”.
- Motorized optics (SQ 200 mil - 500mil).
- Offline ink/Ink Less.
- Defect area and size identification and display.
- Bond Pad mask.
- Auto training and auto start.
  - Automatic lot number recognize by OCR.
  - Device program load for Prober, Mapper or Vision PC.
  - Auto focus, auto light level adjustment.
  - Wafer Alignment, reference chip location recognize.
  - Generate sampling chips for reference chip image shots.

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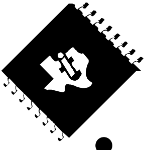
As of 04/25/00 MM



Hiji AVI Current Methodology -2/2

- **Capability**

Programming

- Process area selection or setting
- Minimum detect size setting in process area.
- Ink chip screening or skip function.
- Light level adjustment setting for Inspection VS reference images.
- Set Magnification(SQ 200 mil - 500mil).
- Specific area setting with filter(set minimum detect size).
- Set detect sensitivity(Low, Mid, Hi., 1 - 3 STD DEV.)

Test accuracy technique

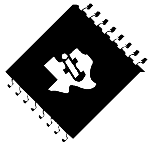
- Particle wipe off Filtered Air(N2) blow.
- Retest mode.
- Auto stop for abnormal percentage defect wafer.
- AVI fail location display(Wafer map, Chip map) or defect size,.
- Review defect location and defect identify by color capture screen.

Reporting

- Generate overlay, wafer map. (YAKITORI MAP)
- Auto print report at any lot operation end .

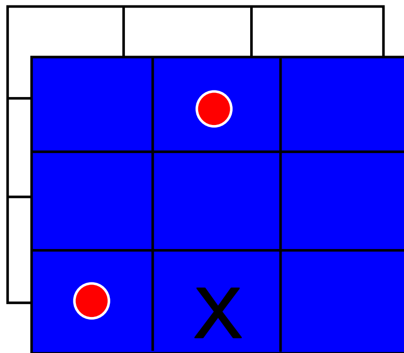
01/18/99ーMM- 03/6232

As of 04/25/00 MM

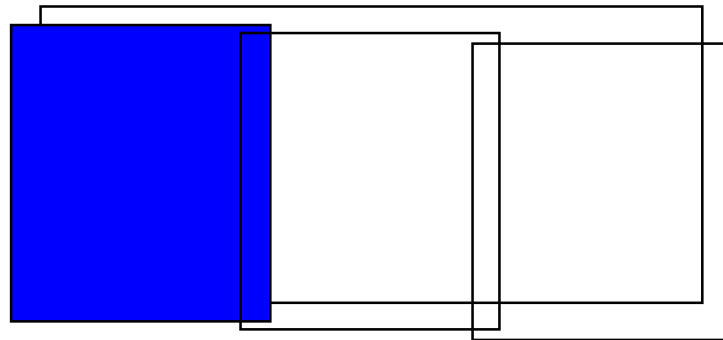


AVI System Multi/Sub. Chip inspectio..

Multi chips inspection



Divided chip part Inspection for big chip



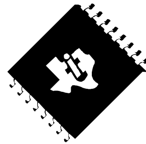
Ex.

3x3 chips/1 shot

1/3 chip area/1 shot

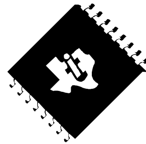
● INK chip Elec. fail

X Visual fail



Example AVI Lot report

STI	Avi#	2	Avi Ope. Start		Tue May 02 11:20:46 2000		Avi Ope End		Tue May 02 12:19:49 2000		Operator	
			Bake Oven Start				Bake Oven End				Operator	
Device :	S-104605-T3		W. ID Lot #	J-0022156-01-E4		SMS/370 Lot #		22156			Ink Chk	
	Chip Pass	Chip Fail	AVI			Rework						
Wafer #	Quantity	Quantity	Wafer Yield	QC Q'ty	S. Total	VC	QC	S. Total	Yield	Comment	Engineer Sign	
1	700	4	0.994									
2	704	0	1									
3	699	5	0.993									
4	704	0	1									
5	704	0	1									
6	693	11	0.984									
7	704	0	1									
8	704	0	1									
9	683	21	0.97									
10	702	2	0.997									
11	702	2	0.997									
12	704	0	1									
13	704	0	1									
14	704	0	1									
15	703	1	0.999									
16	702	2	0.997									
17	703	1	0.999									
18	703	1	0.999									
19	704	0	1									
20	703	1	0.999									
21	702	2	0.997									
22	703	1	0.999									
23	704	0	1									
24	703	1	0.999									
Total	16841	55	0.997									
T. wafers	24		Adjust Yield :									
Operator Initial and Date												



AVI Report Example
Each Wafer

WAV 1000 Wafer Map Editor - [03_2000-5-2_1126.cmp]

File Edit View Window Help

Wafer Information

Facility : Hiji　Device : S-1046

Rows, Cols : 44 , 24　Wafer Number : 3

Lot Number : 0022156　Die Sizes(x , y) : 245.00

Wafer ID : J-0022156-03-B7　Wafer Size : 6

Test Start : 11:26:08 02/05/2000

Test Stop : 11:27:29 02/05/2000

Good : 699 99.29%

AVI Bad : 5　5 0.71%

Color Palette :

- Non Chip
- Testable Chip
- Sample Die
- Edge Chip
- Plug Chip
- Electrical Bad
- Avi Good
- Avi Bad
- Probe Mark Too Large
- Probe Mark Too Small
- Probe Mark Position
- Probe Mark Missing
- Multiple Probe Marks
- Bond Pad Discolored

Ready　NUM

スタート　W/FAB TEST Equipment...　Hiji/Kitsuki WWW - Nets...　Microsoft PowerPoint - [...　WAV 1000 Wafer Ma...　午後 05:14

AVI Report example
Lot Over all （YAKITORI MAP）

WAV 1000 Wafer Map Editor - [Lot Report 0022156]

File Edit View Window Help

Wafer Information

Facility :	Hiji	Device :	S-10460
Rows, Cols :	44 , 24	Die(Row, Col) :	37, 5
Lot Number :	0022156	Die Sizes(x , y) :	245.00 , 1
Total Wafers :	24	Wafer Size :	6

Die Information

Row : 37

Col : 5

Fail Count : 9

Color Palette : Die Failed on __ Wafers:

0 - 4

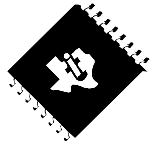
5 - 9

10 - 14

15 - 19

20 - 24

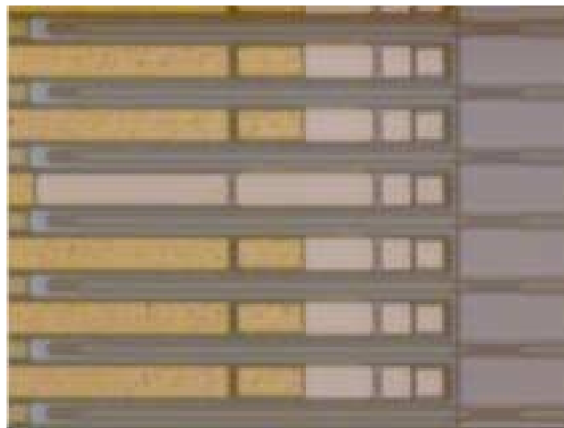
Ready NUM



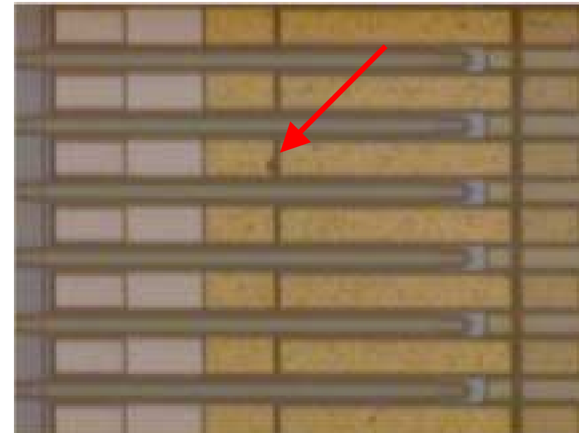
AVI Detect defects example

Void Pattern

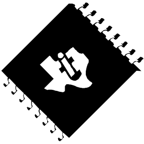
De focus pattern



Missing Pattern



Particle

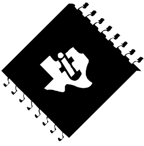


AVI Inspection Time / Wafer Lot

Condition : Lot = 6" 24 Wafers

Ink Less = 350 SQ MIL Shot, Multi/Sub.Chip

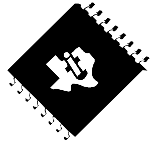
AQL 0.65%、 3 Wafers/Lot=100%



AVI Inspection Defects Analysis Before M/P Test on 104227 Device

Evaluation Lot = 2, n = 67

09/30/98 MM 072/6232



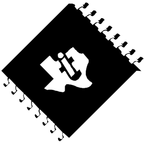
Hiji AVI Future Methodology

- **Ink less(Wafer Map) data link**
  - Electrical ink and data link to data transfer by E- net(No ink operation).
  - Networking connection.

- **Advanced AVI system**
  - 3 dimension (X,Y or Z) inspect. (Bump, Petal, Nozzle)
  - Bond Pad inspection.
  - Defect categorize.
  - Speed up
    - Flash shutter camera possibility.
    - Sampling inspection technique.
    - Single alignment work for Prober and AVI.
  - Detection level (More small size defect)

- **Intelligent AVI System**
  - Reduce foreign material on wafer or ignore function.
  - Auto abnormality defect check.
  - Full Automated Work station.(from Wafer ID)
  - Auto device program creation.

As of 04/25/00 MM



Fast Forward

QC/OG V/M DATA (ppm)

Defect ppm

12000
10000
8000
6000
4000
2000
0

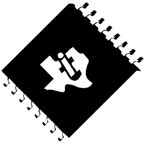
Implement AVI#1

Implement AVI#2

1Q'97 2Q'97 3Q'97 4Q'97 1Q'98 2Q'98 3Q'98 4Q'98 Jan-99 Feb-99 Mar-99 Apr-99 May-99 Jun-99 Jul-99 Aug-99 Sep-99 Oct-99 Nov-99 Dec-99

Date

A
B
C



Hiji AVI (Auto Visual Inspection) future plan

- 1 AVI System
- 2nd AVI
- Ink-less implement.
- Sampling Inspection.
- Clean room application AVI
- Network connection.
- Advanced AVI.
- 3 dimension inspect.
- Joint and parallel operation with M/P test
- Intelligent AVI

`98 `99 `00 `01 `02 `03 `04

06/25/99 MM 03-6232

As of 04/25/00 MM