

SEMI AUX032-0715

ROUND ROBIN STUDY OF METHOD FOR MEASUREMENT OF VOIDS IN BONDED PAIRS OF SILICON WAFERS

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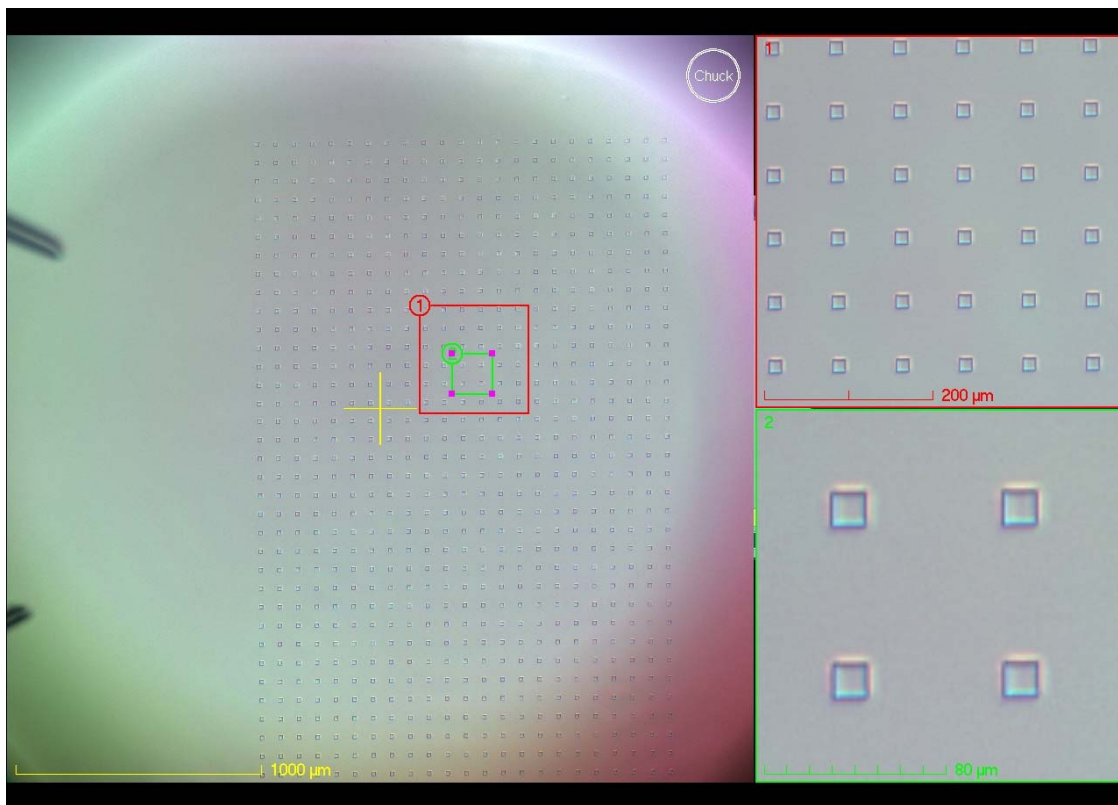
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1 Introduction

1.1 *Purpose and Approach* — This report is written to document the SEMI round robin study of method for measurement of voids in bonded pairs of silicon wafers. It was conducted in support of SEMI 3D13, Guide for Measuring Voids in Bonded Wafer Stacks. This study relied on the voluntary and uncompensated contributions of several participating laboratories. Their efforts are greatly appreciated. The main content of this report is found in the appendices and the corresponding digital files, which include the specimen design, the experimental protocol and data reporting sheet in the form of an Excel file, and the reports of the participating laboratories. A summary is given here as a guide to the user of this Document.

1.2 *Specimens* — The specimens consisted of bonded wafer pairs of standard silicon wafers with intentionally introduced bond voids. The specimen design was focused on manufacturability and reproducibility. The voids were square with sides from 0.5 to 300 μm . Four design thicknesses of voids, in separate BWP, were provided. The thicknesses were 1200, 800, 400, and 40 (nominal) nm. The actual thickness of the nominal 40 nm voids ranged from 10 to 60 nm. They were arranged in arrays of three density types: isolated, semi-dense, and dense. The voids were created by etching recesses on one wafer, and then bonding another wafer to it. A typical optical inspection image of the etched recesses that formed the voids is shown here.



#1 Three different magnifications included

Figure 1
Typical Optical Inspection Image of the Etched Recesses that Formed the Voids

1.3 *Scope* — The scope of the study extended only to detection, location, and sizing of the particular type of voids contained in the experimental specimens. Specifically, the potential and actual effects of bond voids on the performance and reliability of three-dimensional stacked integrated circuits are outside the scope of this study.

1.4 *Limitations* — The present results are directly relevant only to the specific materials studied, at the time frame of the experimental study, and to the instruments used by the contributors. As a result of the specimen production process, the bond voids in the specimens used here did not have strong stress fields surrounding them, as might be the case for voids occurring in the manufacture of production devices. Therefore, the present specimens are not appropriate for

evaluating measurement techniques that rely on local stress fields. The voids used here were located in arrays of same-sized and same-spaced voids. This may have created interference effects in the signals detected from these arrays. No foreign materials were introduced in the neighborhood of the voids, therefore the present specimens are not appropriate for evaluating techniques that rely on detecting the presence of materials different from silicon. The voids in the present study had flat surfaces parallel to the faces of the bonded wafers. Reflections of probes such as ultrasound or infrared light may be influenced by these flat surfaces.

1.5 Results — The results can be categorized into those that produced ‘quantitative detection’, meaning, quantitatively accurate location and sizing, those that produced images, and those that provided an indication of the presence of voids.

1.5.1 Quantitative detection — § 2 gives plots, generated by the SEMI team from the raw data provided, of measured void sizes against designed sizes for the results contributed by participants using acoustic microscopy and infrared microscopy. These techniques found little influence of void density and void thickness on their results. All were able to quantitatively detect the largest voids, and all had lower void size cutoff of the order of 50 μm in their accurate void size measurement capability. Calibration issues, such as whether the diagonal or the side of the void was measured have been omitted from the plotted results.

1.5.2 Imaging — The participants using acoustic and infrared microscopy produced compelling images of the voids. In addition, the participant using ultrasonic interferometry produced informative images of the voids, but did not claim the capability of deriving quantitative void size information from the images.

1.5.3 Indications — One participant applied ultrasonic resonance spectroscopy to the whole wafers. That participant’s report indicated that the presence of the 1200 and 800 nm thick voids was indicated in their application of this technique.

2 Results by Laboratory

2.1 Laboratory 1 — Laboratory 1 used full-wafer resonance at frequencies around 40 khz. They did not fill in the data sheet, but provided the following plot of ratios of vibration response of the whole wafer at different frequencies. The laboratory interprets these results as showing detection of the presence of voids in the wafers with 1200 and 800 nm deep voids. Their written report is included in the attached files.

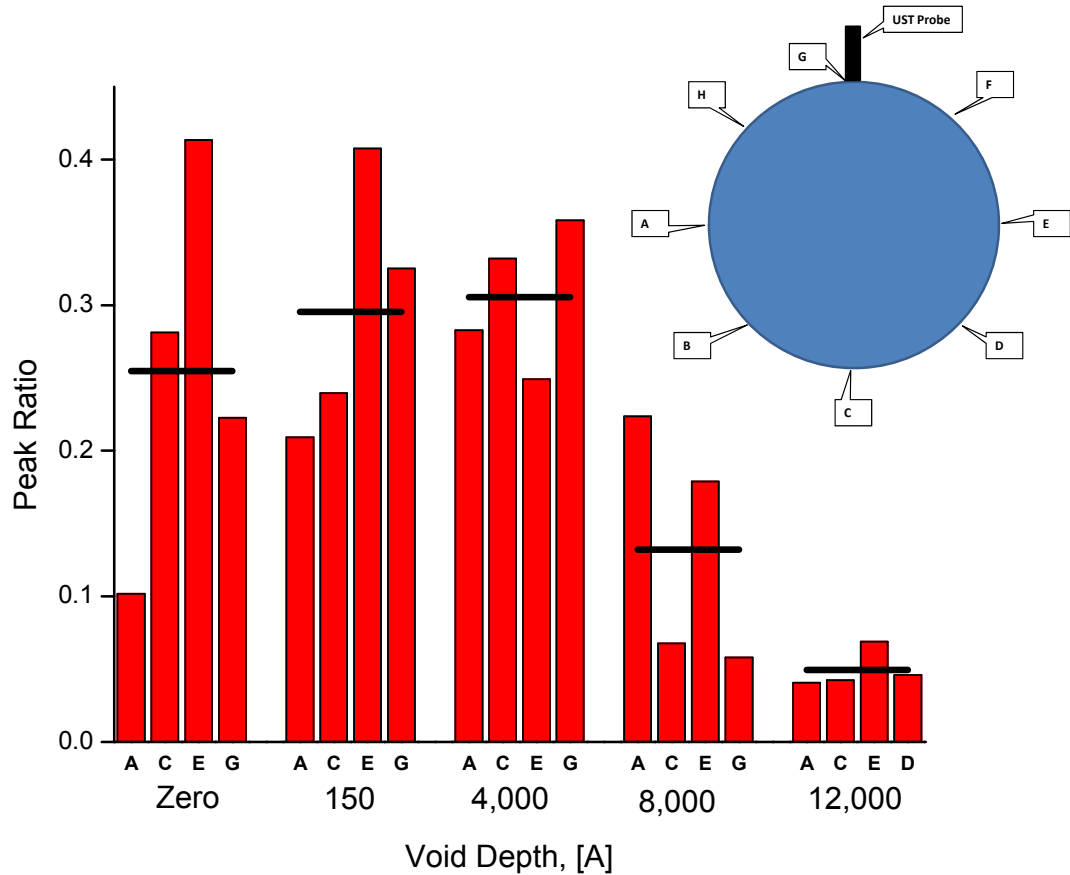


Figure 2
Laboratory 1 Plot of Ratios of Vibration Response of the Whole Wafer at Different Frequencies

2.2 *Laboratory 2* — Laboratory 2 used infrared interferometry to create images of the BWP interface. They provided the following plot showing typical results, and reported that their technique indicated the presence of all the void sizes at all thicknesses, but did not provide quantitative sizing. Their written report is included in the attached files.

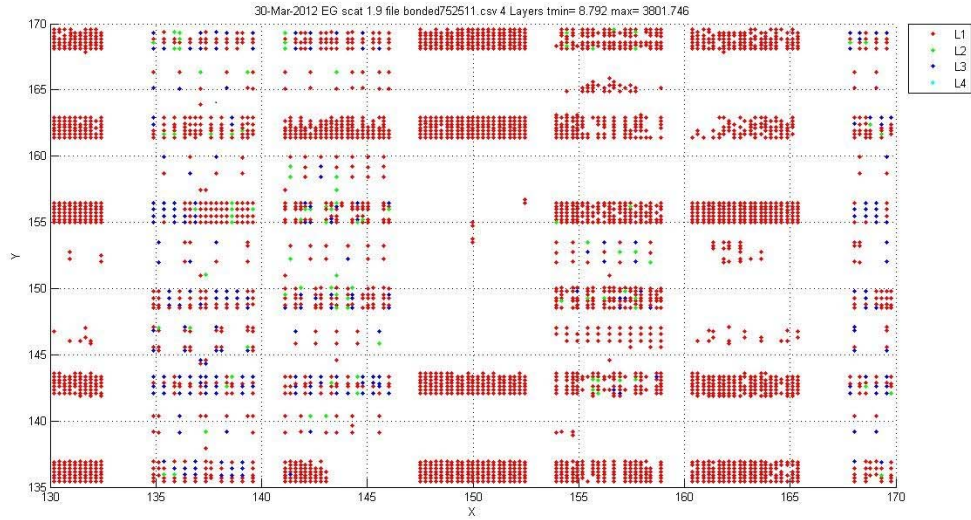


Figure 3
Laboratory 2 Images of the BWP Interface Using Infrared Interferometry

2.3 *Laboratory 3* — Laboratory 3 used infrared microscopy to create images of the voids at the BWP interface, as shown below. Their results are summarized in the following tables and plots, and their written report is included in the attached files.

25 μm voids

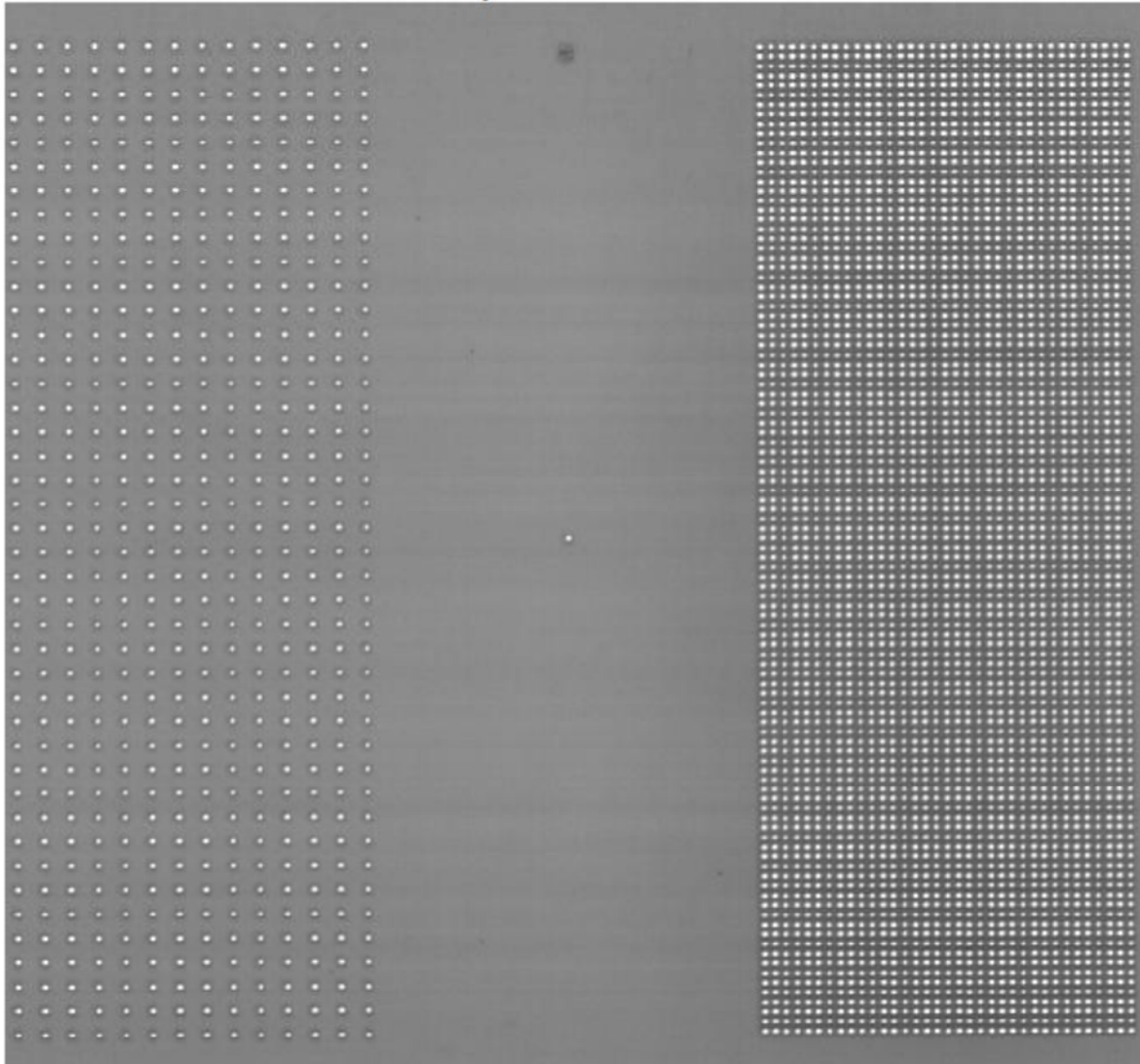


Figure 4
Laboratory 3 Images of the BWP Interface Using Infrared Microscopy

2.3.1 Their reported results on detecting voids of different thicknesses and densities, with different instrument settings, are reproduced here.

Smallest detectable lateral void size

Using 8 μm /pixel resolution:

	Isolated	Semi-Dense	Dense
40 nm	10 μm	10 μm	15 μm
400 nm	2.5 μm	5 μm	15 μm
800 nm			
1200 nm			

Using 0.8 μm /pixel resolution:

	Isolated	Semi-Dense	Dense
800 nm	0.5 μm	0.5 μm	2.5 μm

Figure 5
Laboratory 3 Reported Results on Detecting Voids of Different Thicknesses and Densities Using Different Instrument Settings

2.3.2 They provided quantitative sizing results in the data sheets. Those results are shown in the following three plots:

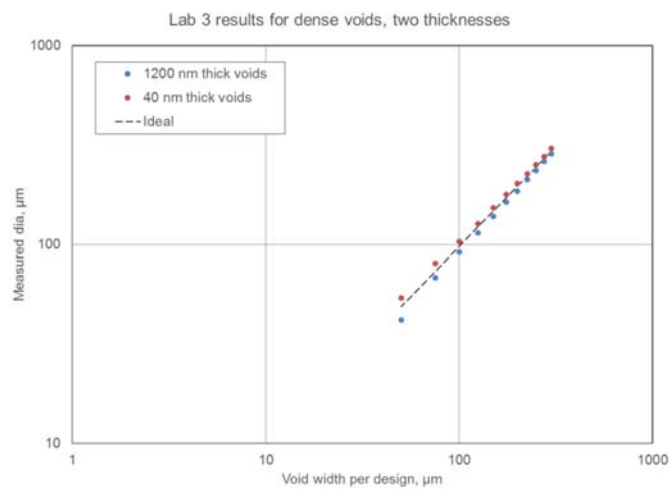
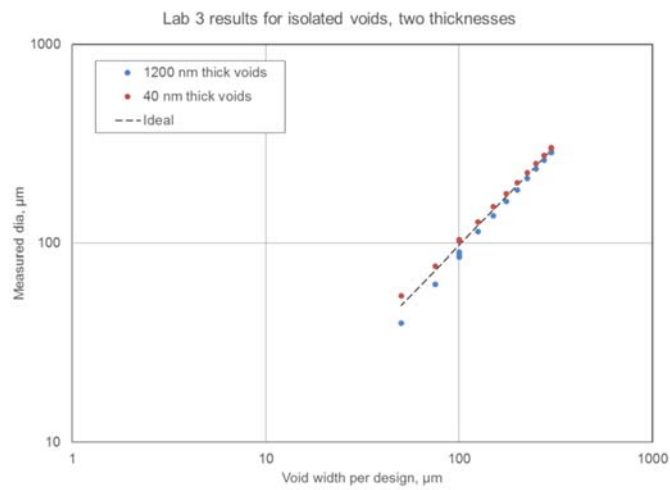
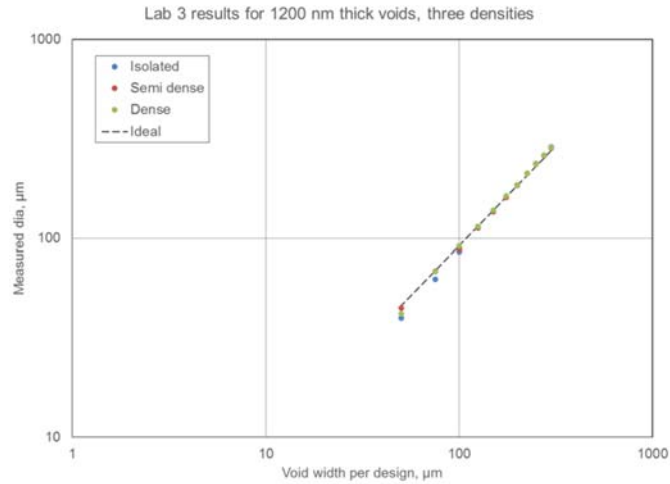


Figure 6
Laboratory 3 Quantitative Sizing Results

2.3.2.1 The data for these plots were collected with the 8 μm per pixel instrument setting. Quantitative results on void sizes were obtained from 300 μm wide down to 50 μm wide voids for all void densities and thicknesses.

2.4 *Laboratory 6* — Laboratory 6 used ultrasonic microscopy with a 190 MHz transducer. They provided results on detection of presence of voids and quantitative sizing results in the data sheets. The team tabulated their report on detection of presence in the following table. Their sizing results are shown in the following two plots.

Table 1 Results from Laboratory 6 on Minimum Void Sizes for Which Presence was Detected, μm

Void Thickness, nm	Void Densities		
	<i>Isolated</i>	<i>Semidense</i>	<i>Dense</i>
40	10	10	15
1200	5	0.5	0.5

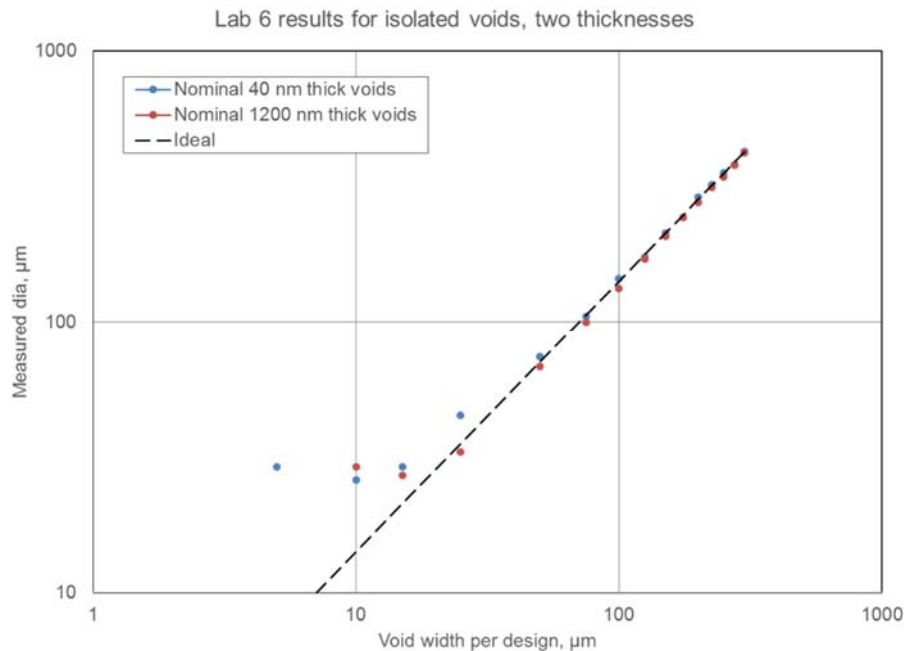


Figure 7
Laboratory 6 Results for Isolated Voids, 40 nm and 1200 nm Thickness

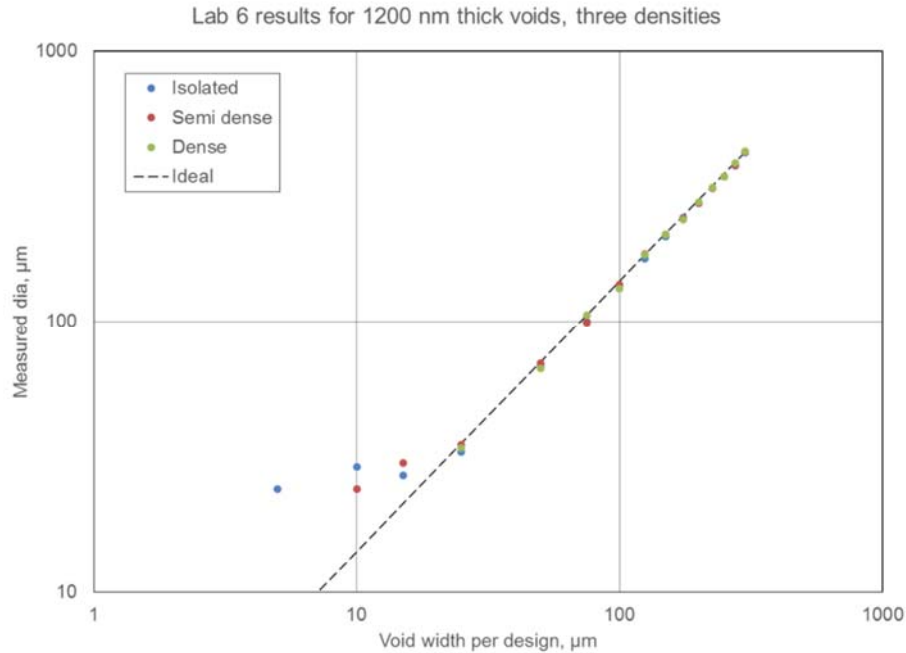


Figure 8
Laboratory 6 Results for 1200 nm Thick Voids, Three Densities

2.4.1 Quantitative results on void sizes were obtained from 300 μm wide down to 50 μm wide voids for all void densities at the largest and smallest thicknesses.

2.5 *Laboratory 7* — Laboratory 7 used ultrasonic microscopy with a 200 MHz transducer. They provided results on detection of presence of voids and quantitative sizing results in the data sheets. The team tabulated their report on detection of presence in the following table. Their sizing results are shown in the following two plots.

Table 2 Results from Laboratory 7 on minimum Void Sizes for Which Presence was Detected, μm

Void Thickness, nm	Void Densities		
	<i>Isolated</i>	<i>Semidense</i>	<i>Dense</i>
800	15	15	25
1200	10	10	15

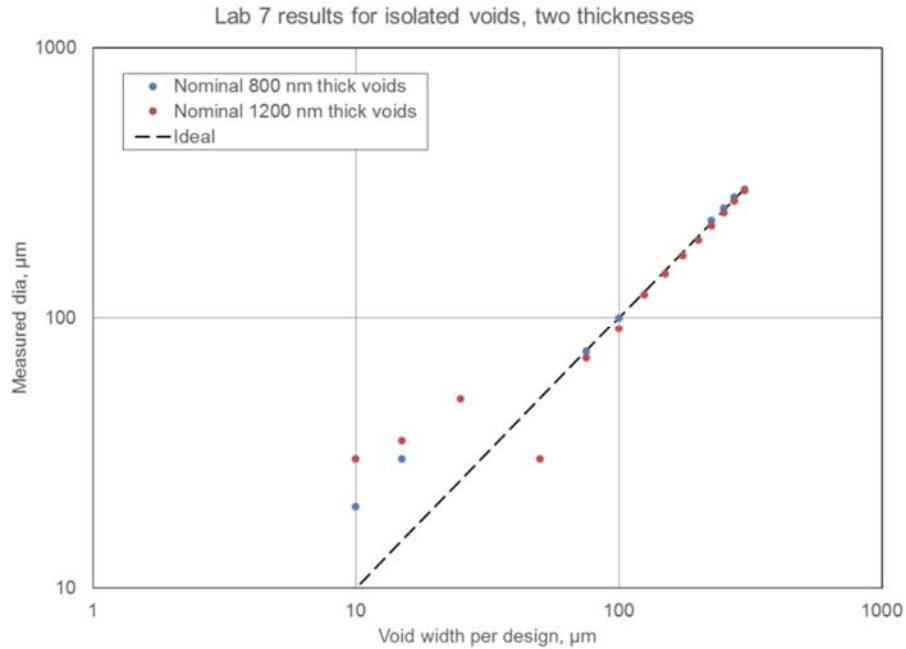


Figure 9
Laboratory 7 Results for Isolated Voids, Two Thicknesses

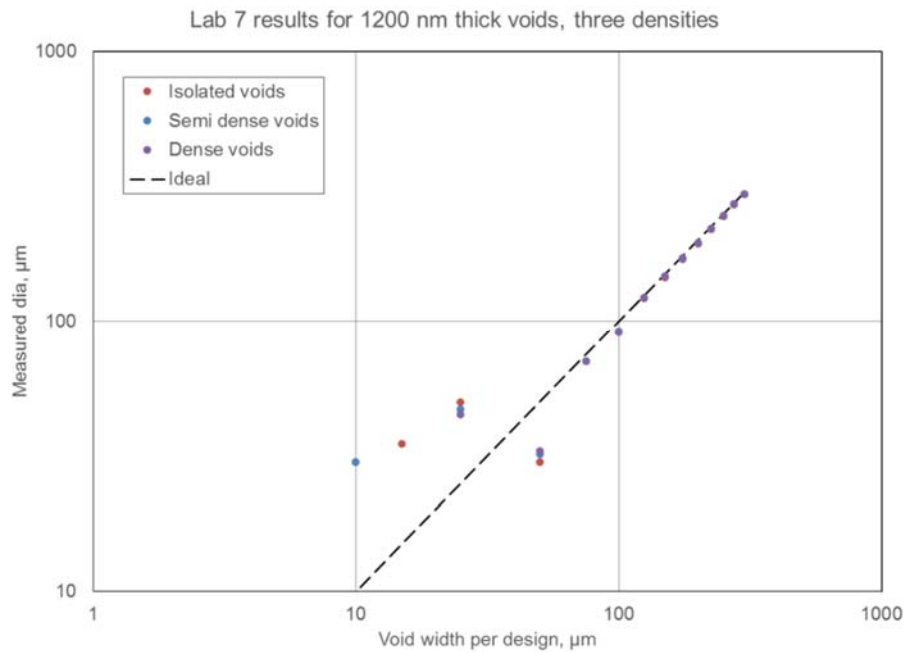


Figure 10
Laboratory Results for 1200 nm Thick Voids, Three Densities

2.5.1 Quantitative results on void sizes were obtained from 300 μm wide down to 75 μm wide voids for all void densities for the 1200 and 800 nm thick voids.

2.6 *Laboratory 8* — Laboratory 8 measured their reported void sizes manually from their infrared microscopy images. A sample image of dense 2.5 μm wide voids with a nominal thickness of 150 nm is shown here.

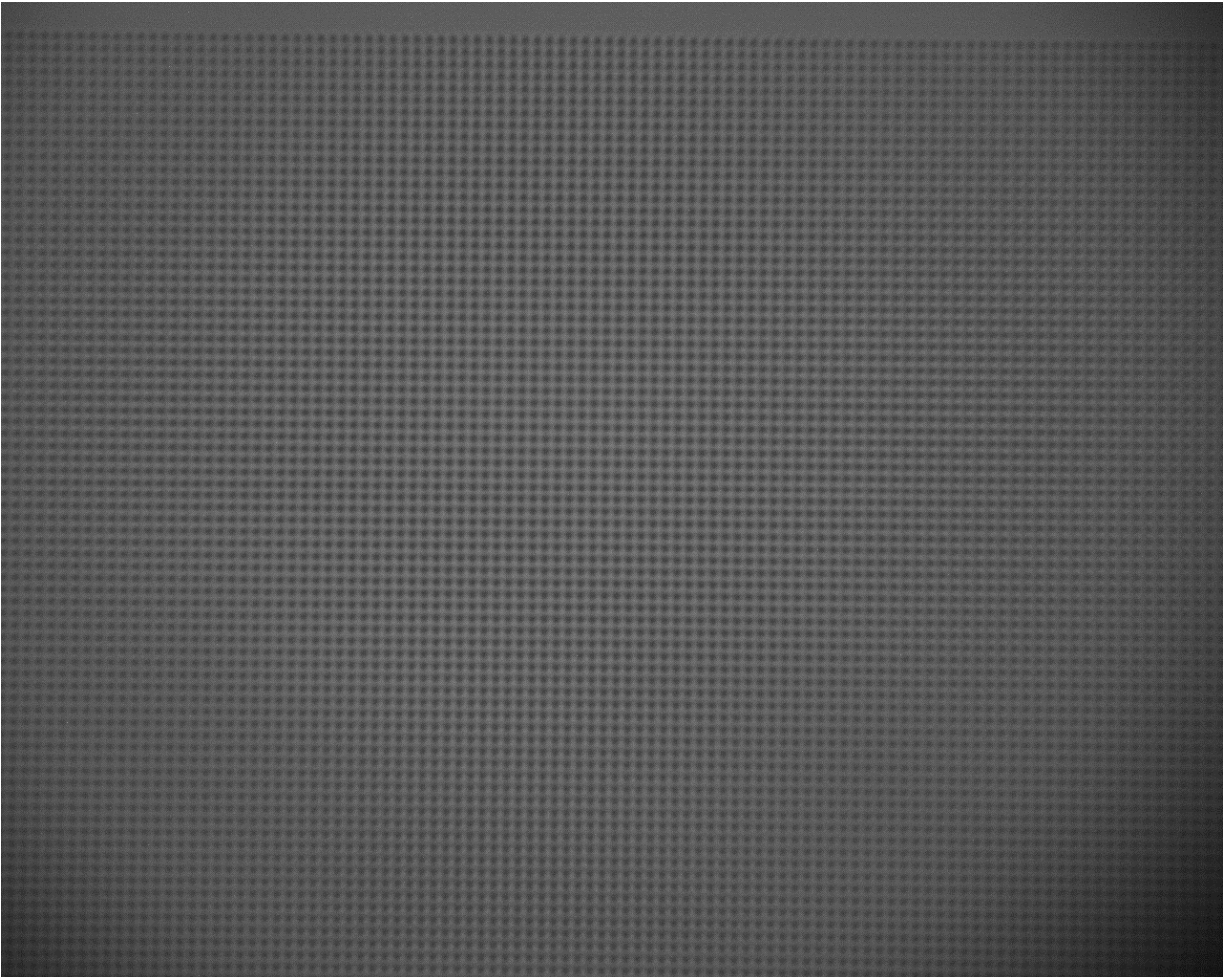


Figure 11
Laboratory 8 Sample Image of Dense 2.5 μm Wide Voids with a Nominal Thickness of 150 nm

2.6.1 Results for void detection by this technique are summarized in the following table.

Table 3 Results from Laboratory 8 on Minimum Void Sizes for Which Presence was Detected Using a Camera with Resolution Specified as 1024×1280 Pixels with Pixel Size 5 μm

Void Thickness, nm	Void Densities		
	<i>Isolated</i>	<i>Semidense</i>	<i>Dense</i>
40	1.0	1.0	2.5
400	1.0	1.0	2.5
800	1.0	1.0	2.5
1200	1.0	1.0	2.5

2.6.2 Void sizing results are shown in the following plot for semi-dense voids at the least and greatest thicknesses.

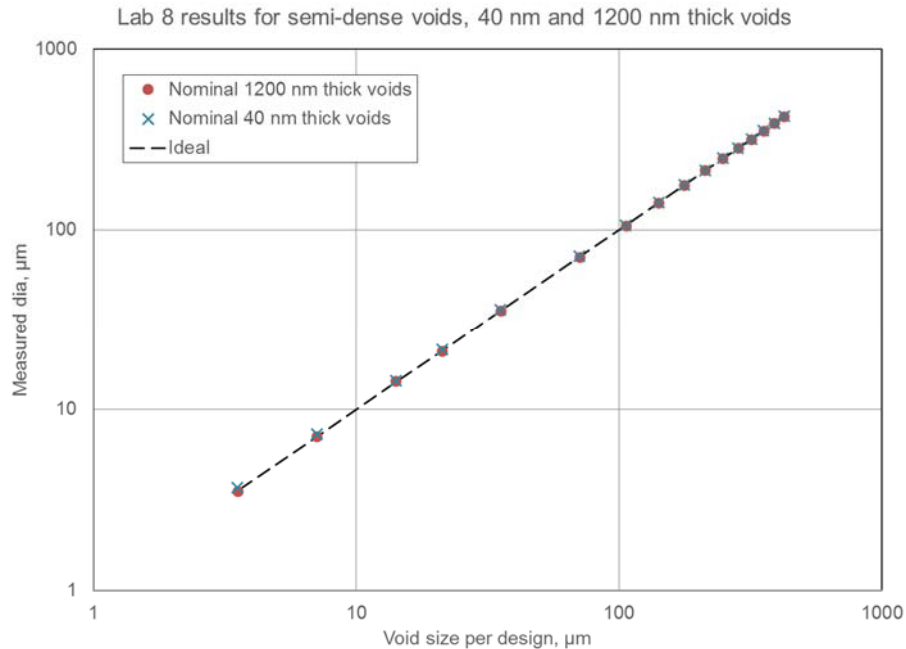


Figure 12
Laboratory 8 Results for Semidense Voids, 40 nm and 1200 nm Thick Voids

2.6.3 Laboratory 8 presented results for detection at all the supplied void thicknesses, and reported detection of voids from 300 μm wide down to 1 μm wide for isolated and semi-dense voids of all thicknesses, and from 300 μm wide down to 2.5 μm wide for dense voids of all thicknesses. This laboratory presented quantitative results for sizing semi-dense voids at the maximum and minimum supplied void thicknesses, for void widths from 300 μm to 2.5 μm wide. Laboratory 8 reported these results were obtained by manually measuring the void sizes from infrared microscopy images.

2.7 Laboratory 9 — Laboratory 9 used ultrasonic microscopy with a 200 MHz transducer. They provided results on detection of presence of voids and quantitative sizing results in the data sheets. The team tabulated their report on detection of presence in the following table. Their report indicated detection of the dense voids 40 nm thick “...as a whole, not individual...” for void sizes of 15 to 2.5 μm ; they also indicated similar detection of dense void arrays for voids 400 nm thick for void sizes of 15 to 1.0 μm . Their sizing results are shown in the following two plots.

Table 4 Results from Laboratory 9 on Minimum Void Sizes for Which Presence was Detected, μm

Void Thickness, nm	Void Densities		
	Isolated	Semidense	Dense
40	10	10	25
400	10	10	1

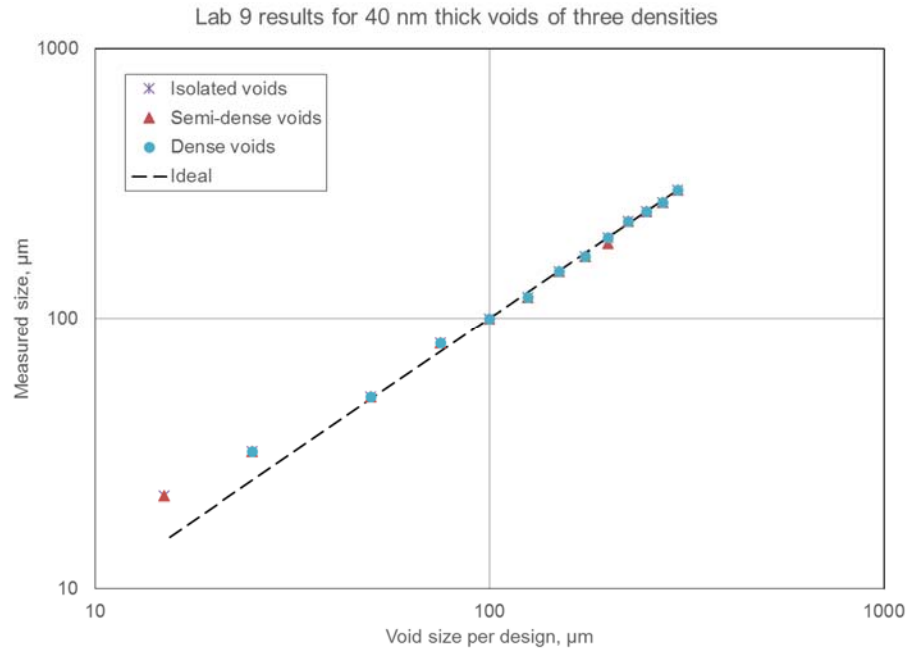


Figure 13
Laboratory 9 Results for 40 nm Thick Voids of Three Densities

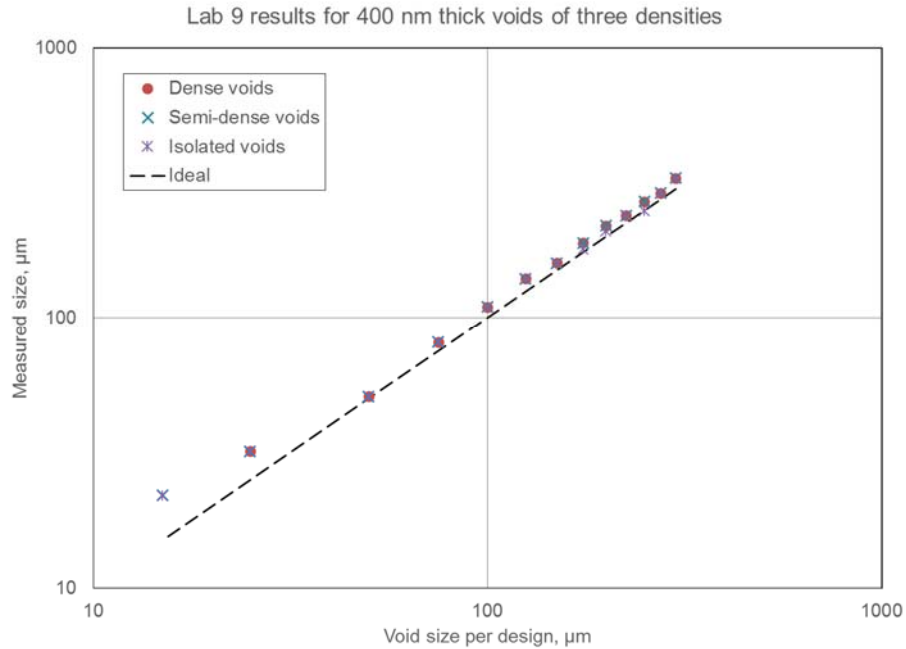


Figure 14
Laboratory 9 Results for 400 nm Thick voids of Three Densities

2.8 *Laboratory 10* — Laboratory 10 used ultrasonic microscopy with a scan resolution of 20 μm . They provided results on detection of presence of voids and quantitative sizing results for the 400 nm thick voids at all three densities. The team tabulated their report on detection of presence of voids in the following table. Their sizing results are shown in the following plot. The void size results for the three densities were indistinguishable.

Table 5 Results from Laboratory 10 on Minimum Void Sizes for Which Presence was Detected, μm

Void Thickness, nm	Void Densities		
	<i>Isolated</i>	<i>Semidense</i>	<i>Dense</i>
400	25	50	50

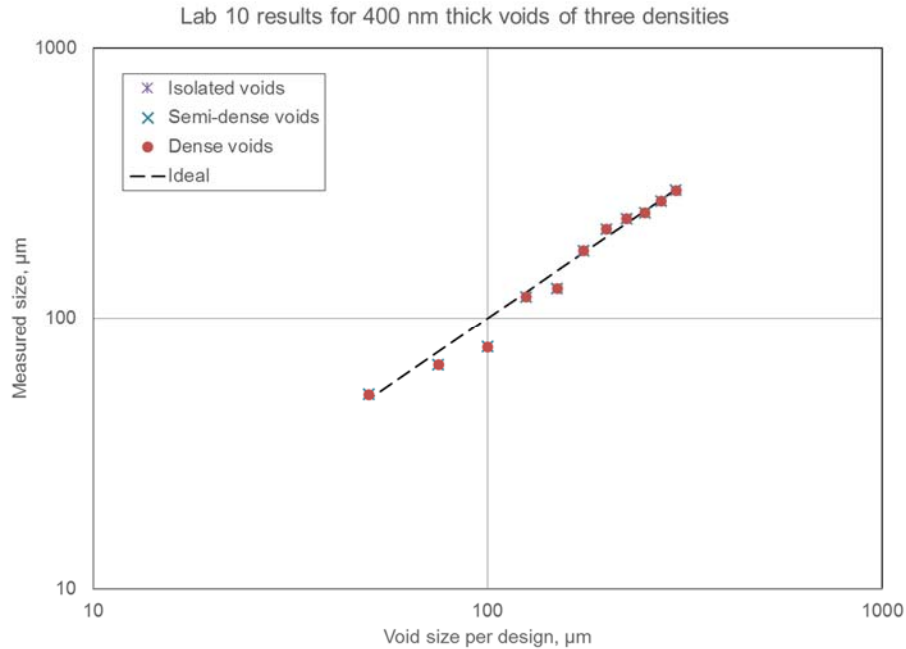


Figure 15
Laboratory 10 Results for 400 nm Thick Voids of Three Densities

2.8.1 Acoustic microscope images of dies containing voids of the two extremes of thickness used here, 15 nm and 1200 nm, are shown below. The images are very similar, indicating the insensitivity to void thickness of this particular technique. The images also show that the image intensity decreases markedly with decreasing void size.

Acoustic microscope images of two specimen dies with different void thicknesses by Lab 10

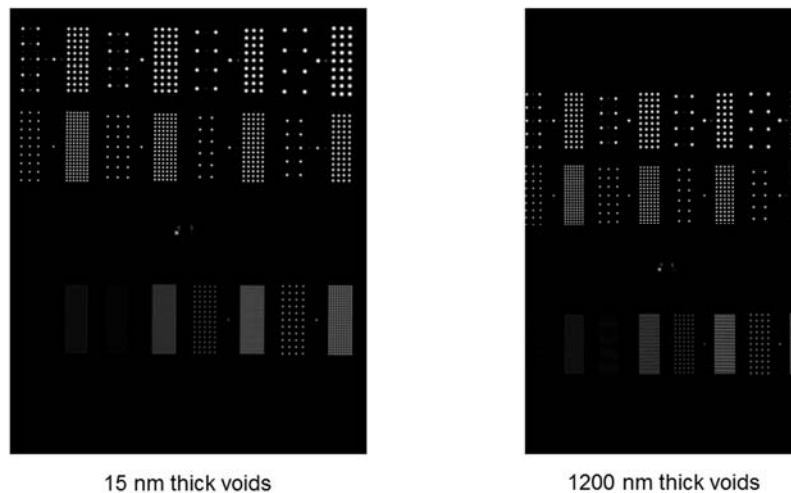
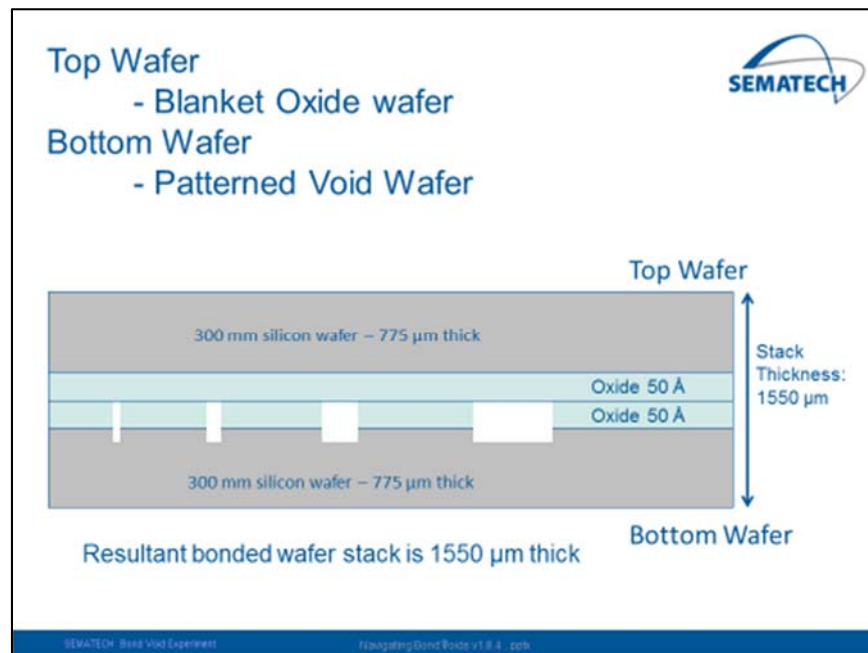
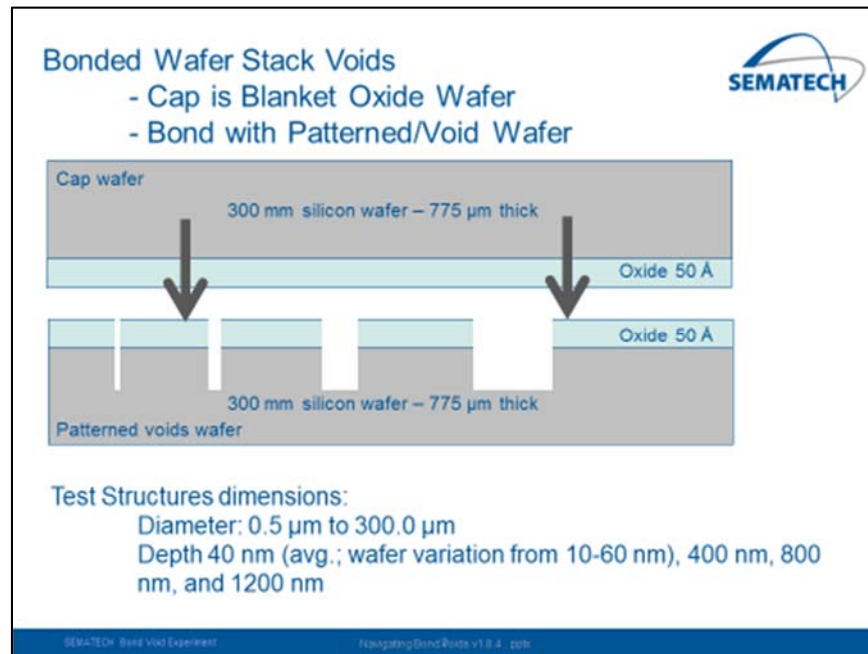


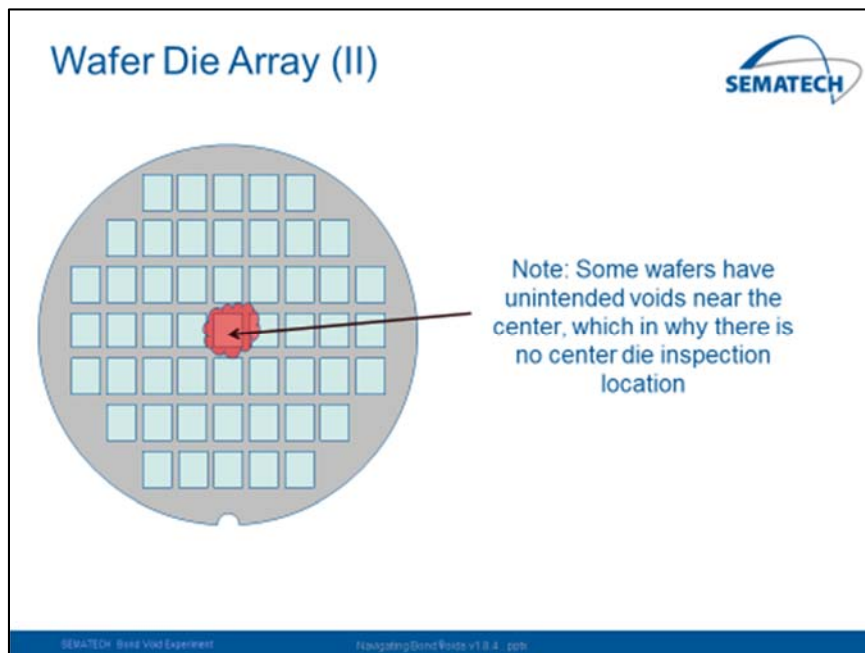
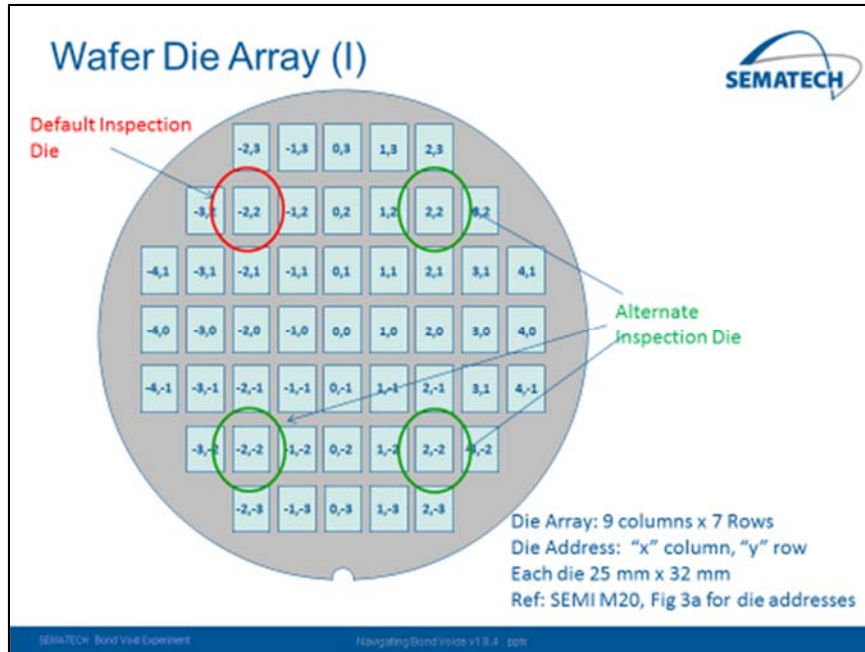
Figure 16
Laboratory 10 Acoustic Microscope Images of Two Specimen Dies with Different Void Thicknesses

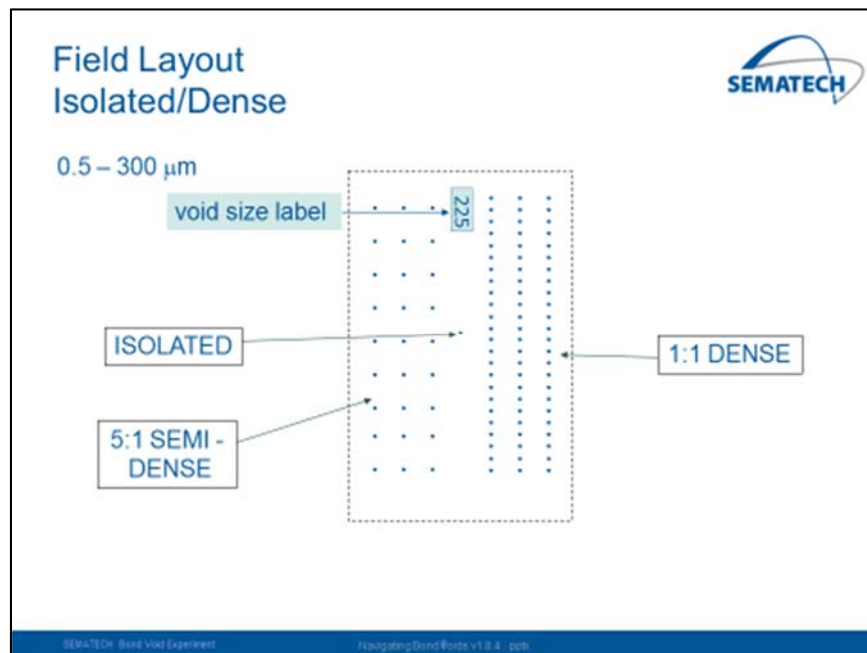
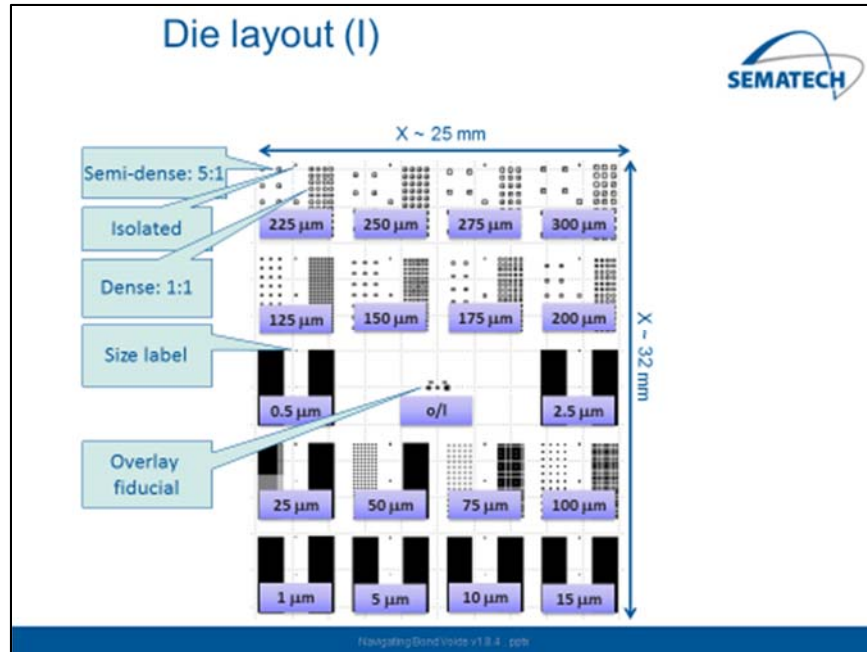
RELATED INFORMATION 1 SPECIMENS

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R1-1 The Specimens are Described in Power Point Format Here







RELATED INFORMATION 2

PROTOCOL FOR THE EXPERIMENTAL STUDY, AS PROVIDED TO THE PARTICIPANTS

NOTICE: This Related Information is not an official part of SEMI AUX032 and was derived from the work of the 3DS-IC Global Technical Committee. This Related Information was approved for publication by full letter ballot procedures on January 5, 2015.

R2-1 Protocol (Version 1.9) for Cooperative Experimental Study on Detection of Voids in the Bondline between Bonded Wafers

R2-1.1 Thank you for your participation in the Cooperative Experimental Study on Detection of Voids in the Bondline between Bonded Wafers. This study is being conducted by the Bond Void Metrology Working Group under the SEMI 3DS-IC Inspection & Metrology Task Force. Its purpose is to document the capability of different wafer bond inspection systems on bonded wafer pairs representative of current fabrication practice.

R2-1.2 Protocol for Participants in the Experimental Study

R2-1.2.1 Each participant is required to have:

- Access to a system capable of inspecting voids in the bond plane of 300-mm bonded silicon wafers, such as are used in 3-dimensional interconnect and in micro electro mechanical systems (MEMS). Liquid immersion is allowed.
- This system must be capable of detection and sizing of small voids (diameters 300 micrometers and less) with depths of 4 nm to 1200 nm.
- For recording and reporting the inspection data, the operator must have capability for data entry in spreadsheet files, and for transferring and writing same.

R2-1.2.2 Each participant will receive:

- A set of four bonded-wafer pair (BWP) test vehicles to be inspected, with a spreadsheet containing their lab's wafer ID information. Each test vehicle contains two standard thickness 300 mm silicon wafers bonded using an oxide bonding process. In each BWP the Cap Wafer is unpatterned; the Void Wafer is patterned with voids from 0.5 μm to 300 μm wide, and depths ranging from 4 to 1200 nm. Each BWP contains two visible, machine readable alphanumeric codes; one each on the stack top and stack bottom, near the orientation notch. The BWP test vehicles will be in slots 11–14 of the FOSB as follows, with the patterned wafer facing down:
 - Slot 11: 1,200 nm deep voids
 - Slot 12: 800 nm deep voids
 - Slot 13: 400 nm deep voids
 - Slot 14: 4–15 nm deep voids

An example of how the wafer shipping information should appear:

Company	Void Depth (nm)	Wafer ID 1 (Cap) - facing up	Wafer ID 2 (Void) - facing down	Slot
Company A	1200	462A3I04SEA6	462A2N4BSEH1	11
	800	462ASI08SED0	462A2J3ASEB7	12
	400	46FGX031SJB1	462A556USEB7	13
	4-15	462A3W85SEG5	462A5198SEG2	14

- b. Spreadsheet file: to be filled in with experimental inspection data: Data Reporting Worksheet v1.8.xlsx.
- c. Additional, descriptive information file (e.g., Navigating Bond Voids v 2.0.pptx).
- d. This document (Protocol v. 1.9).
- e. Cover sheet with a table listing the alphanumeric codes (top and bottom) for your specific wafer set.
- f. Please note that electronic copies of the most current versions of all files will be posted on the 3DS-IC Committee's Web site in the directory:

<https://sites.google.com/a/semi.org/3dsic/3ds-ic-inspection-metrology-tf/5270-bond-void-interlaboratory-experiment>

R2-1.2.3 Preliminary Steps

- a. Copy the empty data file to a writeable drive. Rename it including unique, particular information such as the company name in the file name so we don't receive multiple files with the same name.
- b. Data from each specimen should be recorded on a separate page of the spreadsheet file.
 - i. Locate or create a page, fill in the specimen number, test date, operator name, inspection equipment type, and inspection equipment software version.
 - ii. Record instrument settings and data processing parameters used for final measurement, including, as applicable, adjustments for different specimens. This data can be appended to the spreadsheet or provided as a separate document. If it is more convenient to produce this in hard-copy format, please return these pages experiment coordinator as hard-copy or PDFs of scans.

R2-1.2.4 Setup

R2-1.2.4.1 Place the specimen into the inspection system with its orientation fiducial notch toward the operator and the specimen's center near the center of the inspection system's coordinate system (see Figure R1-1). Using the inspection system, locate the fiducial notch at approximately $[x = 0 \text{ mm}, y = -150 \text{ mm}]$ from the center of the inspection system. Register the specimen origin at $x = 0 \text{ mm}$ and $y = 150 \text{ mm}$ from this fiducial notch.

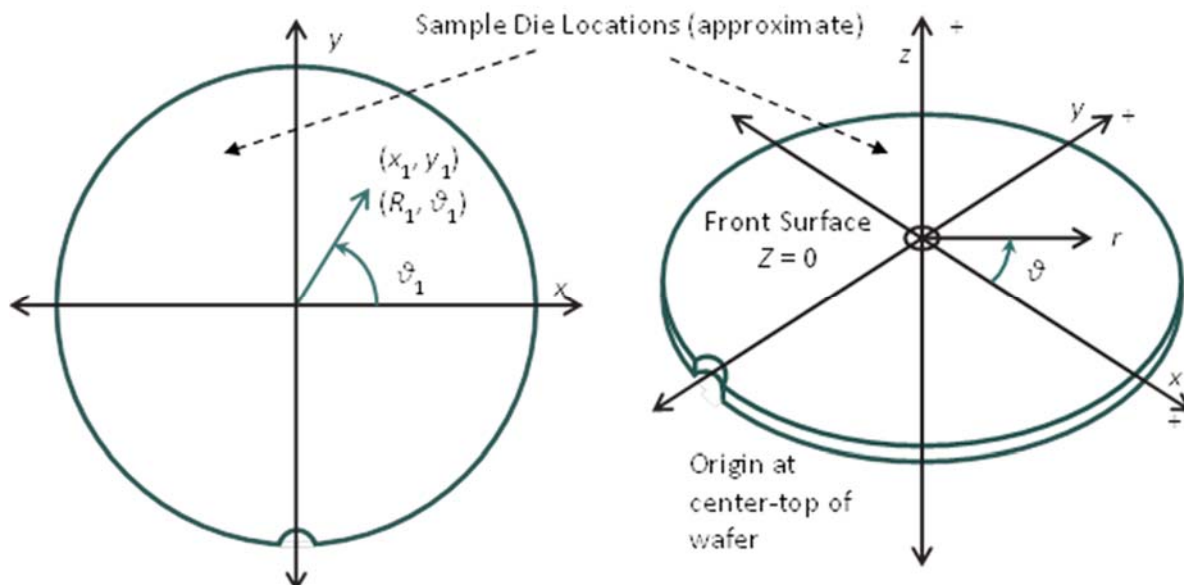


Figure R2-1
Wafer Coordinate System (after SEMI M20)

R2-1.2.4.2 The attached file describes how to identify the chip on the wafer to be measured; the spreadsheet file named *Die_coordinate_worksheet.xls* gives the locations of voids with particular sizes within the chips.

R2-1.2.5 *Measurement Sequence*

- a. Position the bonded wafer pair to inspect the Default Die, whose center is located at coordinate position $-2, 2$.
 - i. Make certain that the wafer is placed in the tool with the 'top' marking towards the sensor.
- b. In that die, locate the 300 μm bond void region, inspect and record the locations of
 - i. Isolated voids
 - ii. Location of one void in a Semidense region, and
 - iii. One void in a Dense region
- c. Repeat this procedure within the Default Die for the 15 other bond void sizes from 275 μm to 0.5 μm .
- d. If Default Die Inspection proves impractical, shift to one of the alternate die located at
 - i. 2,2 or
 - ii. 2,-2 or
 - iii. -2,-2
- e. Complete die inspection using the above procedure.

R2-1.2.6 *Measurement Data Reporting*

- a. For each nominal void size, three rows are provided in the spreadsheet (except for the 15 μm , 100 μm , and 300 μm voids – see item c). Fill these with data for the I, S, and D voids, as defined above. The procedure for each nominal void size, indicated in column B, is detailed as follows. We request that, if possible, all raw data be saved by the participating laboratory in the event of questions by the project team.
- b. For the void size group being investigated, the operator should first attempt to find the isolated (I) void. The approximate locations of the (I) voids are listed in the file *Die_coordinate_worksheet.xls*. If this void is located, the operator will checkmark column F (Y) indicating yes to the question 'Void detected?', in the spreadsheet corresponding to the specimen being inspected, in the appropriate cell. Otherwise the operator should checkmark column G (N). The operator will next record:
 - i. The location of the center of the isolated void in x,y coordinates in columns H and I, using an origin and units that are appropriate for the equipment being used. If the units are not mm, the operator should so indicate in the worksheet.
 - ii. The size of the void as the largest diameter, in micrometers, in column N.
 - iii. The measured thickness of the void, in micrometers by preference, but in other units as appropriate if necessary for the system being used, in column O.

Other information such as the area of the void, comments about its shape, or the filename of an image file can be entered in the spreadsheet, in columns T and beyond.

- c. For three selected void sizes, 15 μm , 100 μm , and 300 μm diameters, the operator will repeat 5 times the size measurement of the isolated void simply by 'pressing the button' of the inspection system to re-measure and re-record the void size of the captured data/image. These data are intended to assess "static repeatability" of the void size measurements.
- d. Two additional rows for each nominal void size are provided in the spreadsheet. Fill these with data for the S, and D voids, as defined above. Enter the relevant data for the S or D void in the appropriate row, as indicated by an X in column C, D, or E. For both the S and D voids, the operator will attempt to locate and characterize a row of 3 adjacent voids. Because the die pattern contains arrays of multiple S and D voids, the operator may choose the 3 adjacent voids to be measured at his or her discretion. If such a row of voids is located, the operator will checkmark column F (Y) indicating yes to the question 'Void (array) detected?' in the spreadsheet corresponding to the specimen being inspected, in the appropriate cell. Otherwise the operator should checkmark column G (N).



- i. The operator will record the location of the centers of the 3 selected voids in the appropriate row in columns H-M in the data recording sheet, in x,y coordinates using the notch as the origin and units in units of mm. If the metrology tool uses a different origin and/or measurement units, the native values will be stored and the data converted to mm and notch-origin.
 - ii. The operator will record the measured maximum diameter and the measured thickness, in micrometers, of the 3 selected voids in columns N-S.
 - iii. Other information such as the regularity of the array or the filename of an image file can be entered in the spreadsheet.
- e. Repeat this procedure to acquire one complete set of data for all void sizes in one inspected die on all four specimens.
 - f. Repeat this procedure to acquire two additional complete sets of data for each void size on all four specimens on different days with the same operator.

R2-1.2.7 *Contacts/Data Reporting Procedure*

Questions about the samples, test structure design, and test protocol may be addressed to:

Name
Company/organization
Street Address
City, State, Zip Code

Email Address
Telephone Number

Provide the complete data file, containing data from 4 samples, via email to:

Name
Company/organization
Street Address
City, State, Zip Code

Email Address
Telephone Number

We ask that you retain and store the 4 samples for 12 months in case additional measurements are desired.

R2-1.2.8 *Data Analysis*

R2-1.2.8.1 The data will be collated and analyzed statistically by the working group team. The results will be publicly announced at a date and location to be determined. Note that the specific results will be published without laboratory names associated with particular data sets.

Thank you for your participation in this cooperative study.

RELATED INFORMATION 4 DATA REPORT CONTRIBUTED BY LABORATORY 3

NOTICE: This Related Information is not an official part of SEMI AUX032 and was derived from the work of the 3DS-IC Global Technical Committee. This Related Information was approved for publication by full letter ballot procedures on January 5, 2015.

NOTE 1: These data were produced using an infrared microscopy instrument.

DATA REPORTING SHEET										Rev 6/21/2013	
Bond Void Test in Support of SEMI Draft Document 5270, under development by the 3DS-IC Committee/Inspection and Metrology Task Force											
Test Date	Operator ID		Supplier	Model		ID		S/W Version			
6/17/2013											
				Detection:		Imaging		[X] Yes [] No			
				Measure Field/Spot Size, mm		8 mm					
				Measure Field/Scan Speed, mm/sec		max. 14 mm/s		Field Shape		[] Round [X] Rectangular	
Ambient Temp @ Test Start		Ambient Temp @ Test End		C	F	Ambient Humidity @ Test Start		Nominal Void Depth			
26.4		26.5		[X]	[]	44.8% RH		40 nm			
Void Detection Measurement Results											
[SAMPLE ID Mark]				Die location - from wafer map				Measurement Data			
Adjacent to Sensor				Die Location (x, y) Indicate with an X				Attached			
Away from Sensor				2.2 2.2 2.2 -2.2				[X] Yes [] No Data Filed at			
* Example-462A31TSEB1				X				-2.2 die 40nm depth.png			
Indicate Reference System Used:											
[X] Wafer reference (origin at center of wafer)											
[] Die reference system (origin @ die center)											
[] Die reference system (origin @ die corner)											
Notes: Please include experimental set up-if ultrasonic microscopy, transducer frequency and pixel size; if x-ray, voxel size, etc.											
Void Size, µm	Void Density		Detected	Void Location, X and Y, mm (Isolated or first S or D void)		Void Locations, X and Y, mm (Additional voids in S and D arrays)		Max. diameter and depth, µm (Isolated or first void)		Max. diameter and depth, µm (Additional voids in S and D arrays)	
	Isolated	S = Semi-dense	D	Y	N	X mm	Y, mm	X mm	Y, mm	X mm	Y, mm
300	X			X		-42.344	78.793			300.61	
	X			X		-42.348	78.793			301.89	
	X			X		-42.352	78.788			300.54	
	X			X		-42.360	78.784			301.15	
	X			X		-42.368	78.779			302.45	
	X	X		X		-44.792	81.039	-43.311	81.041	302.01	
	X	X	X	X		-41.268	81.185	-40.624	81.184	303.63	
	X			X		-48.763	78.803			276.44	
275		X		X		-51.172	80.858	-49.813	80.861	277.3	
		X		X		-47.581	80.995	-47.040	80.994	275.99	
	X			X		-55.182	78.809			250.72	
250		X		X		-57.528	80.677	-56.201	80.680	251.11	
		X		X		-54.197	81.050	-53.699	81.049	250.88	
	X			X		-61.597	78.811			225.97	
	X	X		X		-63.686	81.053	-62.768	81.055	225.06	
	X			X		-60.541	81.052	-60.090	81.051	225.58	
200		X		X		-42.351	72.398			201.43	
	X			X		-44.575	74.395	-43.587	74.398	203.32	
	X			X		-41.220	74.795	-40.825	74.794	202	
	X			X		-48.770	72.404			176.94	
175		X		X		-50.934	74.593	-50.069	74.586	175.56	
	X			X		-47.737	74.845	-47.390	74.845	178.23	
	X			X		-55.189	72.410			152.89	
150		X		X		-57.660	74.657	-56.918	74.655	151.39	
		X		X		-54.204	74.802	-53.907	74.802	152.78	
	X			X		-61.608	72.418			127.54	
125		X		X		-63.956	74.912	-63.336	74.911	124.86	
	X	X		X		-60.622	74.906	-60.377	74.906	127.12	
	X			X		-42.370	59.595			104.27	
	X			X		-42.378	59.599			103.94	
	X			X		-42.378	59.595			102.35	
	X			X		-42.386	59.598			103.71	
	X			X		-42.394	59.577			102.38	
	X	X		X		-44.841	62.085	-44.347	62.081	103.94	
	X			X		-41.436	62.081	-41.238	62.081	104.2	
75		X		X		-48.789	59.601			79.92	
	X	X		X		-51.260	62.028	-50.892	62.025	79.74	
	X			X		-47.878	62.060	-47.732	62.064	80.74	
50		X		X		-55.207	59.602			54.58	
	X			X		-57.674	62.094	-57.433	62.094	55.28	
	X			X		-54.321	62.137	-54.222	62.142	54.11	
	X			X		-61.622	59.617			28.03	
25		X		X		-64.152	62.158	-64.034	62.158	27.94	
	X	X		X		-60.735	62.148	-60.688	62.143	29.89	
	X			X		-42.377	53.196			29.68	
	X			X		-42.381	53.198				
	X			X		-42.385	53.191				
	X			X		-42.393	53.185				
	X			X		-42.401	53.176				
	X	X		X		-44.923	55.892	-44.848	55.887	55.616	
	X			X		-41.498	55.740	-41.467	55.735	55.713	
10		X		X		-48.796	53.202				
	X	X		X		-51.361	55.724	-51.322	55.729	55.680	
	X			X		-	-	-	-	-	
5		X		X		-	-	-	-	-	
	X			X		-	-	-	-	-	
	X			X		-	-	-	-	-	
2.5		X		X		-	-	-	-	-	
	X			X		-	-	-	-	-	
	X			X		-	-	-	-	-	
1.0		X		X		-	-	-	-	-	
	X			X		-	-	-	-	-	
	X			X		-	-	-	-	-	
0.5		X		X		-	-	-	-	-	
	X			X		-	-	-	-	-	
	X			X		-	-	-	-	-	
COMMENTS											
Smallest detectable void sizes for the 40 nm nominal void depth sample: isolated: 10 µm, semi-dense: 10 µm, dense: 15 µm. For these and larger ones coordinates can be determined.											
Smallest lateral size of a void that can automatically be determined: 25 µm.											
Measure field in y direction is 8 mm, scan speed in x direction is maximum 14 mm/s for this 8 µm/pixel resolution.											

DATA REPORTING SHEET Rev 6/21/2013
Bond Void Test in Support of SEMI Draft Document 5270, under development by the 3DS-IC Committee/Inspection and Metrology Task Force

Test Date	Operator ID	Supplier	Model	Test System ID	S/W Version
6/17/2013					
Detection:			8 mm	Imaging ☒ Yes ☐ No	
Measure Field/Spot Size, mm			max. 14 mm/s	Field Shape ☐ Round ☒ Rectangular	
Measure Field/Scan Speed, mm/sec					
Ambient Temp @ Test Start	Ambient Temp @ Test End	C ☒ F ☐	Ambient Humidity @ Test Start	Nominal Void Depth	
26.9	26.7	[X] []	44.2% RH	400 nm	

Void Detection Measurement Results

SAMPLE ID Mark*	Die location - from wafer map	Measurement Data
46F GX035SJD3	Die Location (x, y) Indicate with an X	Attached ☒ Yes ☐ No
462A556XSEH2	-2.2 2.2 -2.2 -2.2	Data Filed at
Example-462A311TSEB1	X	-2.2 die 400nm depth.png

Indicate Reference System Used:
☐ X Water reference (origin at center of wafer)
☐ Die reference system (origin @ die center)
☒ Die reference system (origin @ die corner)

Void Size, μ m	Void Density		Detected	Void Location, X and Y, mm (Isolated or first S or D void)		Void Locations, X and Y, mm (Additional voids in S and D arrays)				Max. diameter and depth, μ m (Isolated or first void)		Max. diameter and depth, μ m (Additional voids in S and D arrays)				Notes: Please include experimental set up-if ultrasonic microscopy, transducer frequency and pixel size; if x-ray, voxel size, etc.
	I Isolated	S Semi-dense		Y	N	X, mm	Y, mm	X, mm	Y, mm	X, mm	Y, mm	Dia, max, μ m	Depth, μ m	Dia, max, μ m	Depth, μ m	
300	X		X			-42.343	78.794					299.33	-			IR microscopy, pixel size = 8 μ m
	X		X			-42.355	78.790					297.92	-			IR microscopy, pixel size = 8 μ m
	X		X			-42.367	78.786					300.03	-			IR microscopy, pixel size = 8 μ m
	X		X			-42.387	78.777					299.95	-			IR microscopy, pixel size = 8 μ m
	X		X			-42.407	78.777					299.22	-			IR microscopy, pixel size = 8 μ m
275		X	X			-44.791	81.046	-43.305	81.041	79.547		300.5	-	299.34	300.37	IR microscopy, pixel size = 8 μ m
		X	X			-41.211	81.184	-40.815	81.182	80.588		299.72	-	300.21	299.66	IR microscopy, pixel size = 8 μ m
		X	X			-48.762	78.796					275.69	-			IR microscopy, pixel size = 8 μ m
		X	X			-51.171	80.861	-49.808	80.860	79.490		273.67	-	274.94	274.52	IR microscopy, pixel size = 8 μ m
		X	X			-47.580	80.990	-47.034	80.997	80.447		275.09	-	274.8	275.12	IR microscopy, pixel size = 8 μ m
250		X	X			-55.181	78.811					249.06	-			IR microscopy, pixel size = 8 μ m
		X	X			-57.527	80.680	-56.291	80.675	79.429		249.56	-	250	249.69	IR microscopy, pixel size = 8 μ m
		X	X			-54.196	81.050	-53.694	81.053	80.547		250.12	-	248.95	250.21	IR microscopy, pixel size = 8 μ m
		X	X			-61.596	78.813					223.07	-			IR microscopy, pixel size = 8 μ m
		X	X			-63.877	81.060	-62.767	81.055	79.938		224.93	-	225.02	225.56	IR microscopy, pixel size = 8 μ m
225		X	X			-60.535	81.056	-60.089	81.054	80.611		223.09	-	225.11	225.35	IR microscopy, pixel size = 8 μ m
		X	X			-42.352	72.400					198.26	-			IR microscopy, pixel size = 8 μ m
		X	X			-44.575	74.397	-43.583	74.398	73.396		200.74	-	200.7	198.84	IR microscopy, pixel size = 8 μ m
		X	X			-41.215	74.794	-40.821	74.788	74.389		199.76	-	199.53	199.9	IR microscopy, pixel size = 8 μ m
		X	X			-48.767	72.400					173.33	-			IR microscopy, pixel size = 8 μ m
175		X	X			-50.930	74.590	-50.064	74.587	73.718		175.29	-	174.75	174.64	IR microscopy, pixel size = 8 μ m
		X	X			-47.733	74.840	-47.385	74.844	74.498		173.98	-	176.06	173.5	IR microscopy, pixel size = 8 μ m
		X	X			-55.189	72.412					150.65	-			IR microscopy, pixel size = 8 μ m
		X	X			-57.656	74.656	-56.914	74.652	73.907		151.65	-	150.05	149.13	IR microscopy, pixel size = 8 μ m
		X	X			-54.203	74.802	-53.903	74.801	74.504		149.7	-	149.73	149.57	IR microscopy, pixel size = 8 μ m
150		X	X			-61.608	72.418					126.3	-			IR microscopy, pixel size = 8 μ m
		X	X			-63.951	74.910	-63.335	74.912	74.287		124.96	-	124.47	126.7	IR microscopy, pixel size = 8 μ m
		X	X			-60.618	74.911	-60.373	74.910	74.682		125.15	-	124.81	125.06	IR microscopy, pixel size = 8 μ m
		X	X			-42.372	59.597					100.79	-			IR microscopy, pixel size = 8 μ m
		X	X			-42.384	59.592					100.43	-			IR microscopy, pixel size = 8 μ m
100		X	X			-42.400	59.592					100.35	-			IR microscopy, pixel size = 8 μ m
		X	X			-42.412	59.583					100.48	-			IR microscopy, pixel size = 8 μ m
		X	X			-42.432	59.579					100.71	-			IR microscopy, pixel size = 8 μ m
		X	X			-44.846	62.084	-44.352	62.087	61.591		100.28	-	101.86	101.22	IR microscopy, pixel size = 8 μ m
		X	X			-41.437	62.085	-41.240	62.084	61.889		102.96	-	102.87	102.32	IR microscopy, pixel size = 8 μ m
75		X	X			-48.791	59.603					75.98	-			IR microscopy, pixel size = 8 μ m
		X	X			-51.261	62.033	-50.890	62.031	61.659		76.22	-	76.13	78.33	IR microscopy, pixel size = 8 μ m
		X	X			-47.880	62.060	-47.733	62.064	61.913		79.47	-	76.87	79.1	IR microscopy, pixel size = 8 μ m
		X	X			-55.210	59.604					54.65	-			IR microscopy, pixel size = 8 μ m
		X	X			-57.683	62.101	-57.435	62.096	61.848		53.39	-	54.81	53.72	IR microscopy, pixel size = 8 μ m
50		X	X			-54.326	62.147	-54.223	62.146	62.049		50	-	53.87	55.32	IR microscopy, pixel size = 8 μ m
		X	X			-61.625	59.615					32.62	-			IR microscopy, pixel size = 8 μ m
		X	X			-64.157	62.165	-64.035	62.165	62.036		30.41	-	33.89	29.98	IR microscopy, pixel size = 8 μ m
		X	X			-60.745	62.148	-60.693	62.148	62.099		29.07	-	31.88	28.27	IR microscopy, pixel size = 8 μ m
		X	X			-42.394	53.197					-	-			IR microscopy, pixel size = 8 μ m
15		X	X			-42.396	53.193					-	-			IR microscopy, pixel size = 8 μ m
		X	X			-42.410	53.180					-	-			IR microscopy, pixel size = 8 μ m
		X	X			-42.424	53.180					-	-			IR microscopy, pixel size = 8 μ m
		X	X			-42.436	53.173					-	-			IR microscopy, pixel size = 8 μ m
		X	X			-44.929	55.699	-44.854	55.694	55.623		-	-			IR microscopy, pixel size = 8 μ m
10		X	X			-41.504	55.744	-41.473	55.744	55.717		-	-			IR microscopy, pixel size = 8 μ m
		X	X			-48.799	53.203					-	-			IR microscopy, pixel size = 8 μ m
		X	X			-51.375	55.745	-51.320	55.736	55.687		-	-			IR microscopy, pixel size = 8 μ m
		X	X			-55.218	53.205					-	-			IR microscopy, pixel size = 8 μ m
		X	X			-57.802	55.756	-57.774	55.760	55.729		-	-			IR microscopy, pixel size = 8 μ m
5		X	X			-42.360	66.000					-	-			IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
2.5		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
1.0		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
0.5		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m
		X	X			-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μ m

COMMENTS
Smallest lateral size of a void that can automatically be determined: 25 μ m.
Measure field in y direction is 8 mm, scan speed in x direction is maximum 14 mm/s for this 8 μ m/pixel resolution.

Bond Void Test in Support of SEMI Draft Document 5270, under development by the 3DS-IC Committee/Inspection and Metrology Task Force

Test Date	Operator ID	Test System				S/W Version
6/17/2013		Supplier	Model	ID		
		Detection:			Imaging ☒	☒ Yes ☐ No
		Measure Field/Spot Size, mm		8 mm		
		Measure Field/Scan Speed, mm/sec		max. 14 mm/s	Field Shape ☒	☐ Round ☒ Rectangular
Ambient Temp @ Test Start	Ambient Temp @ Test End	C ☒	F ☐	Ambient Humidity @ Test Start	Nominal Void Depth	
26.6	26.7	☒	☐	44.5% RH	800 nm	

Void Detection Measurement Results										Die location - from wafer map									
SAMPLE ID Mark*										Die Location (x, y) Indicate with an X									
Adjacent to Sensor										-2,2 2,2 2,2 -2,2									
Away from Sensor										X									
* Example -462A31TSEB1										Attached ✓									
										☒ Yes ☐ No Data Filed at ☐ No ☐ Yes -2_2_die_800nm_depth.png									
Indicate Reference System Used:																			
X										(Wafer reference (origin at center of wafer)									
										Die reference system (origin @ die center)									
										Die reference system (origin @ die corner)									

Void Size, μm	Void Density			Detected		Void Location, X and Y, mm (Isolated or first S or D void)		Void Locations, X and Y, mm (Additional voids in S and D arrays)				Max. diameter and depth, μm (Isolated or first void)		Max. diameter and depth, μm (Additional voids in S and D arrays)				Notes: Please include experimental set-up if ultrasonic microscopy, transducer frequency and pixel size, if x-ray, voxel size, etc.	
	I Isolated	S = Semi-dense	D Dense	Y	N	X mm	Y, mm	X mm	Y, mm	X mm	Y, mm	Dia. max, μm	Depth, μm	Dia. max, μm	Depth, μm	Dia. max, μm	Depth, μm		
300	X			X		-42.362	78.824					299.8	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.362	78.821					299.11	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.374	78.815					299.02	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.378	78.815					298.61	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.390	78.806					298.79	-					IR microscopy, pixel size = 8 μm	
	X	X	X	X		-44.807	81.064	-43.326	81.068	79.564	299.34	-	298.61	-	298.42	-			IR microscopy, pixel size = 8 μm
275	X			X		-41.227	81.215	-40.635	81.212	80.610	298.94	-	299.32	-	299.9	-			IR microscopy, pixel size = 8 μm
	X			X		-48.777	78.820					273.5	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-51.184	80.882	-49.829	80.886	79.515	274.4	-	274.03	-	274.18	-			IR microscopy, pixel size = 8 μm
	X			X		-47.596	81.019	-47.055	81.020	80.472	273.35	-	273.96	-	273.75	-			IR microscopy, pixel size = 8 μm
	X			X		-55.199	78.829					249.89	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.545	80.703	-56.308	80.700	79.440	249.95	-	249.32	-	250.03	-			IR microscopy, pixel size = 8 μm
250	X			X		-54.212	81.074	-53.718	81.076	80.571	248.77	-	248.89	-	249.43	-			IR microscopy, pixel size = 8 μm
	X			X		-61.614	78.829					225.03	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-83.898	81.073	-82.784	81.075	79.951	224.41	-	222.92	-	224.97	-			IR microscopy, pixel size = 8 μm
	X			X		-60.552	81.074	-60.109	81.071	80.629	224.64	-	223.25	-	223.63	-			IR microscopy, pixel size = 8 μm
	X			X		-42.367	72.424					199.62	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-44.589	74.423	-43.805	74.421	73.422	199.75	-	199.26	-	198.84	-			IR microscopy, pixel size = 8 μm
225	X			X		-41.232	74.825	-40.841	74.822	74.420	197.97	-	198.23	-	199.46	-			IR microscopy, pixel size = 8 μm
	X			X		-48.786	72.420					173.74	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-50.947	74.614	-50.086	74.618	73.738	174.35	-	173.34	-	173.2	-			IR microscopy, pixel size = 8 μm
	X			X		-47.754	74.875	-47.406	74.877	74.523	173.64	-	174.71	-	172.66	-			IR microscopy, pixel size = 8 μm
	X			X		-55.205	72.429					148.65	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.674	74.674	-56.935	74.674	73.931	150.34	-	148.23	-	149.24	-			IR microscopy, pixel size = 8 μm
150	X			X		-54.216	74.820	-53.924	74.824	74.524	149.22	-	149.12	-	148.33	-			IR microscopy, pixel size = 8 μm
	X			X		-61.624	72.434					124.25	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-83.968	74.927	-83.352	74.928	74.304	124.13	-	123.83	-	125.76	-			IR microscopy, pixel size = 8 μm
	X			X		-60.635	74.924	-60.390	74.927	74.675	124.88	-	124.46	-	124.14	-			IR microscopy, pixel size = 8 μm
	X			X		-42.362	59.621					98.57	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-42.380	59.621					98.8	-					IR microscopy, pixel size = 8 μm	
100	X			X		-42.394	59.617					98.79	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.398	59.612					98.72	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.406	59.608					98.64	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-44.853	62.111	-44.363	62.112	61.617	98.86	-	99.22	-	99.3	-			IR microscopy, pixel size = 8 μm
	X			X		-41.448	62.112	-41.251	62.111	61.916	99.75	-	101.56	-	99.01	-			IR microscopy, pixel size = 8 μm
	X	X		X		-48.811	59.626					74.72	-					IR microscopy, pixel size = 8 μm	
75	X			X		-51.272	62.053	-50.905	62.055	61.680	74.44	-	76.55	-	75.04	-			IR microscopy, pixel size = 8 μm
	X	X		X		-47.891	62.090	-47.741	62.089	61.943	76.81	-	75.7	-	75.38	-			IR microscopy, pixel size = 8 μm
	X			X		-55.220	59.626					51.69	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.691	62.116	-57.442	62.114	61.867	51.95	-	51.38	-	50.89	-			IR microscopy, pixel size = 8 μm
	X			X		-54.333	62.169	-54.234	62.165	62.064	52.47	-	52.43	-	53.16	-			IR microscopy, pixel size = 8 μm
	X	X		X		-61.635	59.626					27.11	-					IR microscopy, pixel size = 8 μm	
25	X			X		-64.169	62.183	-64.042	62.187	62.054	28.74	-	25.56	-	27.29	-			IR microscopy, pixel size = 8 μm
	X			X		-60.752	62.171	-60.701	62.170	62.117	28.37	-	29.07	-	23.19	-			IR microscopy, pixel size = 8 μm
	X			X		-42.392	53.217					-	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.396	53.217					-	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.400	53.217					-	-					IR microscopy, pixel size = 8 μm	
	X			X		-42.407	53.209					-	-					IR microscopy, pixel size = 8 μm	
15	X			X		-42.415	53.209					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-44.938	55.721	-44.863	55.721	55.645	-	-					IR microscopy, pixel size = 8 μm		
	X			X		-41.509	55.771	-41.477	55.770	55.744	-	-					IR microscopy, pixel size = 8 μm		
	X			X		-48.806	53.226					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-51.380	55.761	-51.329	55.761	55.712	-	-					IR microscopy, pixel size = 8 μm		
	X			X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
10	X			X		-55.229	53.231					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.811	55.779	-57.783	55.775	55.748	-	-					IR microscopy, pixel size = 8 μm		
	X			X	X	-42.377	66.029					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X			X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
5	X			X		-55.229	53.231					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.811	55.779	-57.783	55.775	55.748	-	-					IR microscopy, pixel size = 8 μm		
	X			X	X	-42.377	66.029					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X			X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
2.5	X			X		-55.229	53.231					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.811	55.779	-57.783	55.775	55.748	-	-					IR microscopy, pixel size = 8 μm		
	X			X	X	-42.377	66.029					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X			X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
1.0	X			X		-55.229	53.231					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.811	55.779	-57.783	55.775	55.748	-	-					IR microscopy, pixel size = 8 μm		
	X			X	X	-42.377	66.029					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X			X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
0.5	X			X		-55.229	53.231					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X		-57.811	55.779	-57.783	55.775	55.748	-	-					IR microscopy, pixel size = 8 μm		
	X			X	X	-42.377	66.029					-	-					IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X			X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	
	X	X		X	X	-	-	-	-	-	-	-	-	-	-	-	-	IR microscopy, pixel size = 8 μm	

ITEM NO.	DESCRIPTION	QTY	UNIT	PRICE	TOTAL	TAXES	DISCOUNTS	NET TOTAL	TERMS	DATE	REMARKS	
1	COMMENTS											
	Comments: acceptable hole sizes for the 600 mm nominal hole depth samples, located, 2.0 mm, bottom center, 0 mm, center, 0 mm, 1 or more and larger holes indicated can be determined.											

Smallest lateral size of a void that can automatically be determined: 25 μm .
Measure field in y direction is 8 mm, scan speed in x direction is maximum 14 mm/s for this 8 μm /pixel resolution.