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TECHNICAL DOCUMENT COVER PAGE

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Client: TXU Power		

Document Purpose/Summary:
The goal is to characterize the samples from the TXU DBA testing of coating samples for Unit 1 Containment. This report will document a size distribution of both epoxy chips and zinc particulate from the coating debris. The material examination is done with a scanning electron microscope (SEM) and a digital Optical Microscope.

This report is safety related.

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Project Manager to provide a brief description of each document revision, including rationale for the change and, if applicable, identification of source documents used for the change.

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1.0 BACKGROUND

TXU contracted with Keeler and Long to perform a test resulting in Report No. 06-0413, "Design Basis Accident Testing of coatings Samples for Unit 1 Containment, TXU Comanche Peak SES" dated April 13, 2006. The paint chip samples from that test were then shipped to TXU for recording and/or further examination. There were initially two baskets of large flat paint chips documented via photographs in the TXU Keeler and Long report. After the DBA test, there were still chips in the two trays and debris on the bottom of the autoclave. TXU obtained all of this debris in 3 plastic sets of samples. It was observed that some of the large chips rolled up, while others would be described as flat chips. The goal is to characterize the samples (i.e. size distribution of both epoxy chips and the zinc particulate that was on the coatings). The coatings were reported as a Carboline product, which was comprised of two distinct layers. These distinct layers were individually evaluated as well.

2.0 PURPOSE

Alion will perform a paint chip characterization on the chips that were generated from the TXU test performed by Keeler and Long. The scope will be to perform a size distribution analysis of paint chips (as best possible). This will involve a combination of visual, optical magnification and/or Scanning Electron Microscopy (SEM) of the smaller sizes or coating thickness. Size distribution analysis in this case is quantifying a size distribution to fit the NUREG-06916 distribution, which is comprised of the following categories: [1]

- Small (1/64th to 1/32nd inch),
- Medium (1/8th to 1/4th inch),
- Large (1-2 inch) flat
- Large (1-2 inch) curled.

Alion staff also binned the paint chips into a distribution that was more distinct than that noted above. Chips that were in length ½" to 1" and from ¼" to ½" were also included in a size distribution as medium large and medium small.

2.1 Scope

Alion has obtained three (3) samples of the TXU coating material provided in small paint cans. One sample can was labeled upper autoclave, one was labeled lower autoclave, and one was labeled bottoms (See Figures 5, 12 and 16). Thus, the samples are defined as paint debris from the upper portion of the autoclave chamber (vapor phase), lower portion of the autoclave (immersion phase) and the bottoms of the autoclave. Prior to performing any tests a receipt inspection of the samples were performed, logging macroscopic photographs of each sample and documenting visual inspections.

Coating layer thickness and particulate sizes can be measured directly from SEM images that have been calibrated with a known measurement reference standard (MRS). Individual layers of epoxy and zinc coating can be measured via SEM using backscattered electron beam imaging. With backscattered electron beam the epoxy layer (or carbon based) shows up as a more black or darker grey in SEM images. The zinc coating layers because zinc is a higher atomic number element shows up as white or very grayish white in SEM images. Also the zinc coating layer is distinct as the zinc oxide particles are shown as spherical matter. The epoxy layer does not have distinct particulate matter embedded, but can be shown to be porous (i.e. through small air voids). Elemental Dispersive Spectroscopy (EDS) was also performed on the samples to derive elemental compositions for the coating materials.

[1] Note an attempt was made to try and handle separate the small paint chips 1/64th to 1/32nd inch, however, the paint chips were too fragile for handling and hence they were placed on a flat sheet of paper and counted via macrophotography and optical microscopy to be within the size distribution.

3.0 METHODOLOGY

The methodology to be utilized for the coating samples Visual and Optical Microscopy measurement shall comprise of first performing a receipt inspection as noted in section 4.0. Next the Optical Microscopy Calibration shall be performed to ensure accurate and traceable measurements in accordance with section 5.1. Individual sample measurements will be performed in accordance with the guidance provided in section 6.0. Macrophotographs were taken of as received paint chips and particulate and recorded in digital images. Then the coatings from each autoclave section were separated out by size characterization. The chip length measurements were recorded on logs shown in Attachment A. Each chip was characterized if it was flat or curled, and the length of each chip at it's longest apex. The chips were sorted by those that were greater than 1" in length, those that were ½ to 1", ¼ to ½", 1/8th to ¼" and then below 1/8". The digital macrographs were then taken to illustrate the binning process. Chips were counted to identify how many chips from each autoclave portion fell within each size characterization (for length). The samples that were obtained from the bottoms portion of the autoclave were not binned by size as the debris was in fines and reserved for Optical and SEM measuring.

4.0 PROCEDURES

See Attachment B for the actual procedures utilized for the data acquisition and receipt inspections.

Receipt Inspection MRS and Samples
Figures 3 and 4 illustrate the MRS from receipt inspection. Receipt inspection was performed on the MRS and is documented in Attachment B. Receipt inspections were noted and documented on individual forms for each sample provided in Attachment A. Unique ID numbers were provided for the TXU samples. A material control log was completed for each sample noting dimensions, photo ID, handling and disposal instructions. These logs are for sample inventory and control only and not relevant for actual testing.

4.1 Visual Process

Each Autoclave portion was separated out so as not to mix autoclave samples. The Upper Autoclave debris samples were categorized first, then the Lower Autoclave debris and finally the bottoms samples. The visual process included taking receipt inspections of the materials in the as-received condition in the paint cans. The samples were gently removed so as not to damage or break the fragile paint chips. A surgical forceps and tweezers were used to separate out all paint chips by size. The chips were then measured with a steel marked ruler, and the ruler was placed next to the chips, which were photographed for future reference. All chips were removed from the batch lot and placed onto blank sheets of paper and numbered. The numbering of each chip then correlates to the log that is found in Attachment A, and the individual length recorded for that chip. The chip was also noted if it was curled or flat for further delineation. Chips that were less than 1/8th inch were not measured directly with a ruler. These were subjected to both the optical measurement process and via using a counting process with the digital images. Figures 6 through 15 and 17 show the as-received paint chips, and those then that were binned by length.

4.2 Optical Process

Digital Optical Microscopy was performed at the University of Nebraska Metallurgy Laboratory on 6/4/07. Using a Leitz Digital Optical Microscope. The MRS was inserted first into the optical microscope stage to take digital images for performing calibration and further length measurements. Images were collected of the MRS and then subjected to calibration measurement process knowing the size of each MRS grid line. Alion staff have been utilizing the University of Nebraska Metallurgy Equipment since 1985. Digital Optical process for image acquisition was documented per Reference 1. All images were recorded on a log form for further reference when performing measurement process and calibrations (Attachment B).

4.3 SEM Process

4.3.1 Background

SEM process for image acquisition was documented per Reference 1. Images were collected on a JEOL SEM instrument at the University of New Mexico Dept. of Meteoritics on 6/7/07. Alion personnel have

been fully qualified to utilize the JEOL SEM by the UNM staff. Alion personnel have been performing numerous SEMs with this instrument since 1997.

4.3.2 Sample Preparation and Handling

Prior to performing SEM imaging, small sub samples were extracted from the TXU autoclave portions and identified as IDs 06-06-07:01 through 06-06-07:03. Some paint chips were placed on their side in order to perform layer thickness measurements. Paint chips from both the upper and lower autoclave were placed on their side to distinguish if there was any difference in thickness measurements or any disbanding. This was annotated on the SEM holder identification sheet. Also some paint coatings were separated out by color such as green and beige coating chips and small samples of front and back of each coating was placed on the SEM stub to evaluate the front and backsides of each type of coating. Also coatings from the lower and upper autoclave were included. As well as dust from the bottom of the autoclave. The stubs were then placed into the SEM holder along with the MRS. The MRS was inserted into the SEM holder with the samples for measurement calibration performance. Sample holder x-y positioning is controlled by joystick or software that is configured for the type of sample holder installed (i.e. multiple stubs).

4.3.3 SEM Instrument

The JEOL instrument at UNM was powered up by Alion personnel in accordance with the process noted in Reference 1. This procedure is provided in QA files, and illustrates fine detail required in order to establish imaging capability (i.e. to ensure electron lens focusing and preventing stigmatism). The instrument was operated at low vacuum (~35 mPA). Double sided cellulose tape was applied to each stub to minimize charging.

Prior to collecting sample images a calibration of the SEM instrument scale bar was performed. The MRS was scanned to verify the serial number and grid pitch dimensions (Figures 22 and 23). Calibration of the scale bar is discussed further in the calibration section. The scale bar depicted on SEM images is generated from software utilized with the JEOL instrument. As such, a calibration was performed of the scale bar against a known measurement standard. Figures 22 and 23 show some the MRS grid patterns that were utilized (more images were used for the calibration than what are illustrated, see log for full set of images). The scale bar was calibrated at the 2 μm level due to the fact that all measurements of fiber and particle lengths are within this range. The MRS grid pattern itself is accurate to within +/- 0.016 μm for the 2 μm grid, thus, providing a high level of accuracy in measurements. Information regarding the MRS accuracy and certifications are provided in Alion QA file.

All image digital files collected were documented with a unique ID number for traceability. The ID number for each image is provided on a form (Attachment 1) Reference 1. The form includes the ID number for each sample, the image file name and relevant information regarding date, magnification for the scan, voltage and working distance of the electron beam.

Image files were collected at various magnifications as noted in Reference 1. The images were collected in order of sample location on SEM stub. Figures 24 through 36 are a sampling of the actual images from SEM imaging of the samples provided, and cut. A full set of images is provided in Attachment E on CD that correlate back to the SEM log.

Figures 37 through 46 are the EDS scans that were collected from the JEOL instrument. EDS scans were taken of each paint specimen placed in the SEM holder. All EDS scans are provided in this report for reference and the elements documented in Table 4. A photograph showing the alignment of the specimens is provided in Figure 50.

5.0 CALIBRATION PROCESSES

The digital images collected on the MRS noted as Figures 19, 20, 22 and 23 (for example) were subjected to a measurement process such that the known width of each bar on the calibration grid is a direct write semiconductor pattern which is anti reflective chromium over quartz as 2 μm +/- 0.016 μm. More calibration images were collected than what are illustrated and are provided in Attachment E CD. Not all calibration images are shown due to the large files sizes of each image. The MRS is certified to be accurate to within +/- 0.016 μm for the 2 μm grid pitch. The MRS grid is used to compare against the SEM scale bar marker that is generated through the SEM JEOL instrument software. Actual measurements of the grid pitch were made and compared to the scale bar marker. Scanned images show the MRS with storage container and working form (Figures 3 and 4). Figures 22 and 23 provide a view of the 2 μm grid that is used for SEM scale bar calibration. The 2 μm grid is also shown in Figure 1 of Geller Microanalytical Resource Guide Reference 3. Hence, the SEM Figures 22 and 23 collected on the JEOL SEM instrument matches the Figure 1 of the Geller Microanalytical Laboratory Resource Guide. A verification of the serial number was also performed and is linked to the Certification of Measurement.

The MRS-3XY is coated with a proprietary material, which allows for image observation at any accelerating voltage. Using pitch measurements cancel edge to edge locations as long as like positions are measured. This removes error from measurement of a single line or a space width because illumination can cause edge effects to lead to uncertainty in the edge locations.

5.1 Visual Measurement Process and Size Distribution by Mass

All paint chips that were greater than 1/8th" were measured via direct ruler measurement. Anything less than 1/8th" was photographed and then subjected to digital imaging and measurement via optical microscopy. Once the samples were binned into the appropriate size categories, a laboratory balance was used to weigh each group, thereby allowing the calculation of the size distribution by mass. Figures 51 through 57 show the samples during the binning and weighing process.

For the smallest chip size from the upper autoclave binned by the visual process (< 0.125"), optical microscopy measurements were performed to determine the average chip size. The measurements showed that the average chip size in this range is approximately 1/64" (0.015 inches). See Figures 58 through 63 for the upper autoclave chips measured using optical microscopy, and Attachment C for the spreadsheets documenting the measurements.

The results from the size distribution binning are provided in Table 1a for the Upper portion of the DBA Autoclave chamber.

Table 1a – Upper Autoclave Coatings Measurements

Size Range of Coating	No. of Pieces	Mass (gram)	Percentage of Total Mass (%)
1-2"	17	3.4657	49.1
.5-1"	25	0.9784	13.9
.25-.5"	43	0.4774	6.8
.125-.25"	103	0.5434	7.7
< .125"	NA	1.5901	22.5
Total		7.0550	100

For the smallest size from the lower autoclave binned by the visual process (< 0.125"), optical microscopy measurements were performed to determine the average chip size. The measurements showed that the average chip size in this range is approximately 1/256" (0.004 inches). See Figures 64 through 67 for the lower autoclave chips measured using optical microscopy, and Attachment C for the spreadsheets documenting the measurements.

Table 1b provides the results from the measurement of the Lower portion of the DBA Autoclave chamber specimens.

Table 1b – Lower Autoclave Coatings Measurements

Size Range of Coating	No. of Pieces	Mass (gram)	Percentage of Total Mass (%)
1-2"	23	8.5331	71.3
.5-1"	19	0.8593	7.2
.25-.5"	24	0.4245	3.5
.125-.25"	59	0.3549	3.0
< .125"	NA	1.7960	15.0
Total		11.9678	100

According to Keeler & Long Test Report No. 06-0413 (Ref. 4), which documents the design basis accident testing of the Comanche Peak coating samples, 3.766 grams of debris was collected from the bottom of the autoclave, all of which was fines. In order to provide a conservative size distribution, this quantity of fines is added to the fines quantity for the Upper Autoclave distribution. Note that this is conservative since the Upper Autoclave distribution has a higher percentage of small pieces, which are more likely to transport during post-LOCA recirculation, and are also considered worse in terms of expected head loss across the sump screen.

Based on a qualitative visual inspection, it is estimated that approximately 50% of the material in the bottom of the autoclave is epoxy. See Figure 17 for a macrophotograph of this material.

Therefore, the overall conservative size distribution is summarized below in Table 2.

Table 2 – TXU Paint Chip Size Distribution by Mass

Size Range of Coating	No. of Pieces	Mass (gram)	Percentage of Total Mass (%)
1-2"	17	3.4657	32.0
.5-1"	25	0.9784	9.04
.25-.5"	43	0.4774	4.41
.125-.25"	103	0.5434	5.02
< .125"	NA	1.5901+3.766	49.5
Total		10.821	100

Figure 1 shows a graphical representation of this size distribution.

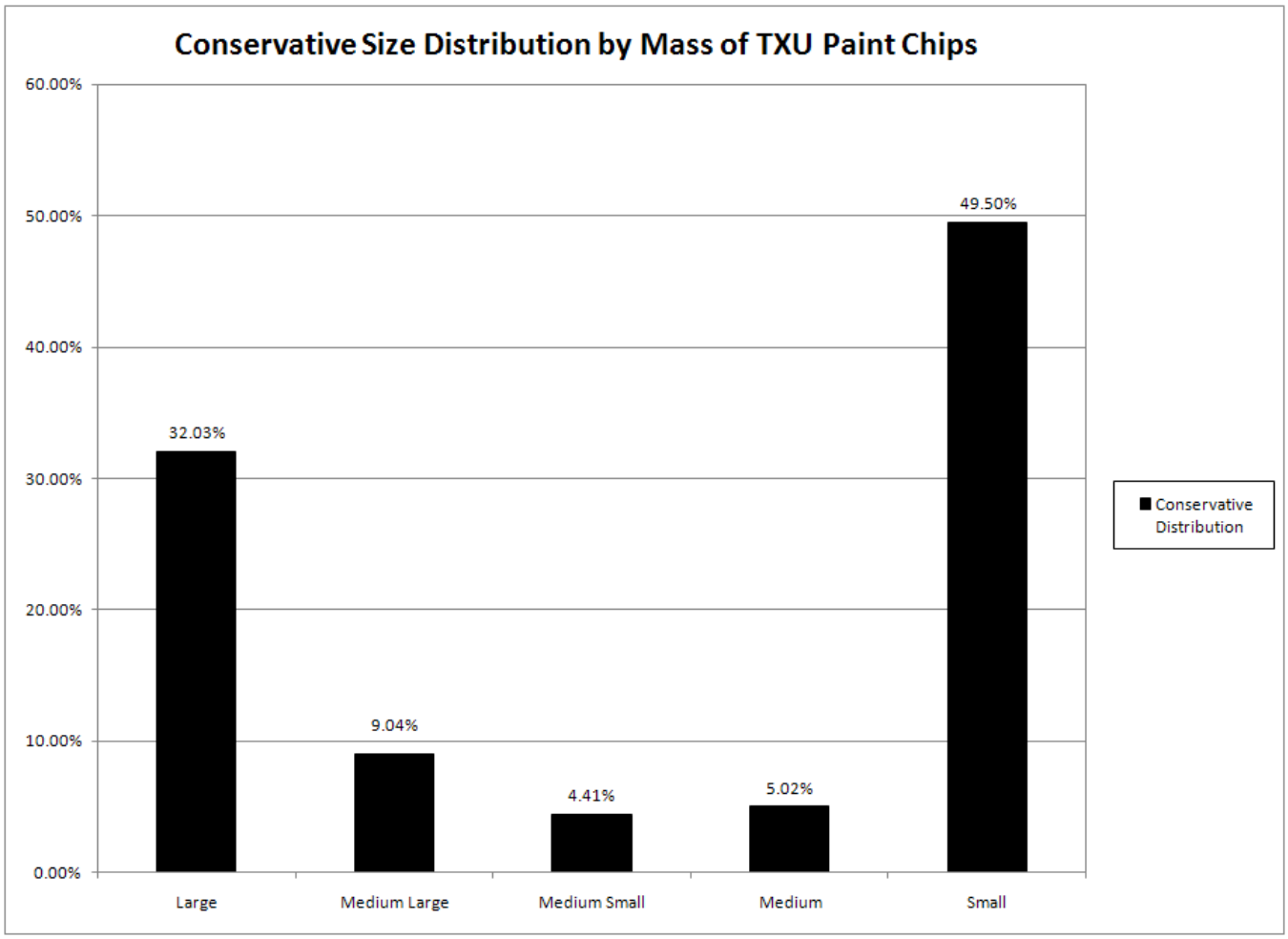

Figure 1- Conservative Paint Chip Size Distribution by Mass

5.2 Scanning Electron Microscopy

A Digital pixel process method was utilized then to measure number of pixels from a digital image and convert it to μm. Utilizing all the images shown from the SEM, measurements were made of the grid calibration bars, and then converted to pixel lengths. A total of 50 measurements were made of each 2 μm bar to come up with a statistical average for conversion of digital image pixels to microns. A conversion factor was calculated to be able to go from various magnifications and is strictly a function of the magnification, which is a linear function in SEM work. For example it was determined that the average conversion factor was 112.07 μm/pixel * Magnification. See Attachment C for all the actual pixel measurements and calculations. The standard deviation for this calculated conversion factor was 2.4 μm/pixel * Magnification or about 2.14%. Which is well within an anticipated measurement uncertainty from direct measurements. There also is a slight accuracy adjustment in that the bar widths are accurate to +/- 0.016 μm. Which at this level of magnification is not relevant, and hence, will not be factored.

The measurement process indicated that the average conversion of microns to pixel length was 112.07 μm/pixel * Magnification. Thus, alternatively this means that 0.0089 pixels is equivalent to one μm in length multiplied by the Magnification. So if at 1,000X, then 8.92 pixels are equal to one μm in length. In order to make sure this process was accurate, additional checks were made against the SEM scale bar, and it was found that the process was correct and accurate at all magnifications. The actual measurements in spreadsheet form are provided in Attachment C.

6.0 MEASUREMENTS

6.1 SEM Chip Layer Thickness Measurements

All Optical and SEM measurements were made using the digital images. A software pixel program (GIMP) was utilized to make the accurate measurements since a calibrated scale bar was not provided in the digital imaging. Only direct digital TIF images were capable of being obtained from the UNL and UNM JEOL instrument. Each digital image had a known pixel count, and direct measurements were made, and also with a software program to draw pixel lines. All pixel lengths were then put into an EXCEL spreadsheet for each fiber measurement and for each image measurement. The EXCEL spreadsheet is provided in Attachment C. The EXCEL spreadsheet was then used for converting the pixel count to a micron measurement. From the Calibration grid, it was known that each grid bar and space are 2 μm. The grid size that was used is the same as that shown in Reference 2, Figure 1.

In order to do length measurements a statistical measurement approach was used. For instance the images collected were evaluated with statistical measurements and then averaged. Various measurements were taken at different magnifications on the SEM instrument. The most accurate measurements being at the higher magnifications. All direct data measurement sheets are located in Attachment C. Measured values were used based on statistical averaging utilizing calibrated processes and hence are considered accurate to within 0.2 μm due to limitations on measurements of the MRS. Figures 47 through 49 show an example of the measurement process that was used from direct images. Note since these files are quite large they were not all included in this report. The images are included though in Attachment E on the CD for QA purposes. All measured images are provided in Attachment E, and the file name is traceable back to the Optical and SEM logs recorded in Attachment B. Table 3 shows the results of the measurements from the SEM images for all Autoclave Coating Layers. The thickness of each coating layer is reported. Thus for example the chips were noted to have an epoxy and a zinc layer this was confirmed via Elemental Dispersive Spectroscopy (EDS) scans that are provided for each coating specimen. Table 3 shows each layer thickness as measured and also reports the total thickness of each paint chip. Table 4 shows the results of the elemental scans on each specimen. Figures 37 through 46 document the EDS scans.

Table 3 Paint Coating Layer Thickness

Paint Coating Layer Thickness via SEM		Average Thickness-mils	Average Thickness All Layers - mils
Upper Autoclave Samples			
Green Chip	epoxy layer	4.3	4.3*
Beige Chip	epoxy layer	6.8	15.2
Beige Chip	zinc layer	8.4	
Lower Autoclave Samples			
Green Chip	epoxy layer	2.8	2.8
Beige Chip	epoxy layer	7.5	10.7
Beige Chip	zinc layer	3.2	

*on the upper autoclave green chip sample it could be seen that virtually all the zinc coating had disbonded from the epoxy layer on the lower autoclave green chip sample there was slightly more zinc coating bonded with the epoxy. The layer was less than 2 mil though

Table 4 Elemental Dispersvie Spectroscopy Scans of Each Debris Type

Sample Type	Elements Present
Dust	Zn, Si, K, O
Bottoms	Zn, Al, Si, Ti, Fe, K, O
Lower Autoclave Samples	
Beige Coating Front	Ti, Al, Si, Na, Zn, O
Beige Coating Back	Zn,Si, Na, O
Green Coating Front	Ti, Al, Si, Cl, Na, Ca, Zn
Green Coating Back	Zn,Si, Na, O, K
Upper Autoclave Samples	
Beige Coating Front	Ti, Si, Ca, O, Zn
Beige Coating Back	Zn, Si, Na, Ti, Fe, O
Green Coating Back	Zn, Ti, Fe, Ni, Si, O
Green Coating Front	Ti, Si, Fe, Zn, Ca, O

Elements are ordered by EDS peak height intensity and thus, predominance within sample measured.
Front is defined as the epoxy side of a paint chip, back is defined as the zinc layer coating side

No unusual elements were observed that are not typically in epoxy/zinc coating type materials. The EDS scanning confirmed that the back side of each coating material and the dust/bottoms were predominantly zinc based materials. The EDS scans also indicated that the front side of each coating specimen was predominantly picking up Ti which comes from Titanium dioxide that is blended in as a paint pigment material. Carbon is not picked up via EDS as it is too low of an atomic number element to be detected with any accuracy via EDS. Other means such as Infrared Fourier Transform techniques are used to confirm types of organic coatings (like epoxy-carbon based).

SEM measurements were made of the dust from the bottoms of the autoclave, and also of particulate that was embedded in the zinc layer of coating debris. Table 5 shows a comparison of the particulate from the bottoms as measured via Optical and SEM methods. The SEM measurements reported for the dust from the bottom of the autoclave and zinc layer is report in Table 6.

Table 5 Bottoms Particulate

Bottoms Particulate	Number of Particles	Average Length-in	Average Length-microns
Very Small <0.0208 Optical Method	425 measured	0.003	79.3
Very Small SEM Method	40 measured	0.023	576.6

Table 6 Particulate and Dust Size

Paint Particulate via SEM	Average Length - mils
Bottoms Sample	22.6
Dust (predominantly zinc from EDS)	1.7
particles embedded in paint coating zinc layer	0.2

The measurements recorded for the dust particulate were binned by size ranges to show a distribution of the diameter of the dust material. The dust material came from the Lower Autoclave Sample and was loose like powder. Figure 2 shows the size distribution for the dust material that was measured. Attachment C provides details on the binning process for the dust diameter.

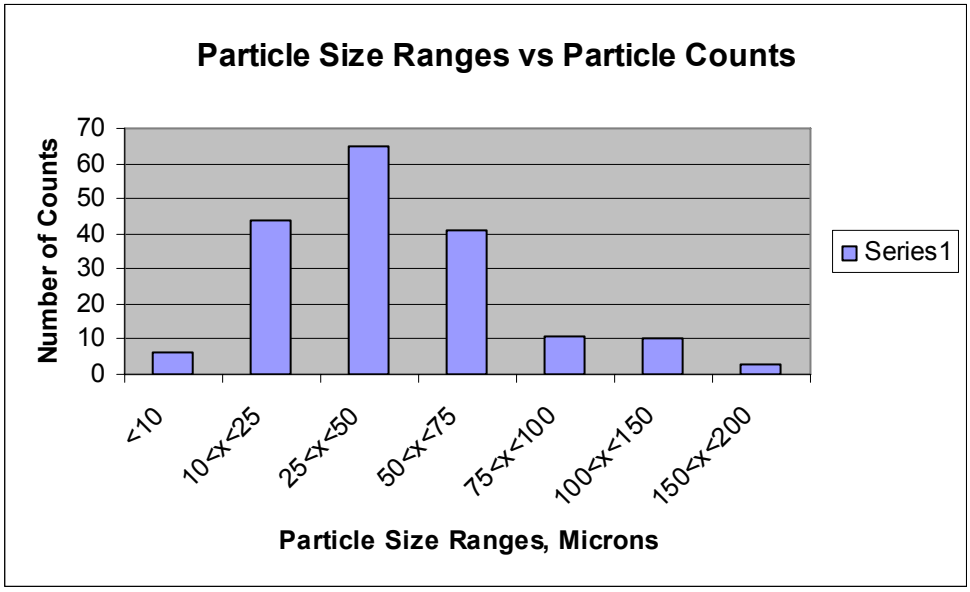

Figure 2 Dust Particle Size Ranges in Microns

This distribution confirms that the average size of the dust particulate material in the Lower portion of the autoclave follows a uniform normal distribution. This distribution shows that the majority of the particulate from the dust has a size that is greater than 25 microns in length.

7.0 CONCLUSIONS

7.1 TXU Chip Length Measurements

The materials provided by TXU were first sorted by whether the paint chip material was from the Upper or Lower Autoclave sample containers. Upper and Lower Autoclave Chips were measured and binned in distributions for length. Also the chip materials were noted whether they were flat or curled and recorded with macrophotography. Then each group of chips was weighed in order to obtain a mass-based debris size distribution. Table 1a provides the results of the measurements for all the paint chips that were in the Upper Autoclave area, and summarizes the mass-based percentages of each group of chips.

Table 1b provides the results of the measurements for all the paint chips that were in the Lower Autoclave area sample group, and summarizes the mass-based size distribution for the debris taken from the Lower Autoclave area.

The fraction of chips that were curled by number was 6.8 and 8.2% for upper and lower autoclave areas respectively. Thus, the number of chips that were curled is relatively small in comparison to the total number of chips. Statistically speaking the number of curled chips in the medium large to large sizes is fairly significant. For these size groupings 40.5 and 57% of the chips are curled for upper and lower autoclave samples respectively (when only considering the medium large and large grouping). This means that for all chips greater than ½ inch in both upper and lower autoclave samples that about 50% of them are curled. It is unknown whether any constraints were in place in the autoclave chamber which could have impacted this phenomenon, (i.e. curling). Only statistical numbers and observations are reported herein.

The material that was provided as the bottoms sample was measured both via Optical and SEM imaging. The SEM imaging measurements indicated that the average length of the bottoms material was 22.6 mils or about 580 microns. This is on the order of less than a 1/32nd of an inch. Thus, all material that was in the bottoms of the autoclave is considered to be in the small grouping of materials. Based on a qualitative visual inspection, it is estimated that approximately 50% of the material in the bottom of the autoclave is epoxy.

The overall conservative size distribution to be used in debris generation and transport analyses is summarized in Table 2 and Figure 1.

7.2 TXU Chip Layer Measurements

All paint coating materials that were provided were measured for paint coating layer thickness. SEM methods were used for measuring paint coating layers. The chips were mounted on their sides perpendicular to the electron beam in order to capture the cross section. Green and Beige coating samples were placed on their sides from both upper and lower autoclave samples. It was noted that both in the upper and lower autoclave samples that the green coating specimens had a thinner epoxy layer than the beige specimens. Very little zinc coating was found to have remained on the green coating samples, and thus, only the epoxy layer could be measured with accuracy. The green coating

samples from upper and lower autoclave had a layer thickness of 4.3 and 2.8 mils on average respectively. It was unknown what the original green coating layer thickness was from the before test condition.

The beige coating specimens had a distinct two layer system which was confirmed to be a carbon based and zinc layer system (carbon based assumed to be epoxy). Each distinctive layer of the beige coating chips were measured. Table 3 documents the results from those measurements. It was found that the epoxy layer for the upper and lower autoclave specimens was 6.8 and 7.5 mils respectively. Thus, the epoxy layer was similar in thickness for both upper and lower autoclave specimens. The zinc layer for the upper and lower autoclave specimens was 8.4 and 3.2 mils respectively. Thus, the zinc layer had a distinction in zinc layer thickness between upper and lower autoclave specimens. This could be attributed to the fact that the lower autoclave coatings were subjected to immersion and disbondment of the zinc layer could be higher. However, just based on observations it is confirmed that there was dust from the lower autoclave specimens in the sample container, which was confirmed to be zinc. Thus, possibly confirming more disbondment of zinc in the lower autoclave specimens than the upper autoclave specimens. The zinc dust from the lower autoclave specimen container was measured and will be discussed in the next section.

The coating thicknesses of the carbon based layers of both the green and beige coatings are typical of a single coat application. It was unknown what the original layer thicknesses were of both carbon and zinc based coatings for comparison of these measurements.

7.3 Particle Length Measurements

The bottoms from the autoclave were subjected to SEM measurement processes since they were too fine for measuring with rulers. The results from the SEM measurements indicate that the average length of the debris from the bottoms is 22.6 mils. Figure 29 shows an example of an image of the bottoms debris. It can be seen that some of this debris is paint chips with a two layer system. However, some of the paint chips look like they have lost some of their zinc layer as well. The debris from the bottoms looks predominantly like small paint chips on the order of less than 1/32nd of an inch.

The lower autoclave sample had a dust component to it. This dust was grayish black and shown in Figure 15. This dust material was virtually absent from the upper autoclave sample (Figure 7). A sample of this dust material was subjected to Optical and SEM measuring. The results from these measurements indicate that the dust from the lower autoclave is on the order of 1.7 to 3.1 mils in length (SEM and Optical averages respectively). The dust was confirmed to be primarily zinc based from Figure 46.

Some of the particulate that was embedded in the backside of the coating systems were also measured to look at the range in sizes. The particles that were embedded in the paint coating zinc layers was on the order of 5 microns in diameter. This measurement was provided only as an observance of the material that was left intact in the zinc layer.

7.4 EDS Conclusions

<u>EDS Scans</u>

In the EDS scans Figures 37 through 46, it can be seen that the common elements in this sample are Zn, Al, Si, O, and Ti which is consistent with coating applications. If a material contains predominantly elements of lower atomic weight they will show up as black. For example carbon or cellulose tape will show up as black under SEM imaging. Materials that are composed of higher atomic weight elements such as Ti, etc. will be predominantly white. This can also be used to look at surfaces of materials to see if there is potential leaching of elements or compounds in certain areas. The surfaces that were on the backside of coatings (green and beige) were confirmed to be zinc based. The surfaces that were on the frontside of coatings were confirmed to be carbon based, and containing Ti, and Al.

8.0 REFERENCES

1. Alion Controlled Procedure ALION-SPP-LAB-2352-24, Revision 3.
2. Geller MicroAnalytical Resource Guide for MRS 3XY
3. Project Plan Number ALION-PLN-TXU-4464-01, Revision 0.
4. Keeler & Long PPG Report No. 06-0413, "Design Basis Accident Testing of Coating Samples from Unit 1 Containment TXU Comanche Peak SES", April 2006.

9.0 PHOTOS AND SEM IMAGES

Figure 3 MRS-3XY Calibration Grid

Figure 4 MRS-3XY Calibration Grid

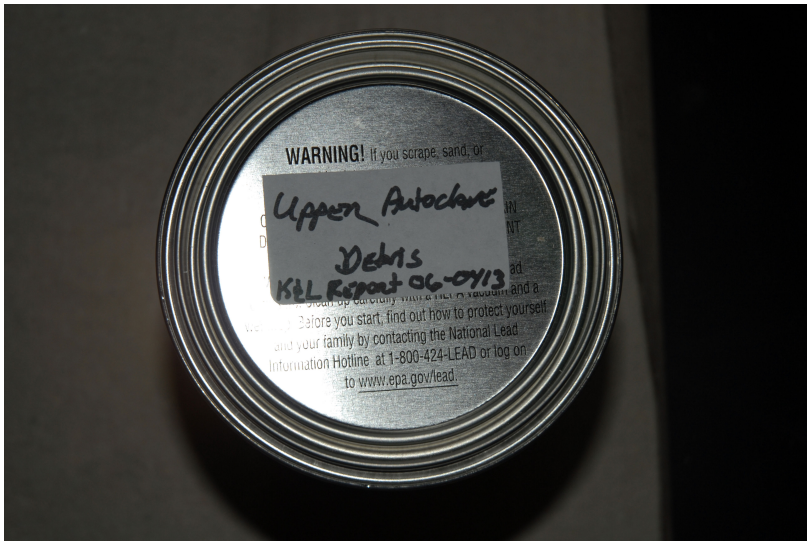

Figure 5 As Received Upper Autoclave

Figure 6 As Received Upper Autoclave Debris

Figure 7 Upper Autoclave Coating Debris

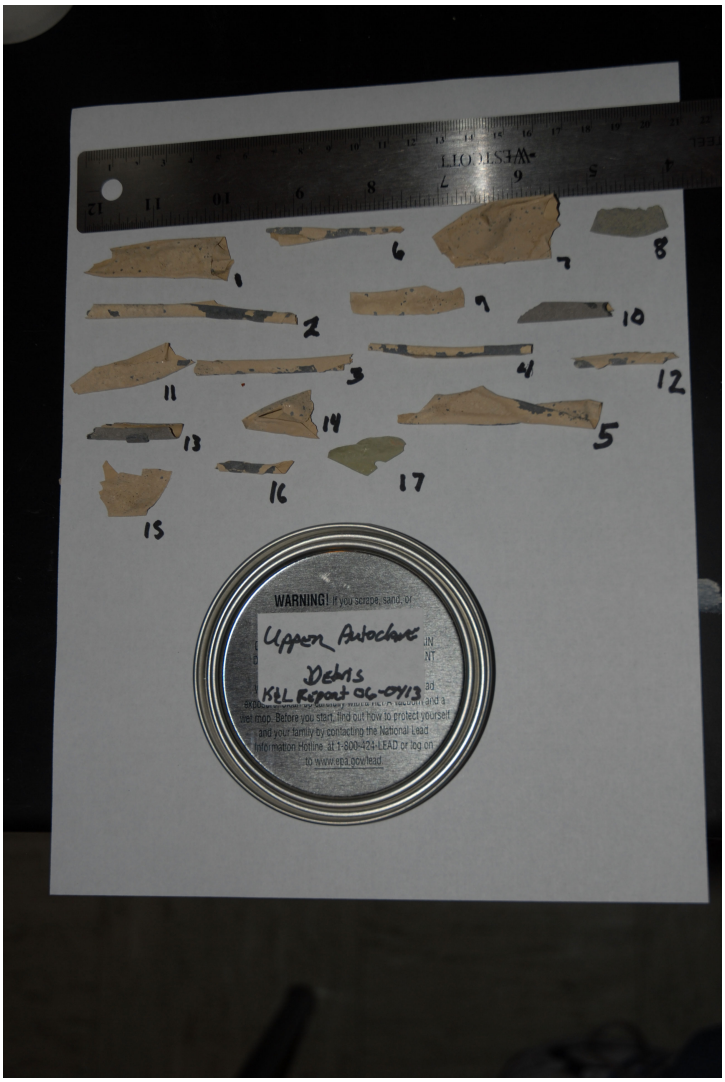

Figure 8 Upper Autoclave Debris > 1”

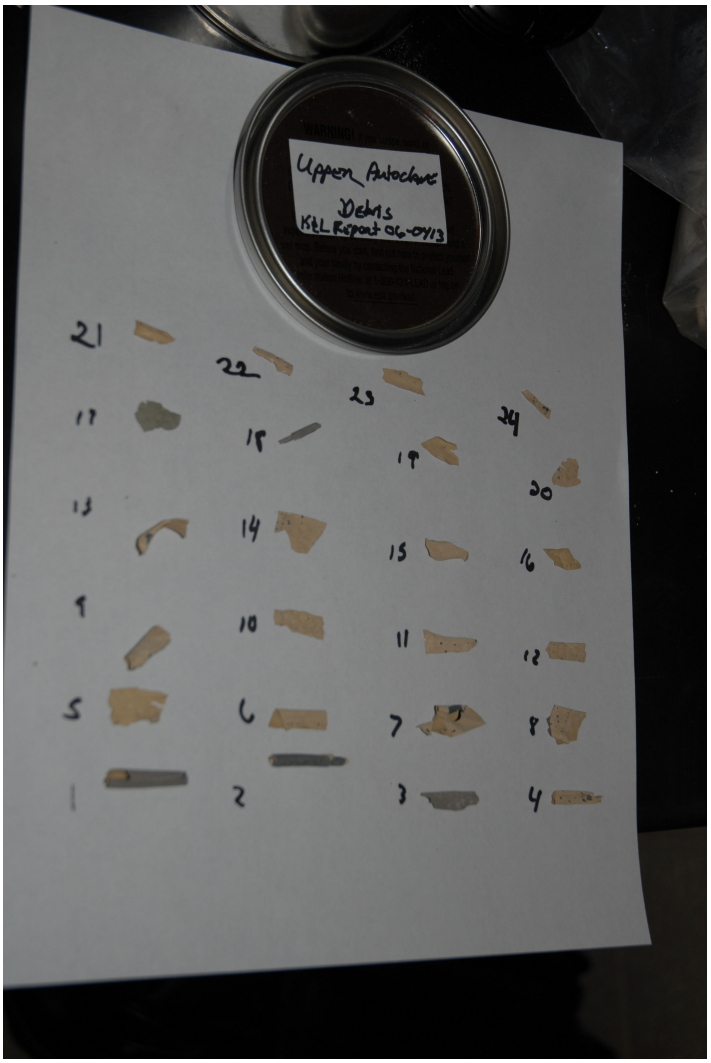

Figure 9 Upper Autoclave Debris ½ - 1”

Figure 10 Upper Autoclave Debris ¼ - ½”

Figure 11 Upper Autoclave Debris 1/8 to ¼"

Figure 12 Lower Autoclave Debris > 1”

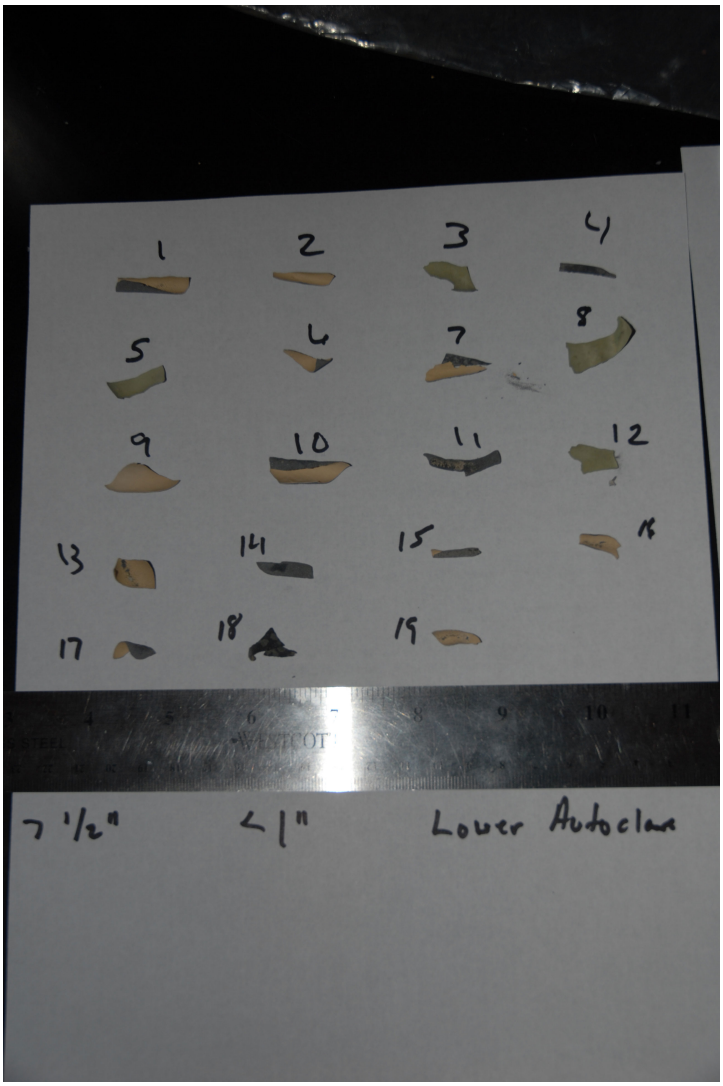

Figure 13 Lower Autoclave Debris ½" to 1"

Figure 14 Lower Autoclave Debris ¼” to ½”

Figure 15 Lower Autoclave Debris < ¼”

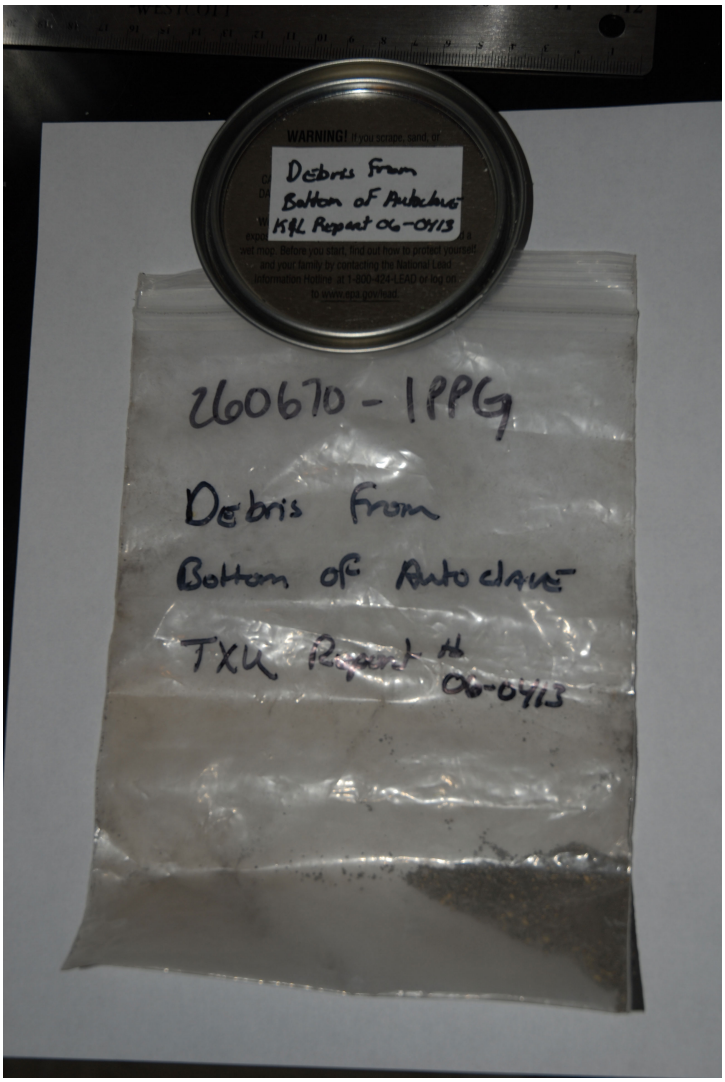

Figure 16 Bottoms of Autoclave

Figure 17 Debris from Bottoms of Autoclave

Figure 18 Sample Debris on Glass Slide

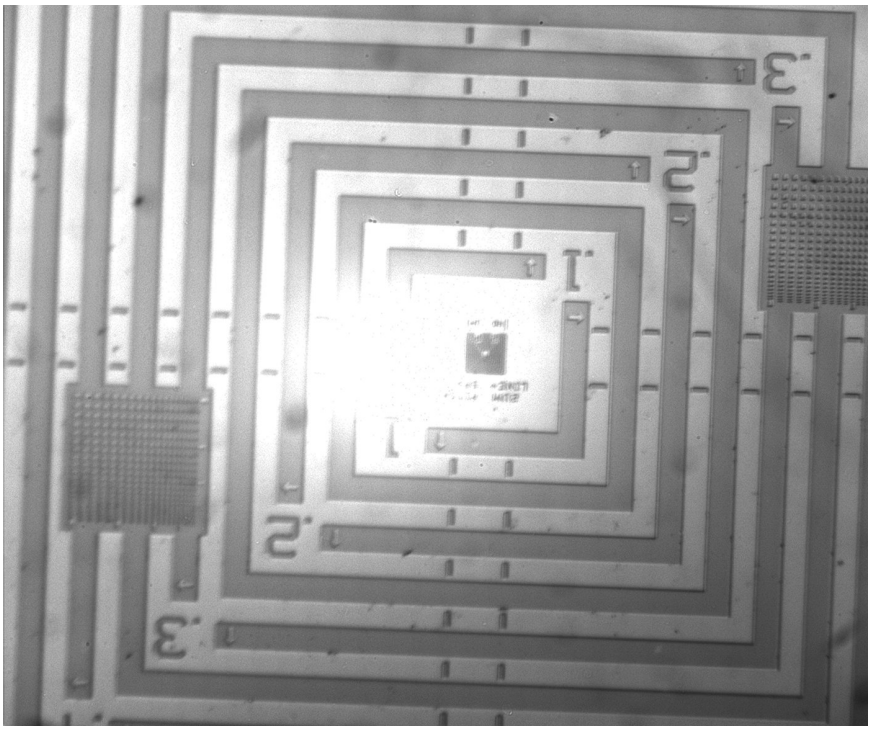

Figure 19 MRS-3XY Optical Microscope, Center of Grid

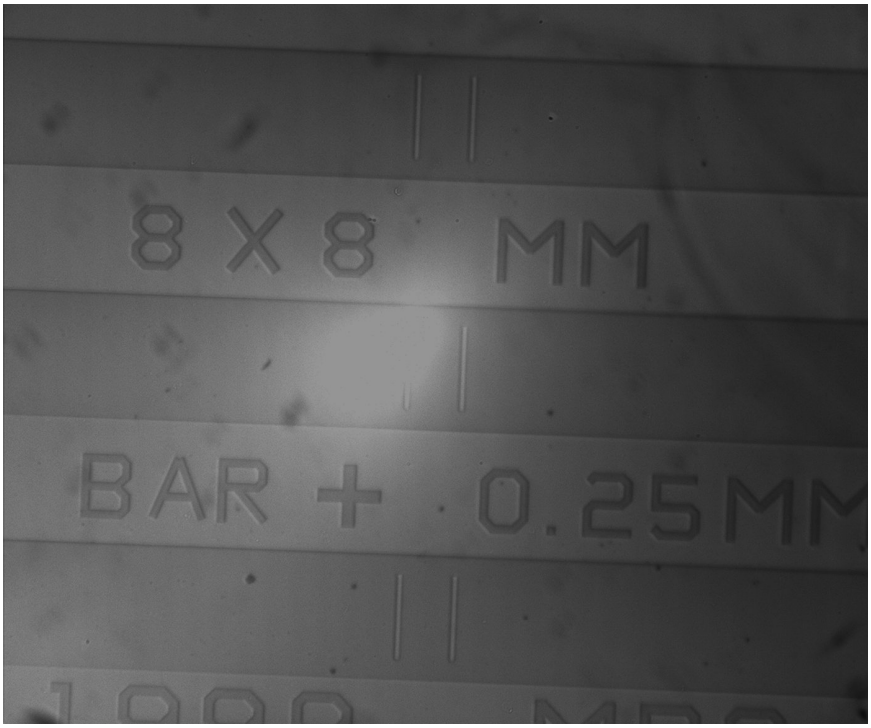

Figure 20 MRS-3XY Optical Microscope, Calibration Bars

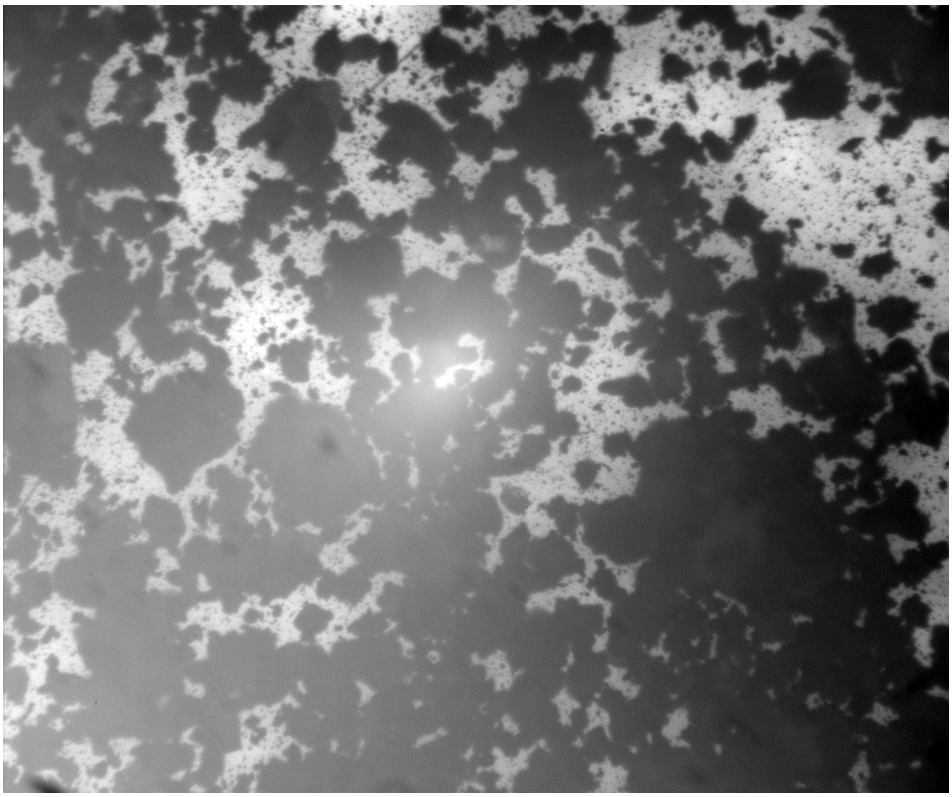

Figure 21 Bottoms Debris Optical Microscope at 5X Magnification

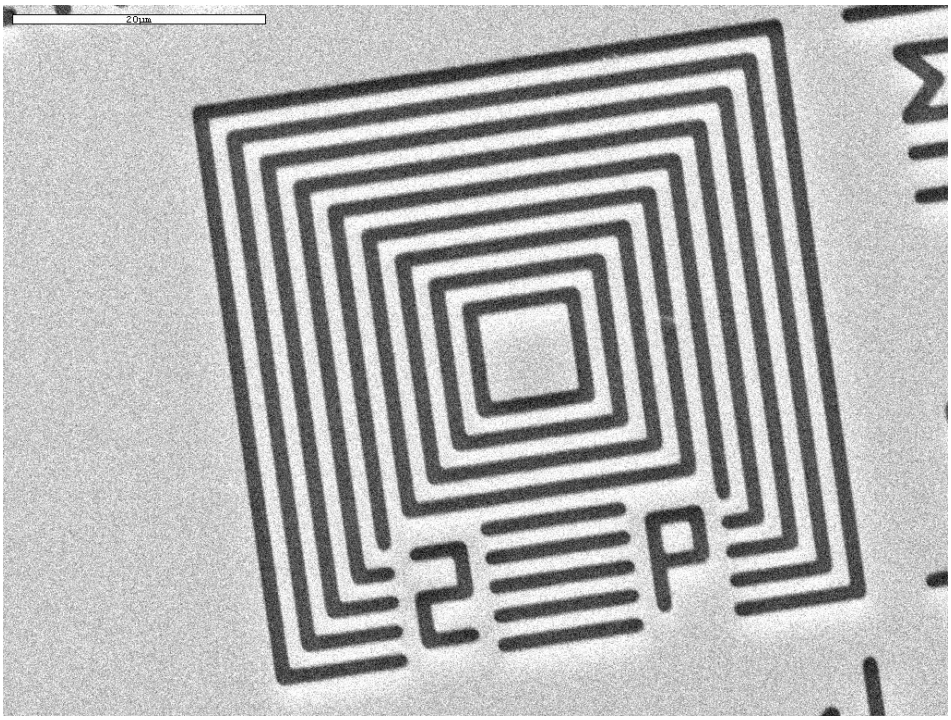

Figure 22 MRS-3XY Under SEM 1,800X Magnification

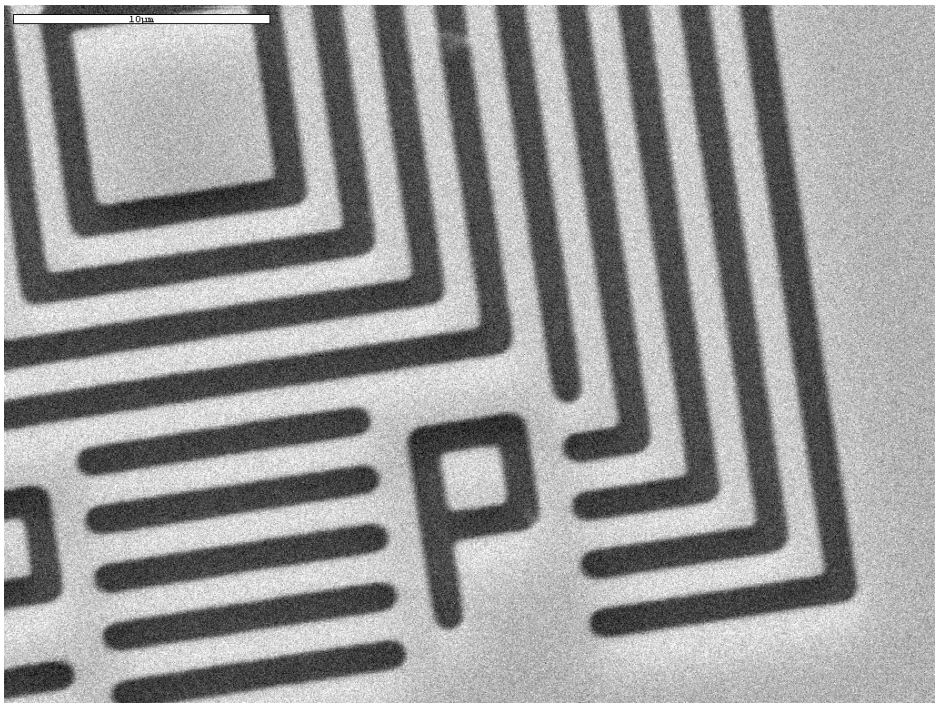

Figure 23 MRS-3XY Calibration Grid SEM 3,700X Magnification

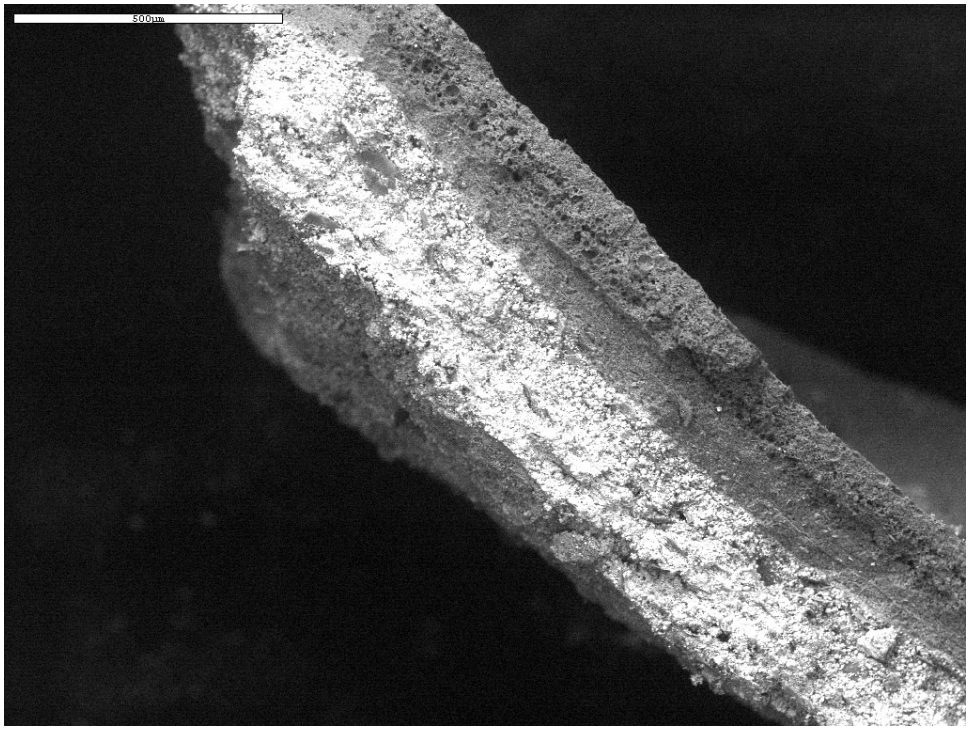

Figure 24 Paint Chip on Side from Upper Autoclave, Beige Chip at 75X (organic layer in black, zinc in white)

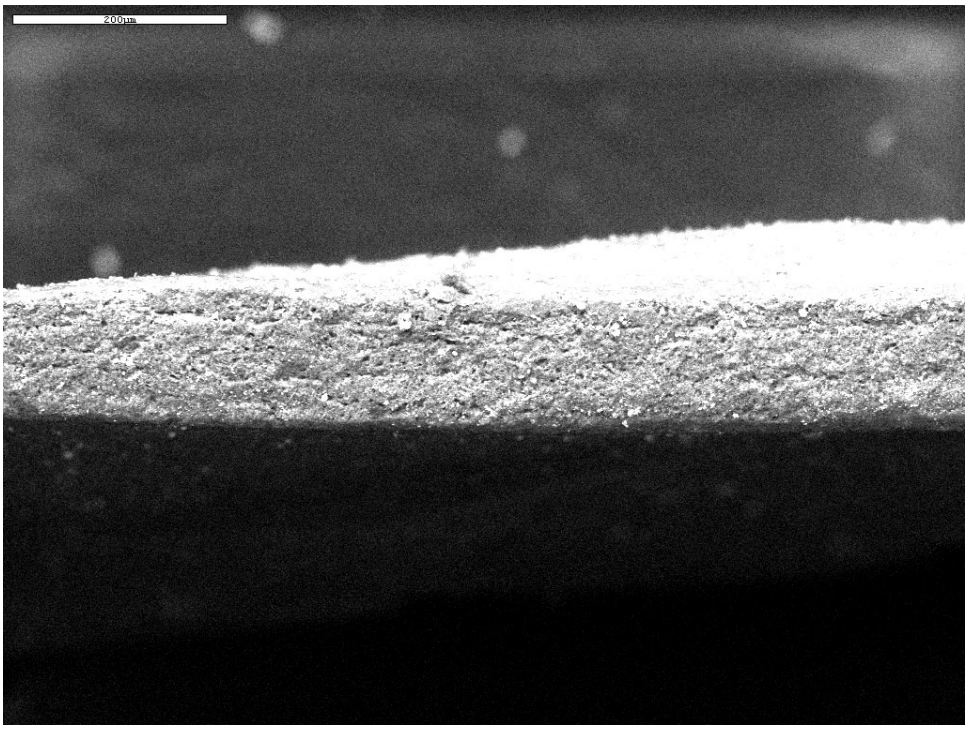

Figure 25 Paint Chip on Side from Upper Autoclave, Green Chip at 150X

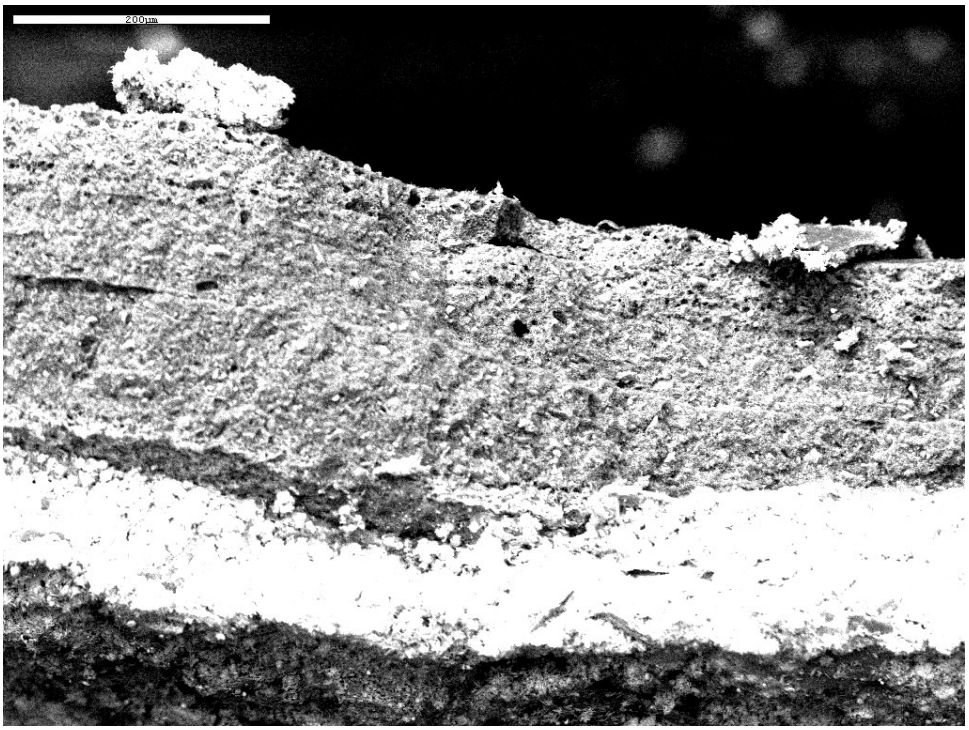

Figure 26 Paint Chip on Side from Lower Autoclave, Beige Chip at 180X

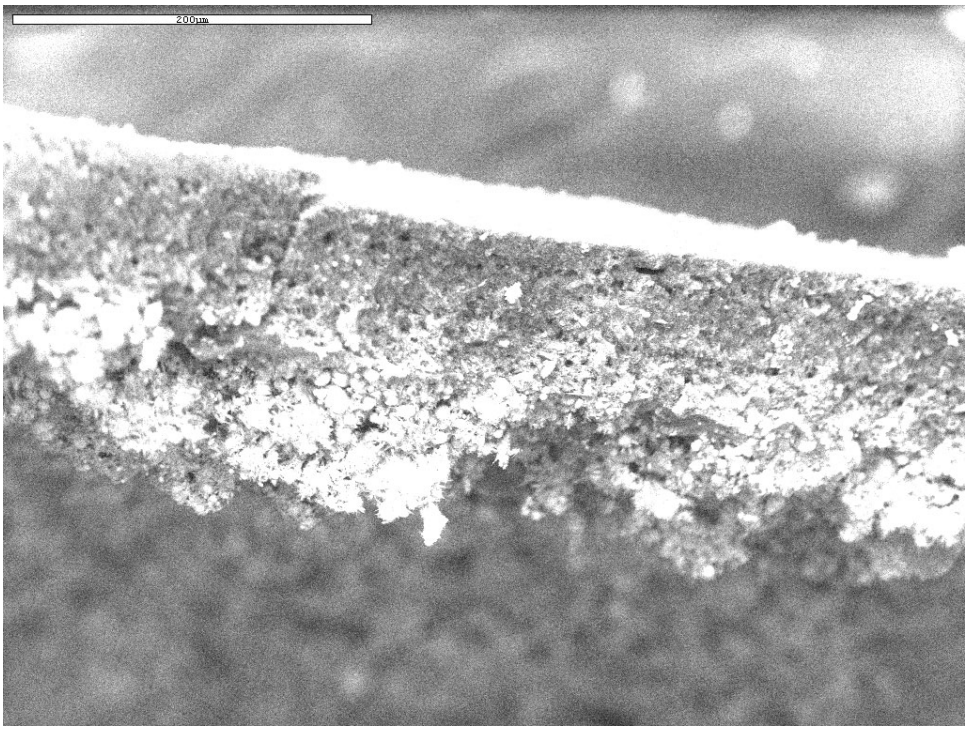

Figure 27 Paint Chip on Side from Lower Autoclave, Green Chip at 250X

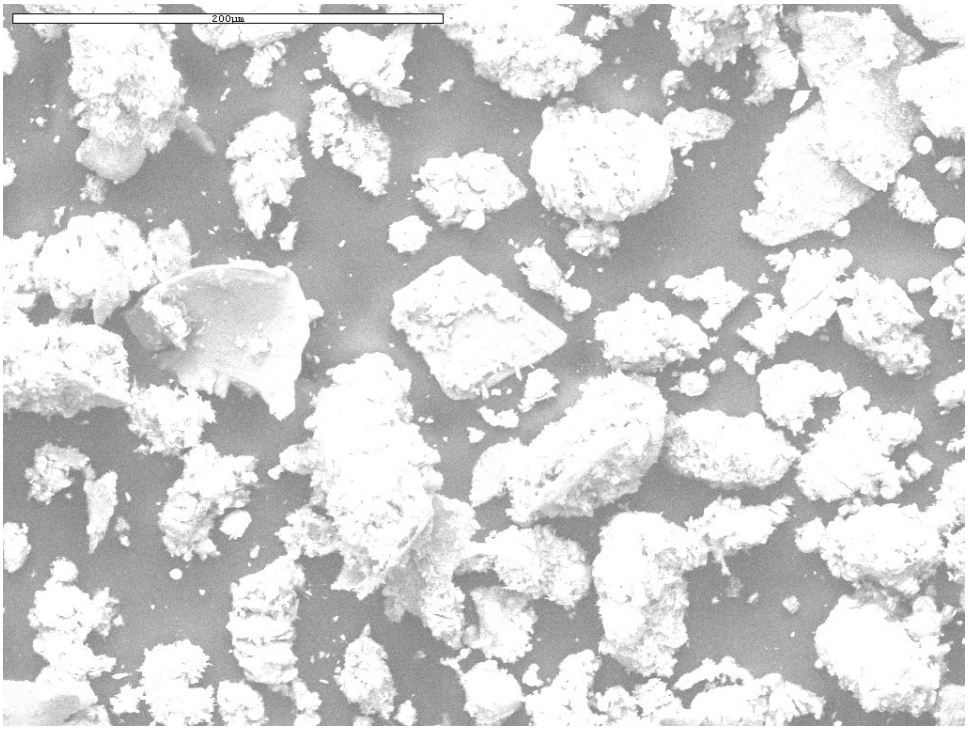

Figure 28 Dust from Paint Debris at 300X

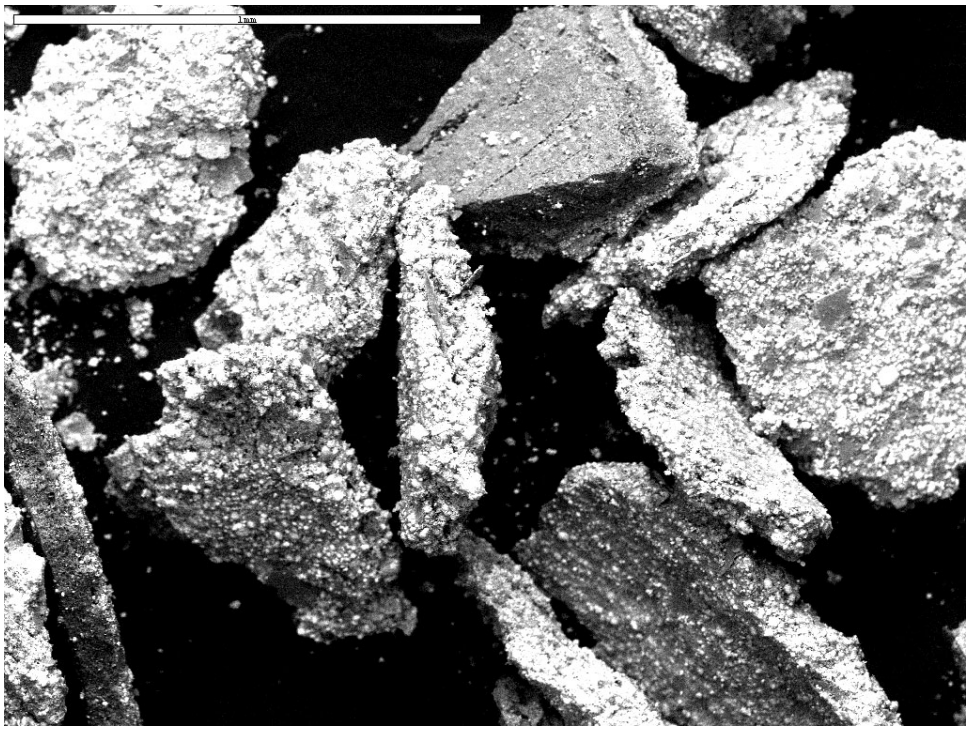

Figure 29 Debris from Bottoms of Autoclave at 65X

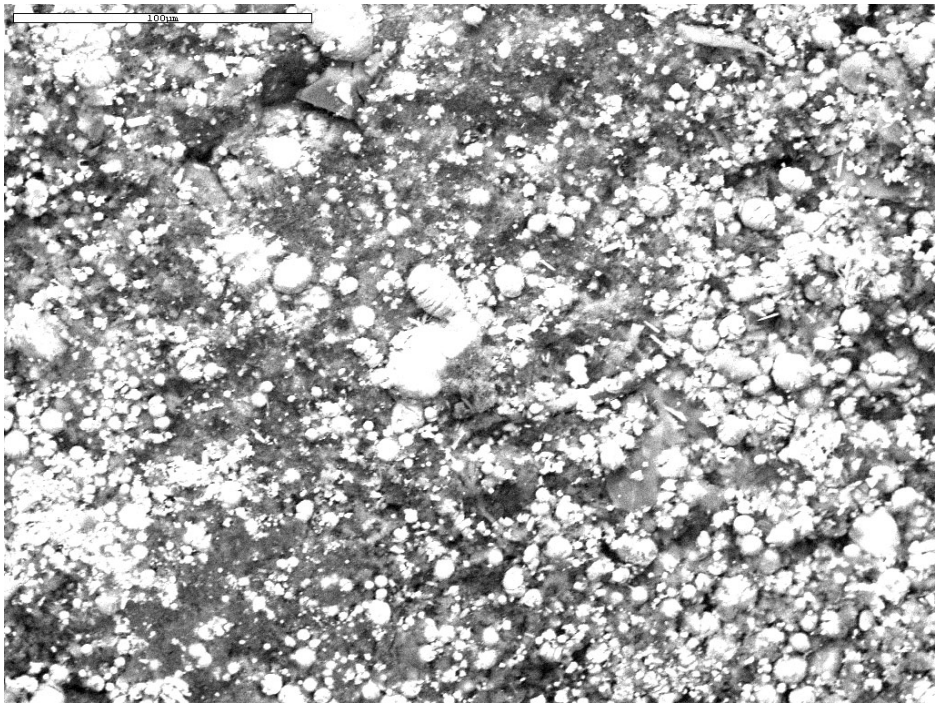

Figure 30 Green Paint Chip from Upper Autoclave Backside (zinc side) at 430X

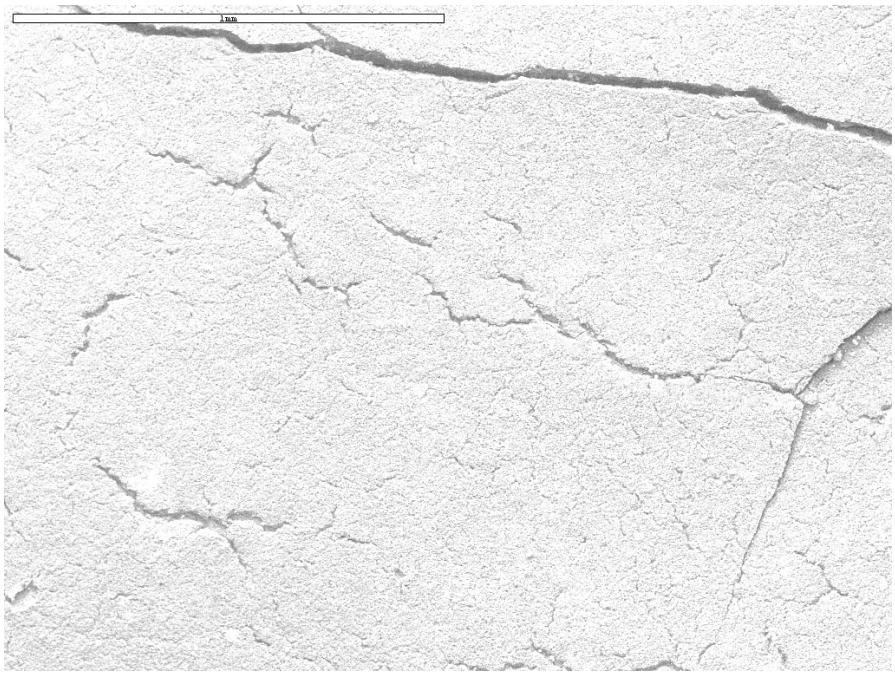

Figure 31 Green Paint Chip from Upper Autoclave Frontside (epoxy side) at 65X

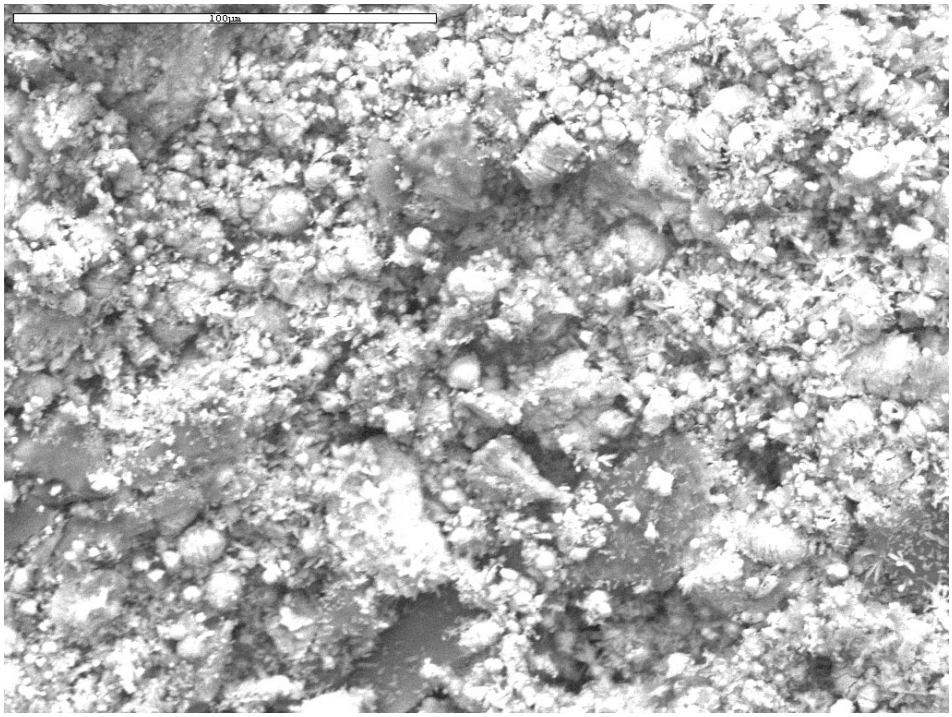

Figure 32 Beige Paint Chip from Upper Autoclave, Backside (zinc) at 600X

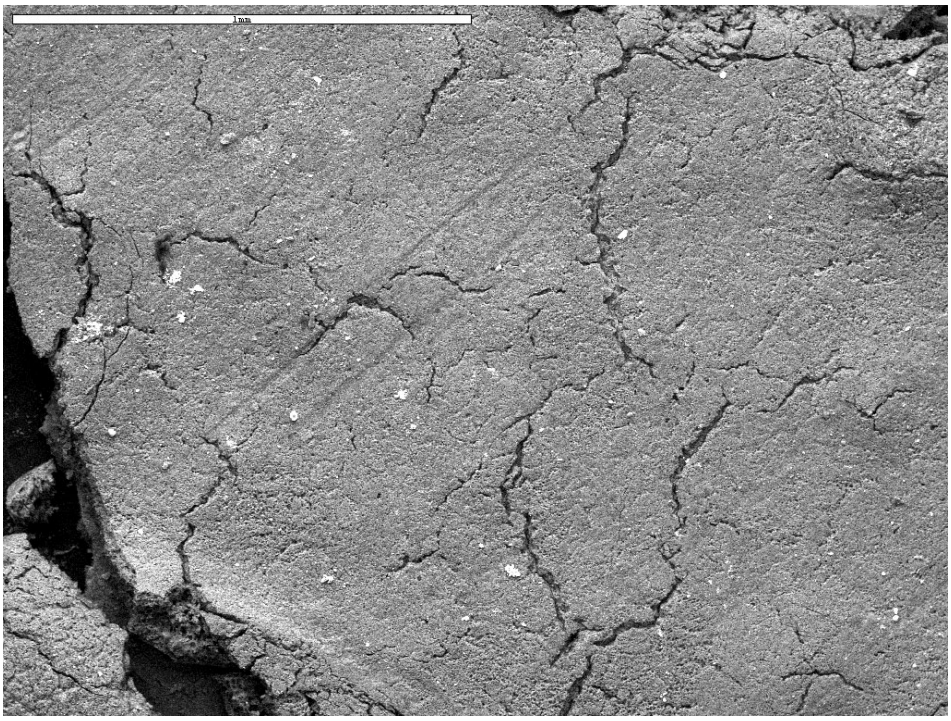

Figure 33 Beige Paint Chip from Upper Autoclave Frontside (epoxy) at 65X

Figure 34 Green Paint Chip from Lower Autoclave Backside (zinc) at 65X

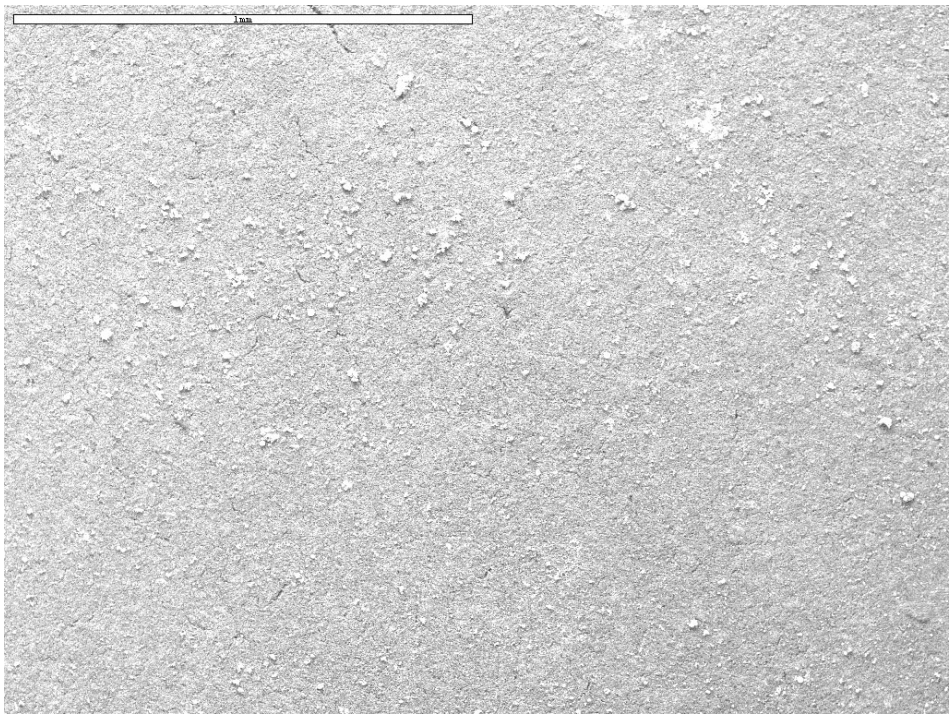

Figure 35 Green Chip from Lower Autoclave Frontside (epoxy) at 65X

Figure 36 Beige Chip from Lower Autoclave Frontside (epoxy) at 65X

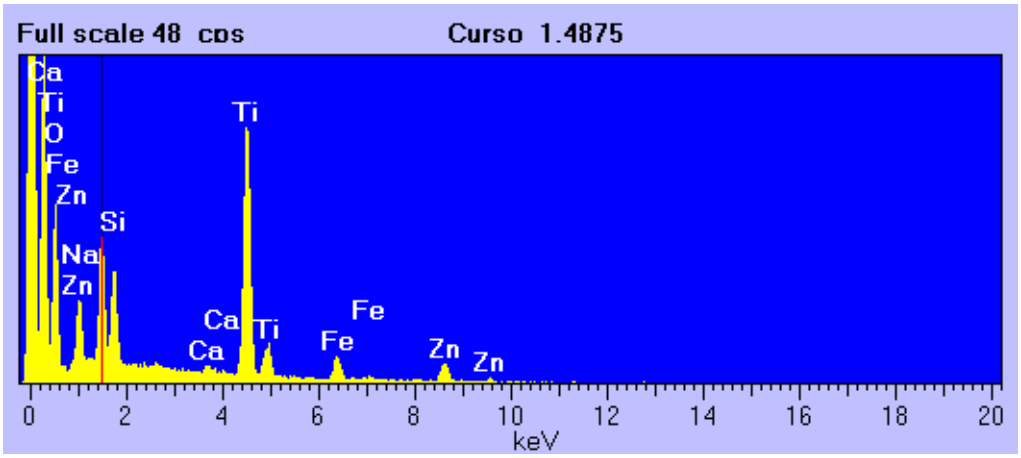

Figure 37 Green Chip Front Side from Upper Autoclave EDS Scan

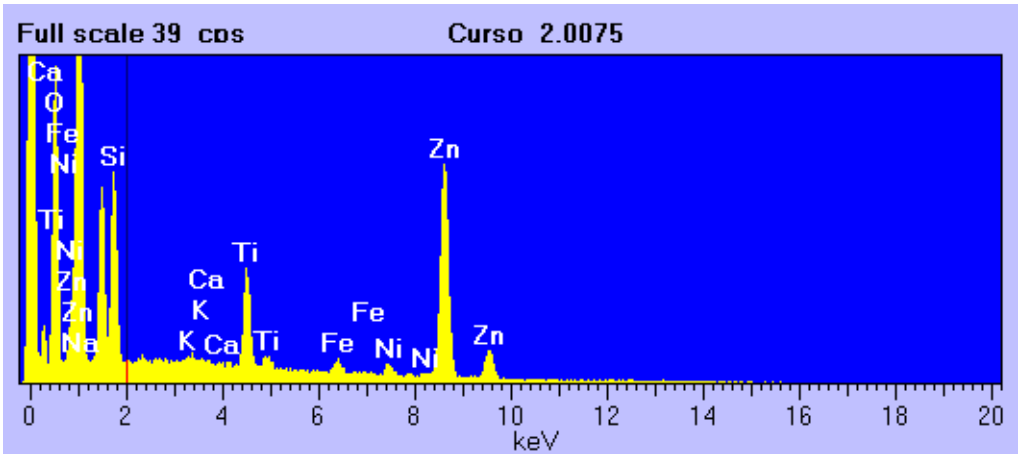

Figure 38 Green Chip Back Side from Upper Autoclave EDS Scan

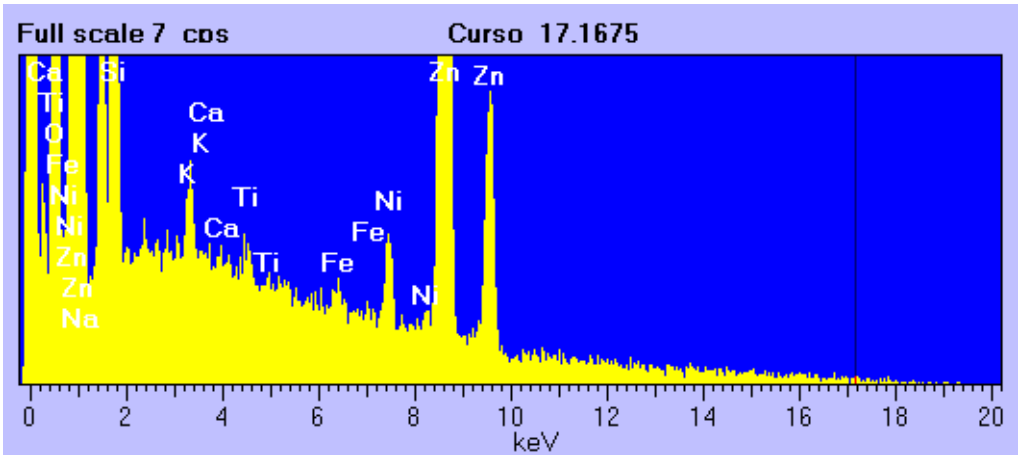

Figure 39 Beige Chip Back Side from Upper Autoclave EDS Scan

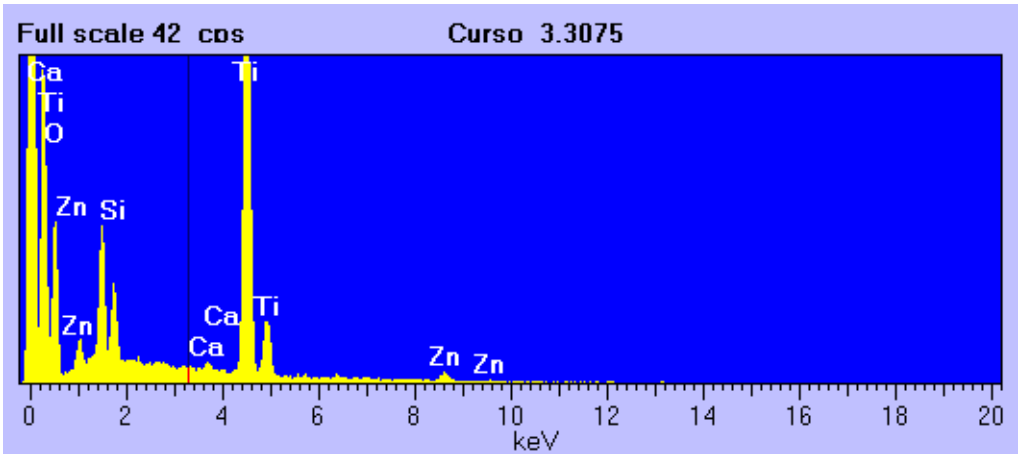

Figure 40 Beige Chip Front Side from Upper Autoclave EDS Scan

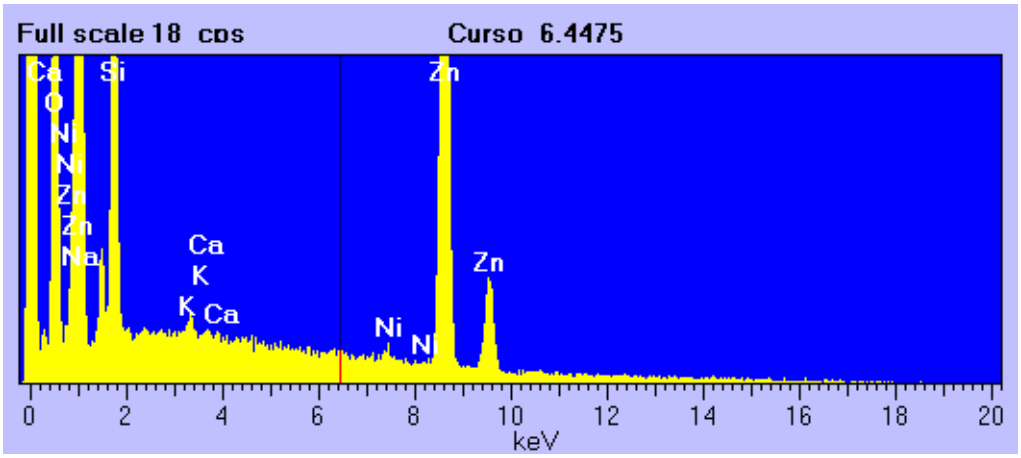

Figure 41 Green Chip Back Side from Lower Autoclave EDS Scan

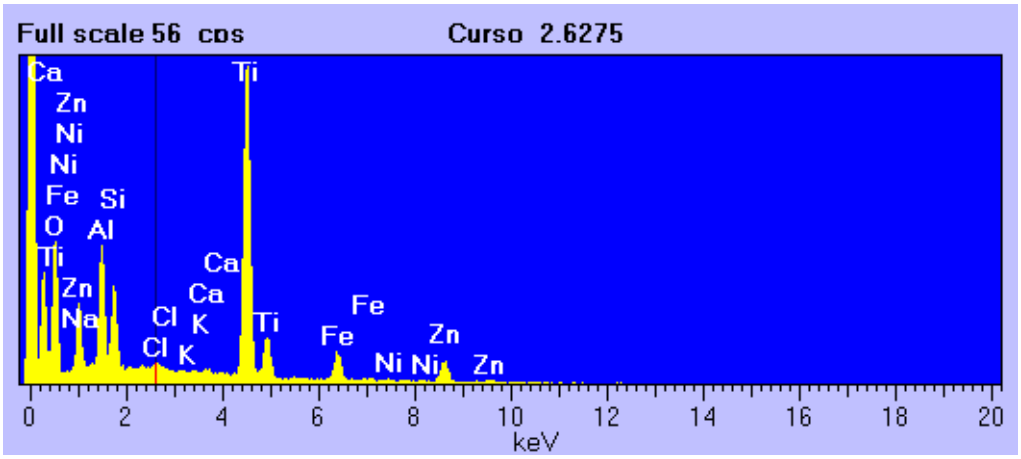

Figure 42 Green Chip Front Side from Lower Autoclave EDS Scan

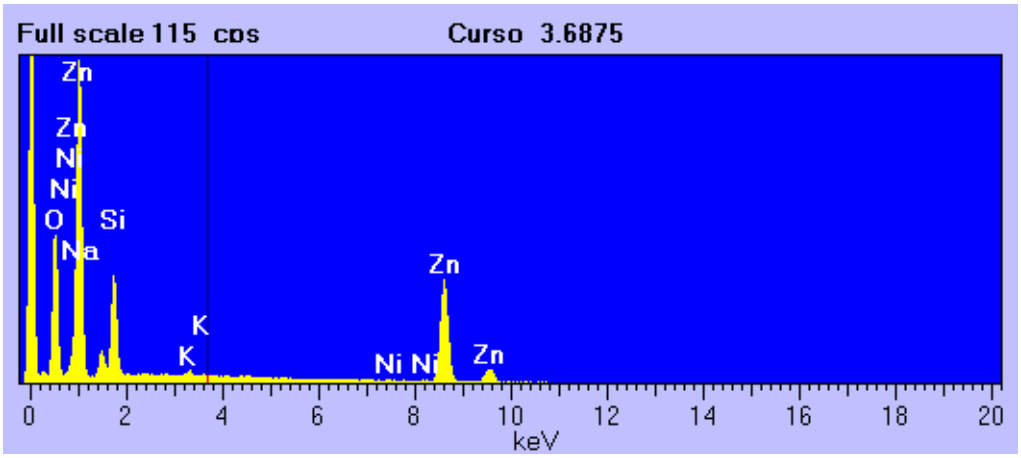

Figure 43 Beige Chip Back Side from Lower Autoclave EDS Scan

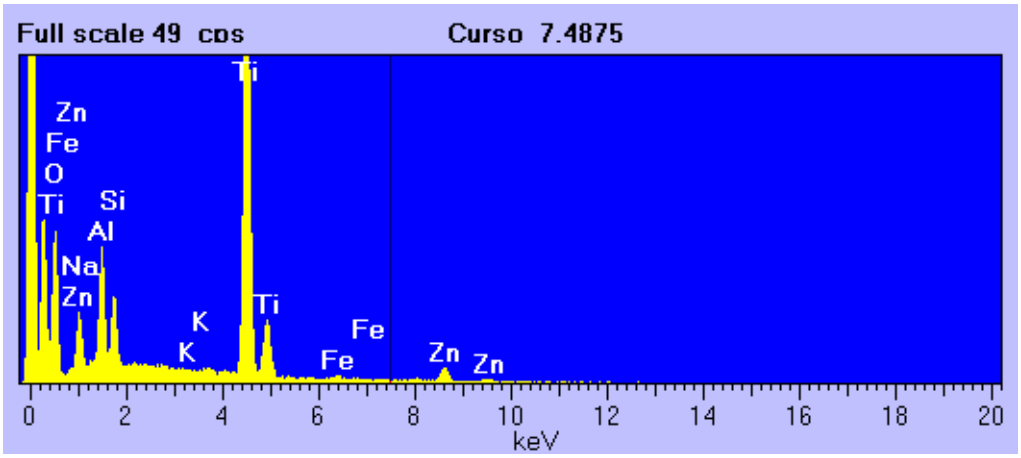

Figure 44 Beige Chip Front Side from Lower Autoclave EDS Scan

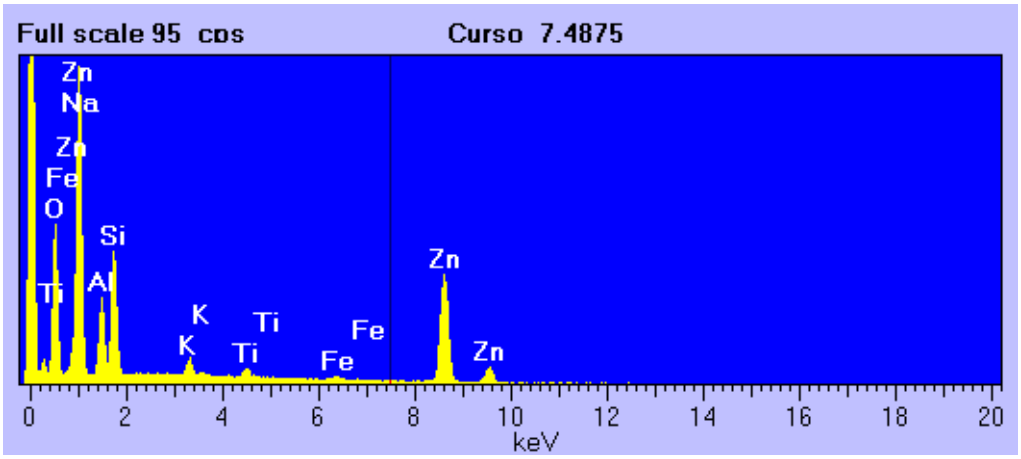

Figure 45 Debris from Bottoms of Autoclave EDS Scan

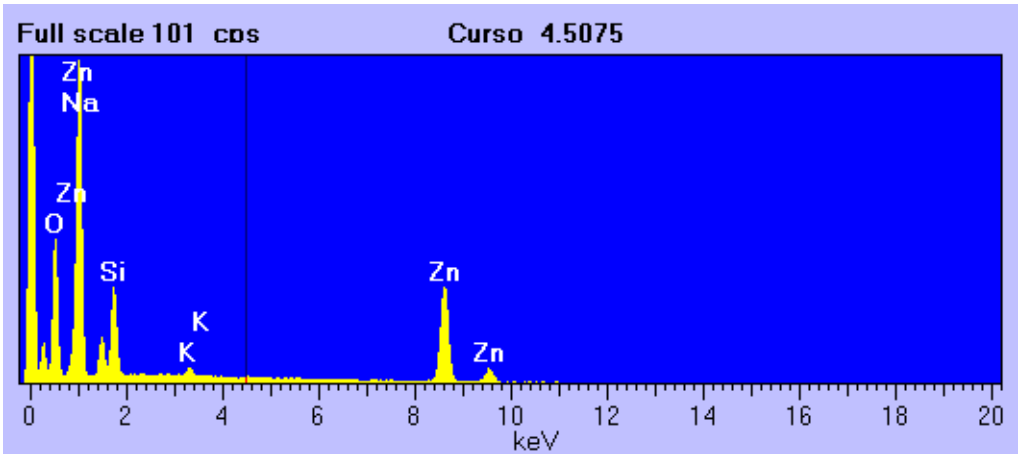

Figure 46 Dust from Lower Autoclave EDS Scan

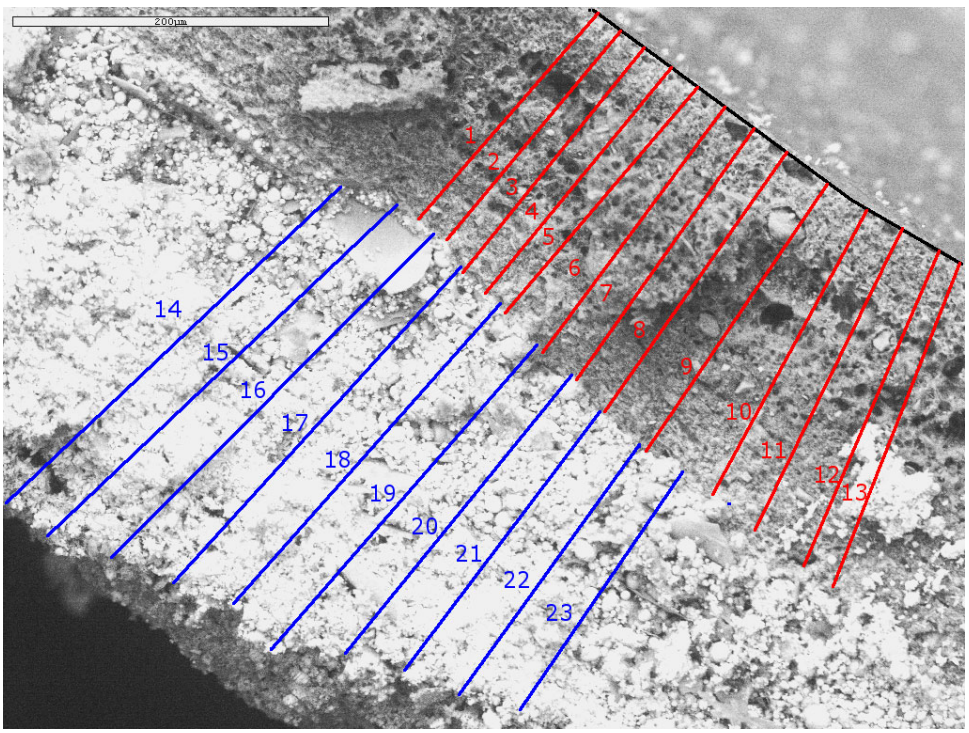

Figure 47 Example of Coating Layer Measurement Process Beige Coating from Upper Autoclave

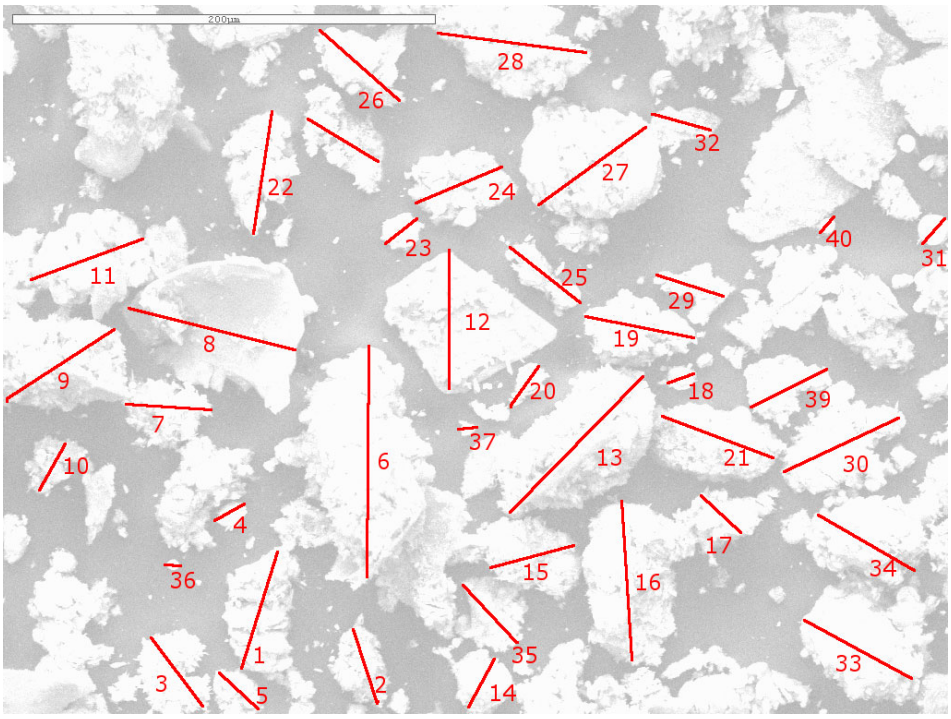

Figure 48 Example of Measurement of Dust from Lower Autoclave

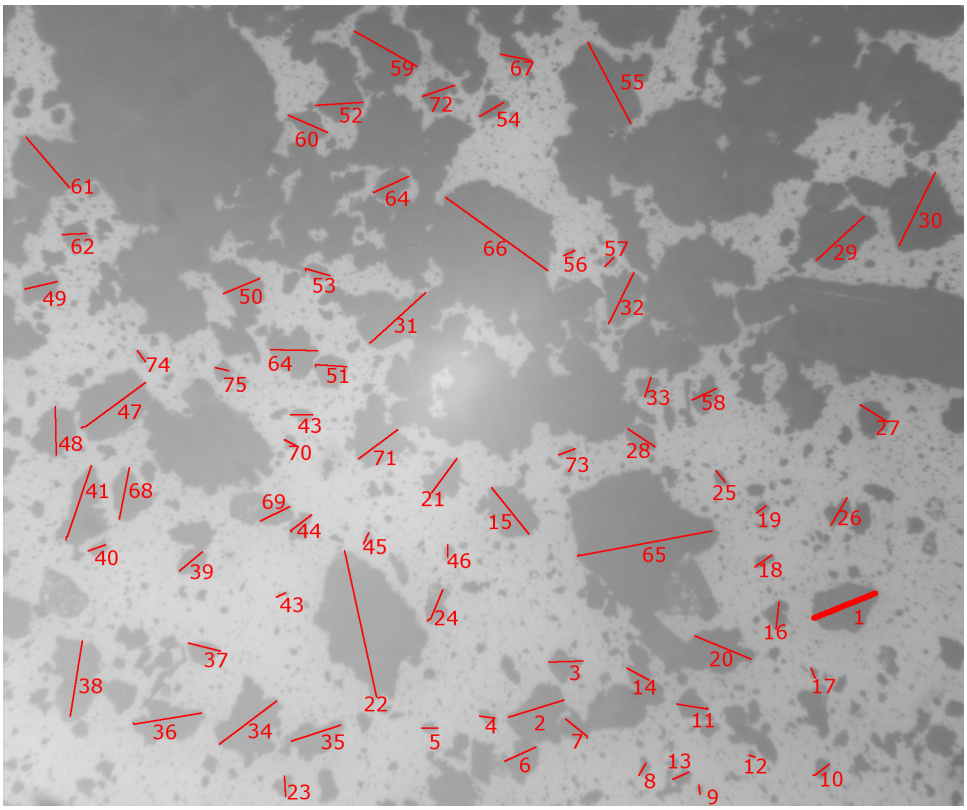

Figure 49 Example of Measurement of Bottoms Debris from Optical Microscopy

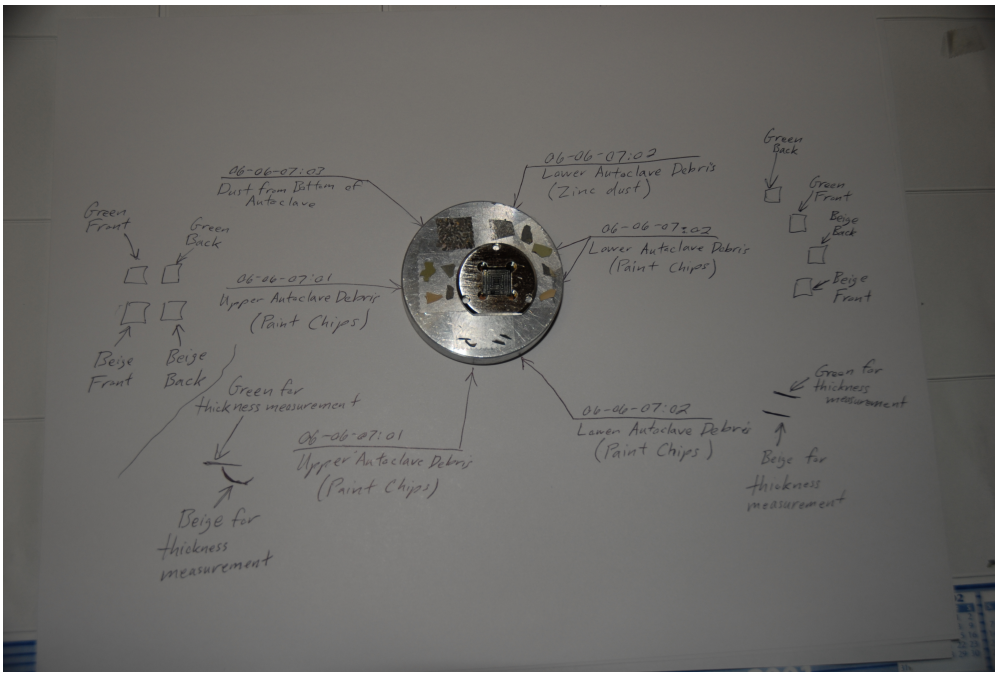

Figure 50 SEM Holder Identification, Specimen Mounting

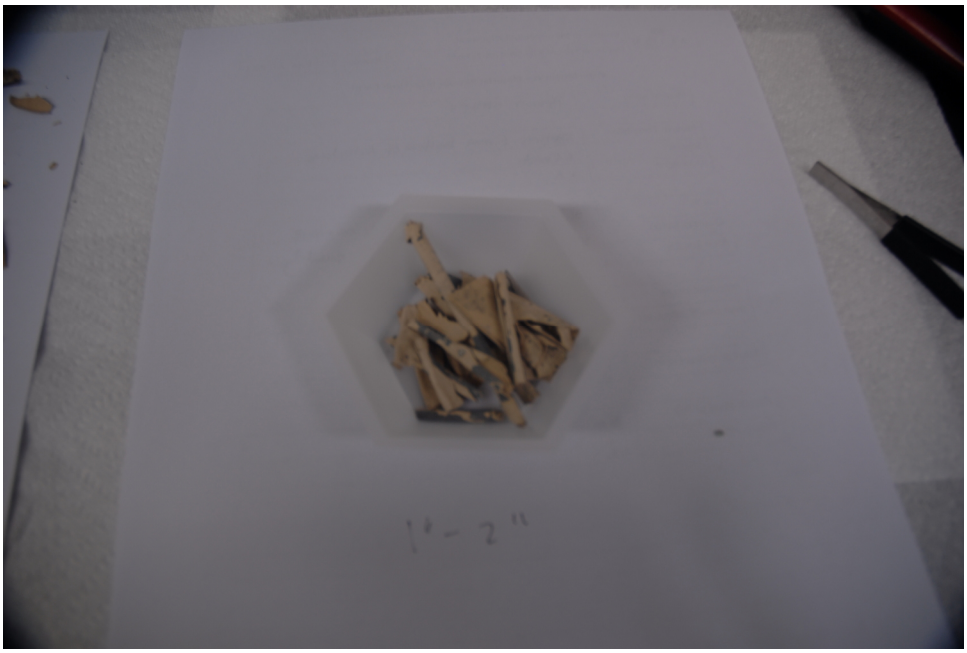

Figure 51 Upper Autoclave Debris > 1” in measuring boat

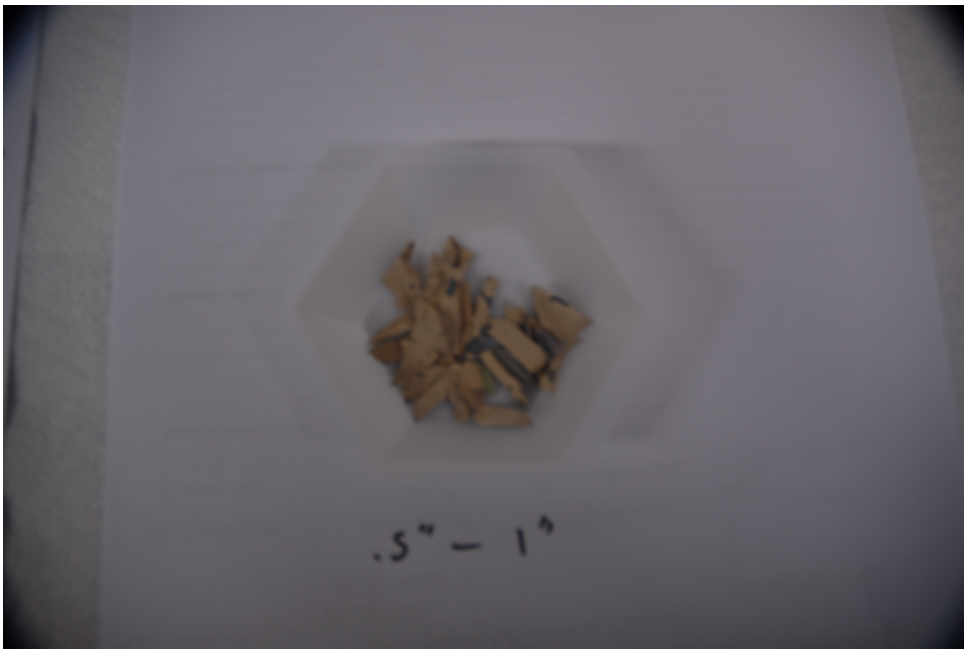

Figure 52 Upper Autoclave Debris ½ - 1" in measuring boat

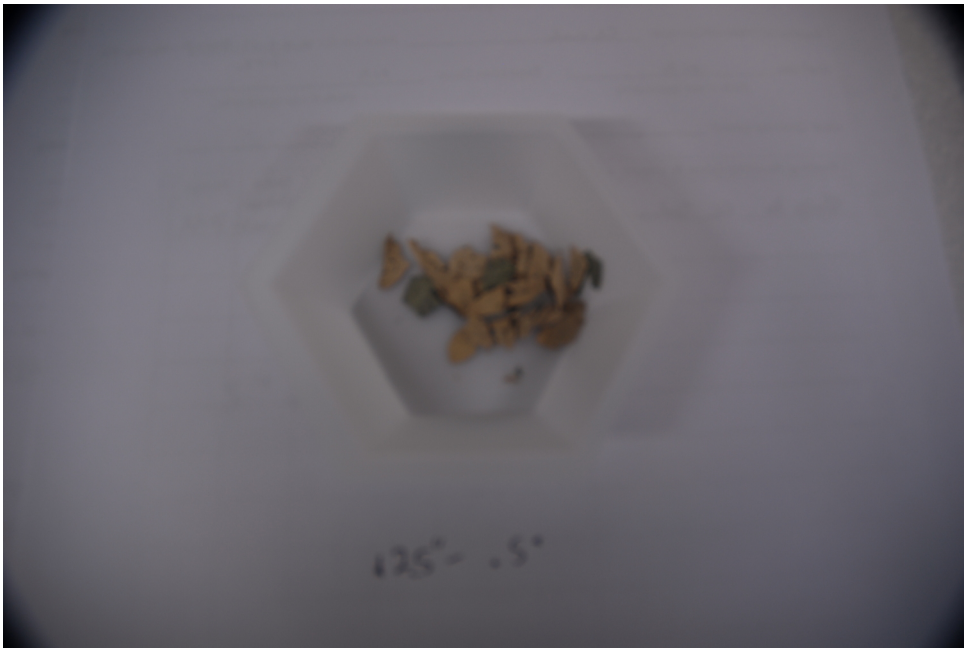

Figure 53 Upper Autoclave Debris ¼ - ½" in measuring boat

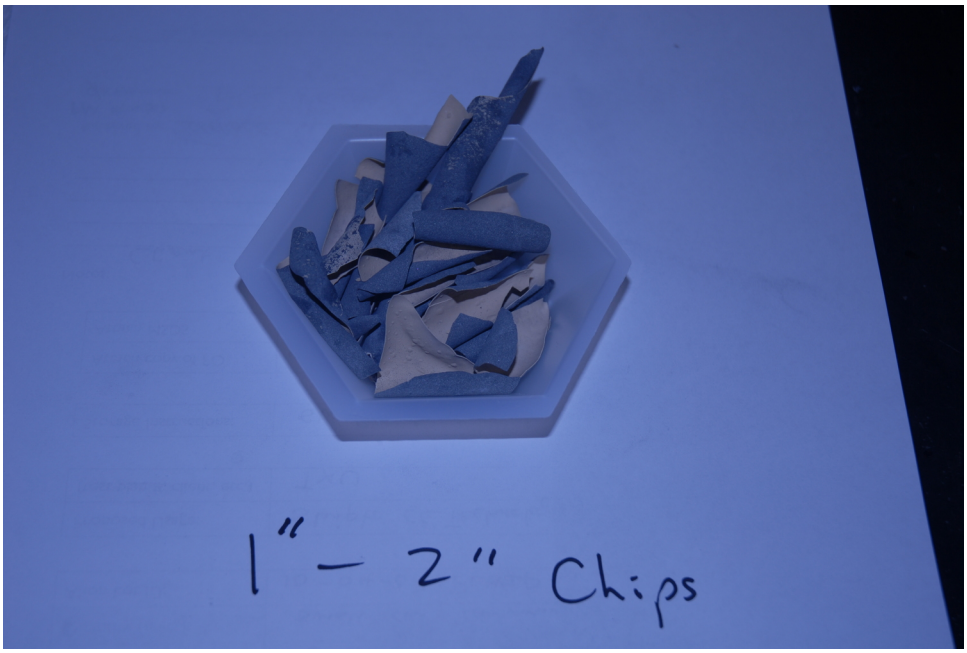

Figure 54 Lower Autoclave Debris > 1" in measuring boat

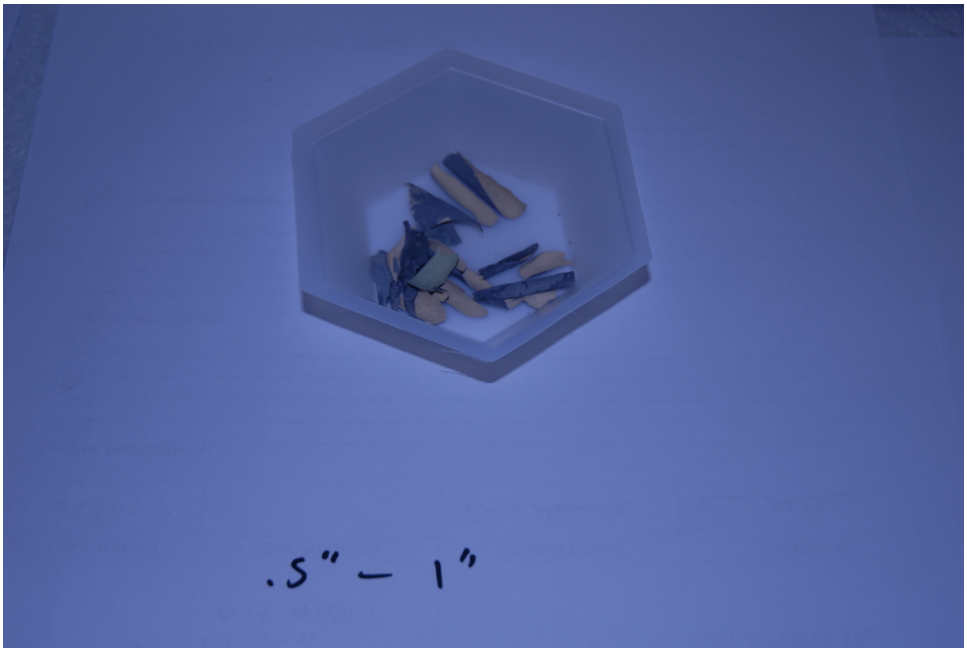

Figure 55 Lower Autoclave Debris ½" to 1" in measuring boat

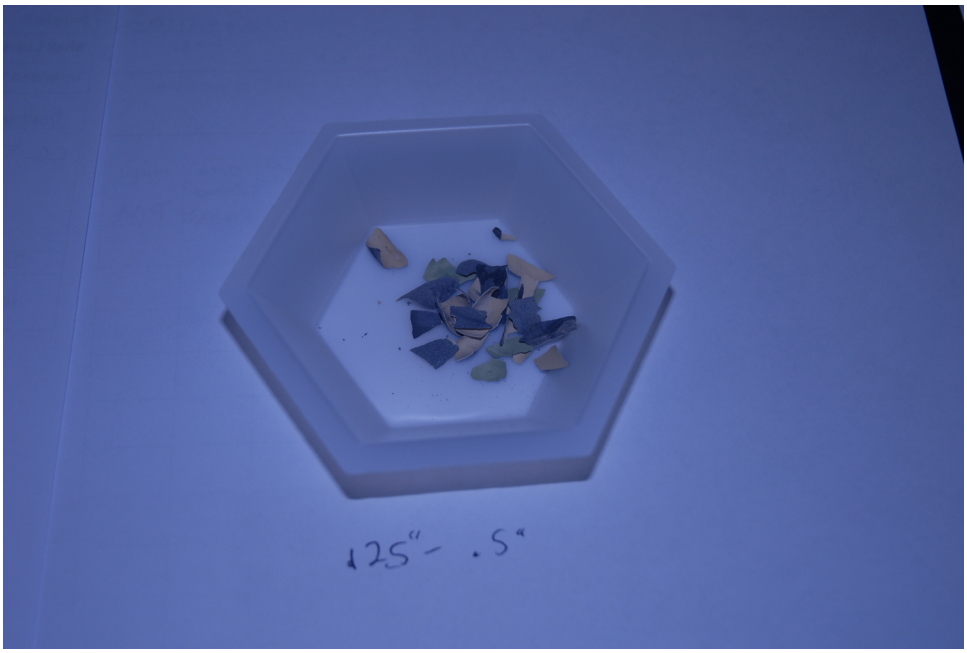

Figure 56 Lower Autoclave Debris ¼" to ½" in measuring boat

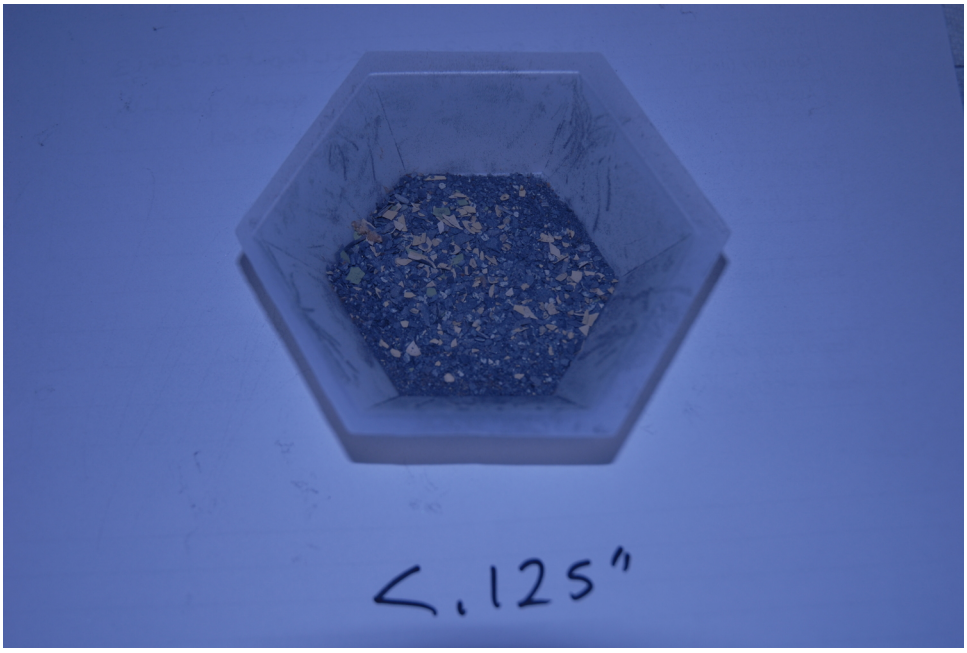

Figure 57 Lower Autoclave Debris < ¼" in measuring boat

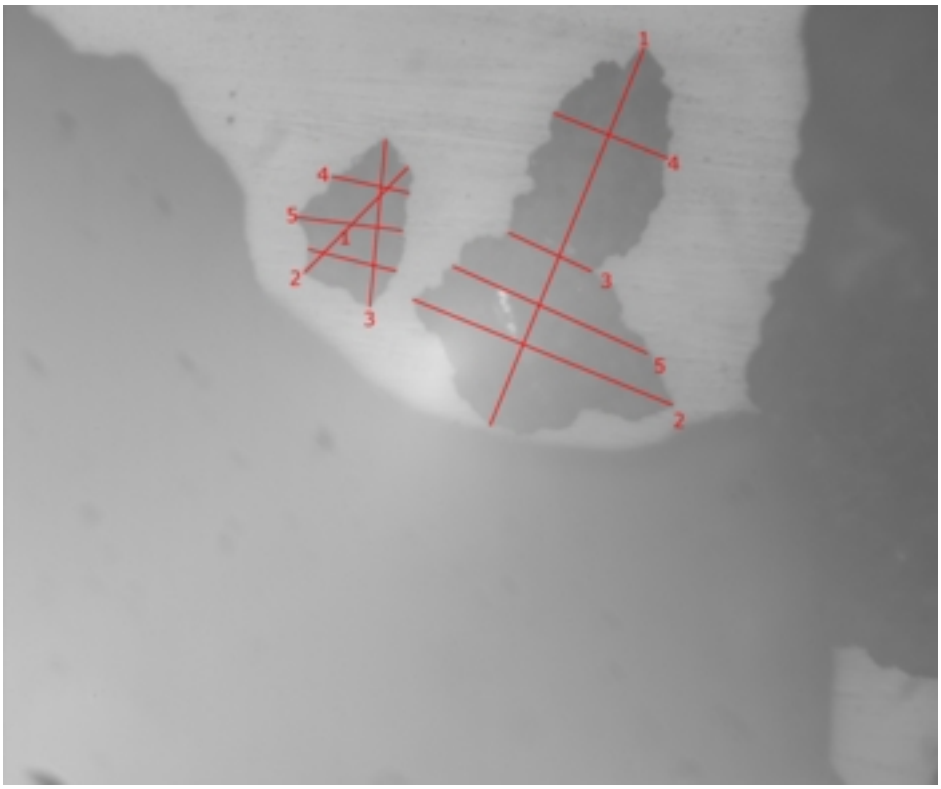

Figure 58 Upper Autoclave Debris < 1/8" measured via optical microscopy (upper1.tif)

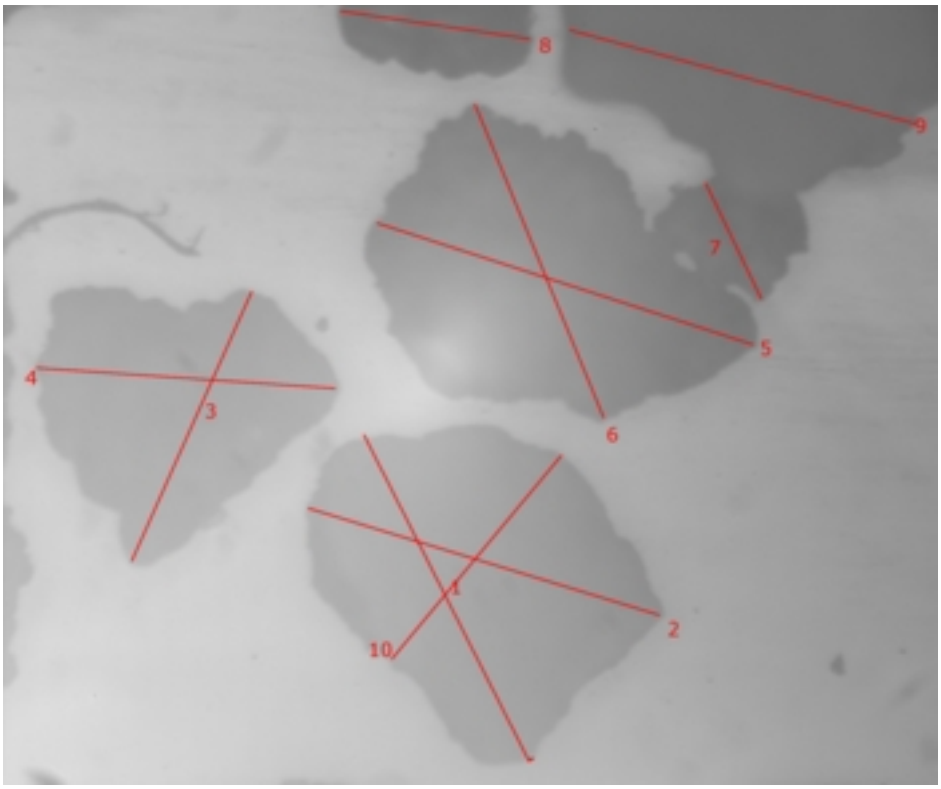

Figure 59 Upper Autoclave Debris < 1/8" measured via optical microscopy (upper2.tif)

Figure 60 Upper Autoclave Debris < 1/8" measured via optical microscopy (upper3.tif)

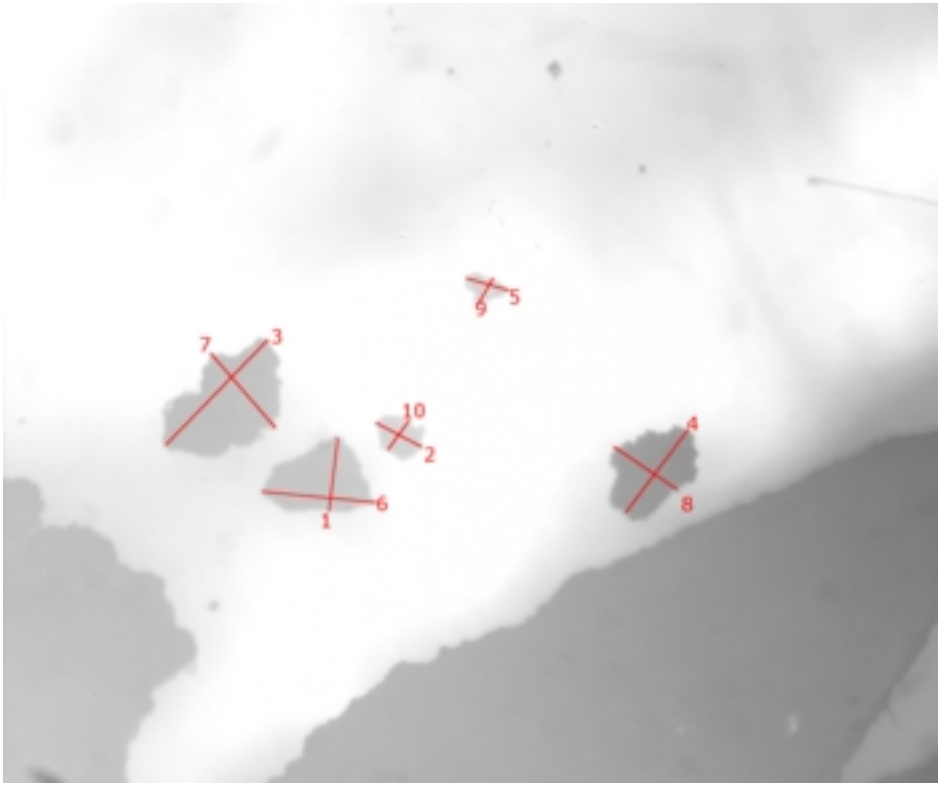

Figure 61 Upper Autoclave Debris < 1/8" measured via optical microscopy (upper4.tif)

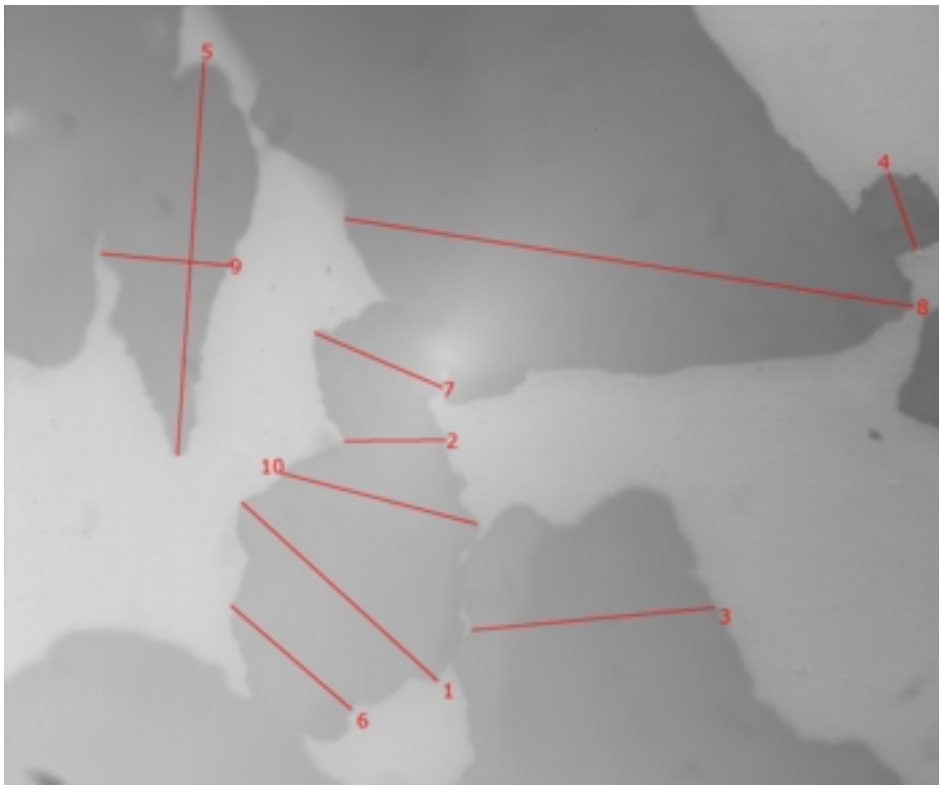

Figure 62 Upper Autoclave Debris < 1/8" measured via optical microscopy (upper5.tif)

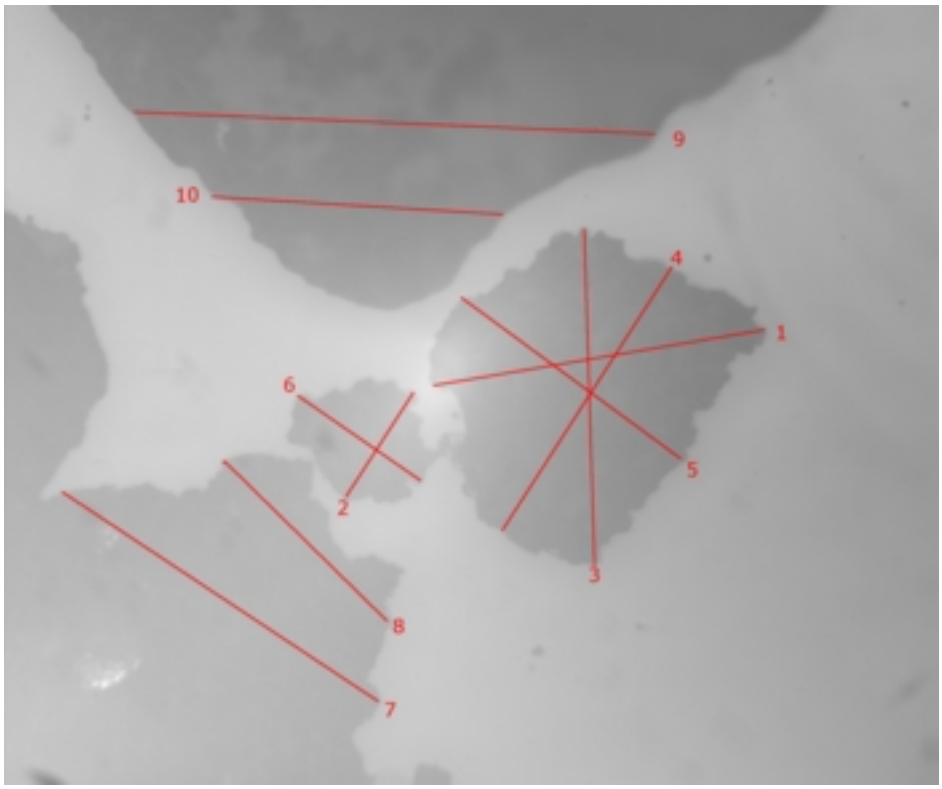

Figure 63 Upper Autoclave Debris < 1/8" measured via optical microscopy (upper6.tif)

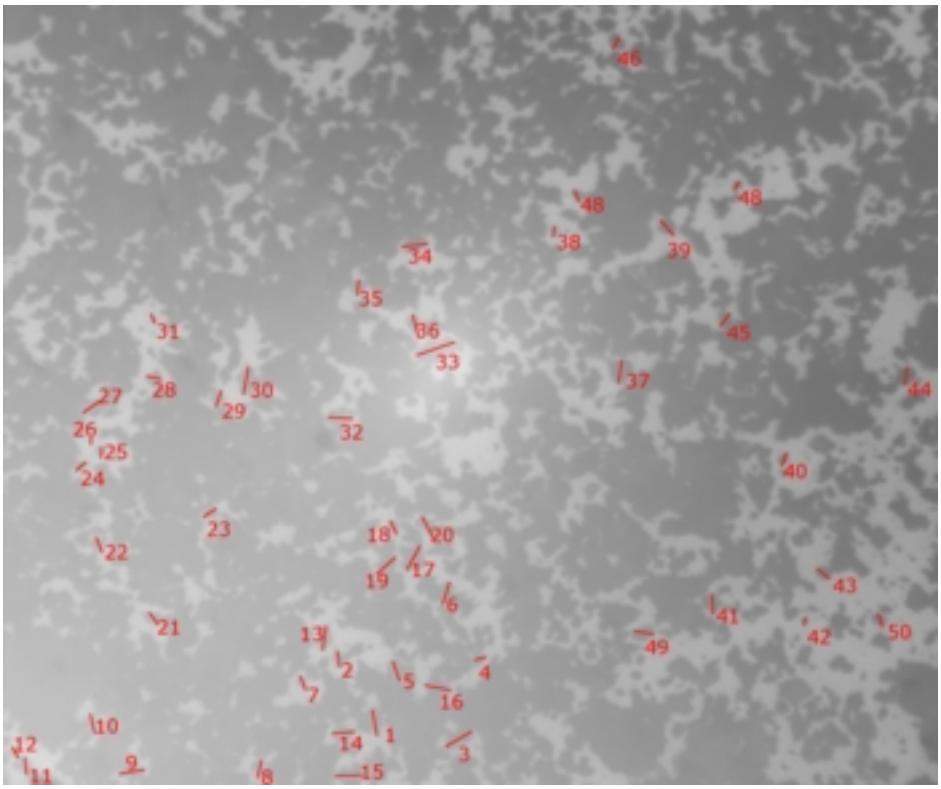

Figure 64 Lower Autoclave Debris < 1/8" measured via optical microscopy (lower2.tif)

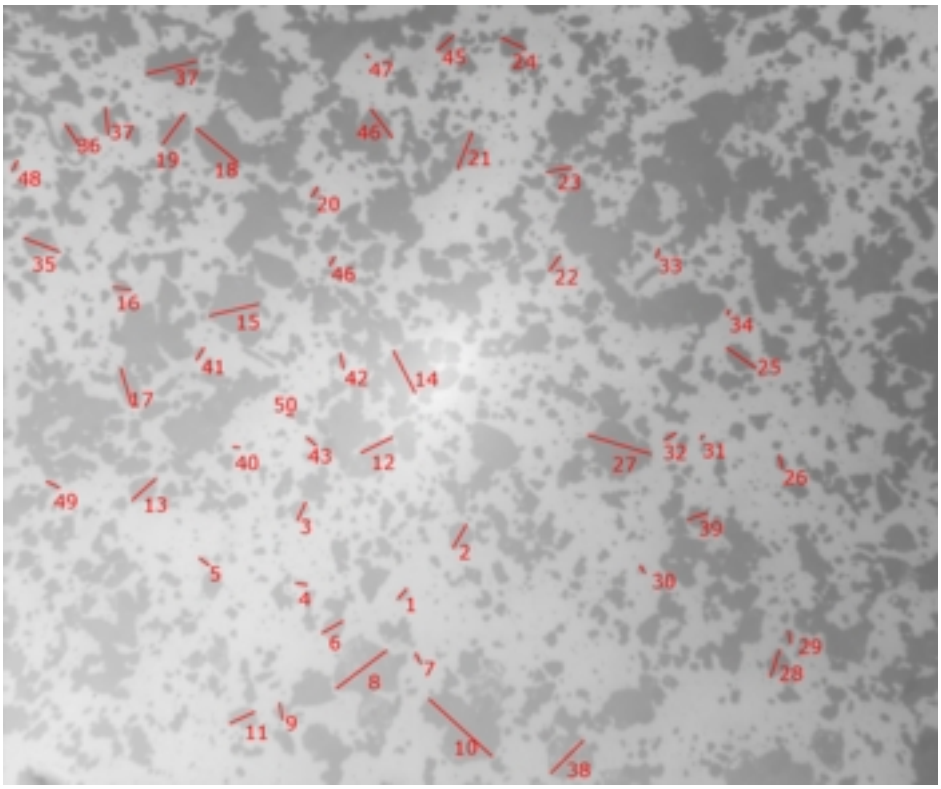

Figure 65 Lower Autoclave Debris < 1/8" measured via optical microscopy (lower3.tif)

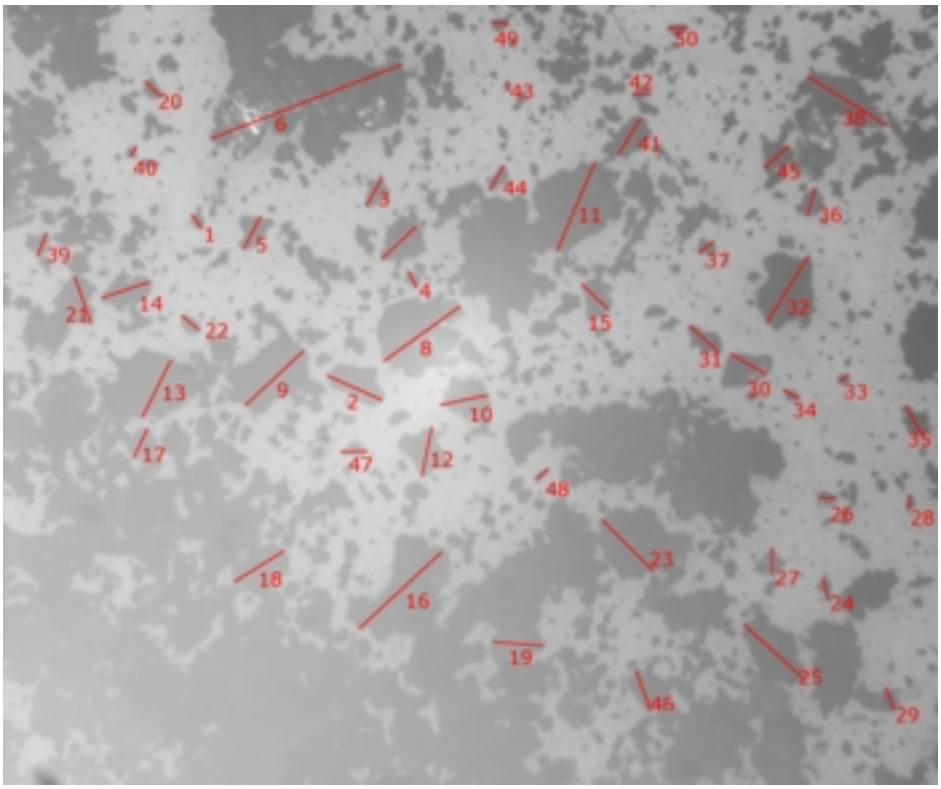

Figure 66 Lower Autoclave Debris < 1/8" measured via optical microscopy (lower4.tif)

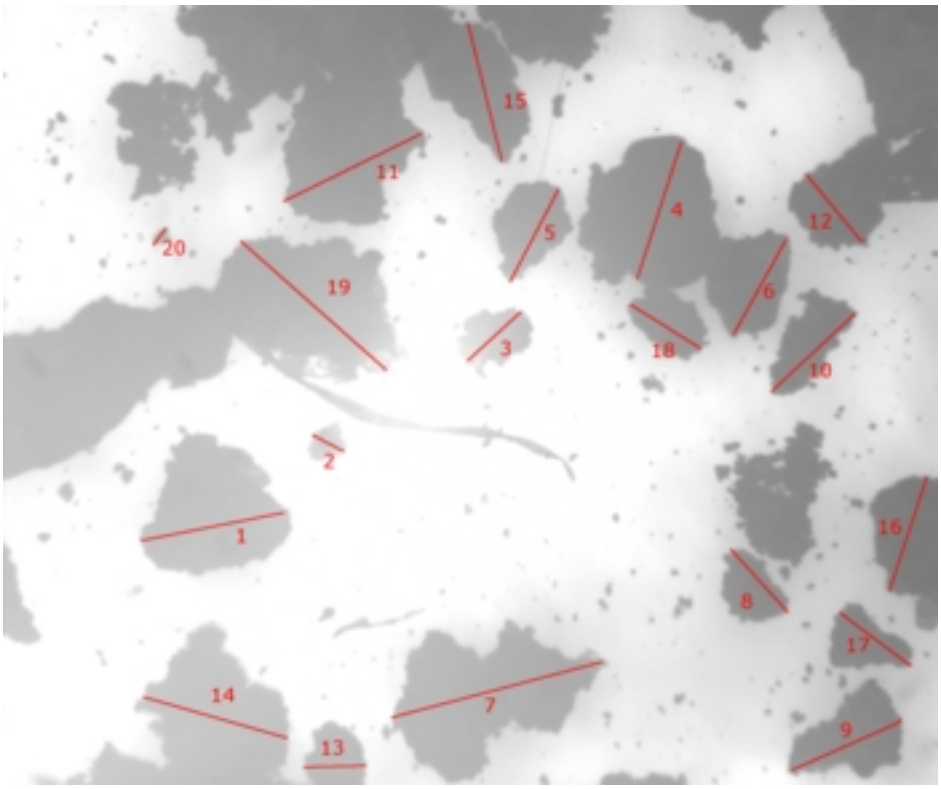

Figure 67 Lower Autoclave Debris < 1/8" measured via optical microscopy (lower5.tif)

Attachment A Autoclave TXU Chip Length Measurements

Upper Autocalve TXU Paint Chip Length Measurements

06-06-07:01 K+L Report 06-0413

Chip Number		>1"		.5-1"		≤.5"	
1		2 1/16	flat	15/16	curl	1/2	flat
2		3	curl	1	curl	1/2	flat
3		2 3/16	curl	13/16	curl	1/2	flat
4		2 3/16	curl	3/4	curl	3/8	flat
5		2 5/8	curl	3/4	flat	~~1/8~~ 1/2 JWS 6/14/07	flat
6		1 7/8	curl	13/16	flat	5/16	flat
7		1 3/4	flat	15/16	curl	1/2	flat
8		1 1/16	flat	5/8	flat	3/4	flat
9		1 9/16	flat	5/8	curl	1/2	flat
10		1 1/4	curl	3/4	flat	7/16	flat
11		1 3/4	flat	13/16	flat	3/8	flat
12		1 5/16	curl	5/8	flat	1/2	flat
13		1 3/8	curl	13/16	curl	5/16	flat
14		1 1/8	flat	13/16	flat	1/2	flat
15		1 1/16	flat	5/8	flat	5/16	flat
16		1 1/16	curl	11/16	flat	5/16	flat
17		1 1/16	flat	5/8	flat	7/16	flat
18				5/8	flat	7/16	flat
19				5/8	flat	7/16	flat
20				9/16	flat	3/8	flat
21				9/16	flat	3/8	flat
22				9/16	flat	3/8	flat
23				9/16	flat	7/16	flat
24				1/2	curl	3/8	flat

Upper Autoclave TXU Paint Chip Log (Cont'd)

06-06-07:01 K+L Report 06-0413

25						1/2	flat
26						1/2	flat
27						7/16	flat
28						5/16	flat
29						1/4	flat
30						3/8	flat
31						5/16	flat
32						5/16	flat
33						7/16	flat
34						3/8	flat
35						3/8	flat
36						5/16	flat
37						3/8	flat
38						7/16	flat
39						5/16	flat
40						3/8	flat
41						1/4	flat
42						5/16	flat
43						3/8	flat
44						3/8	flat

Lower Autocalve TXU Paint Chip Length Measurements

K + L Report 06-0413

Chip Number		>1"		.5-1"		<.5"	
1		1 1/8	flat	1	curl	7/16	flat
2		1 1/8	curl	13/16	curl	7/16	flat
3		1 1/4	flat	5/8	flat	7/16	flat
4		1 1/16	curl	3/4	curl	1/2	flat
5		2	curl	13/16	flat	7/16	flat
6		1 3/8	curl	5/8	flat	5/16	flat
7		1 13/16	curl	13/16	flat	7/16	flat
8		3 5/8	curl	7/8	flat	7/16	flat
9		1 7/8	flat	1	flat	7/16	flat
10		1 3/4	curl	1	flat	7/16	flat
11		1 1/4	flat	1	curl	7/16	flat
12		1 7/8	curl	5/8	flat	1/2	flat
13		1 1/8	curl	9/16	flat	3/8	flat
14		1 3/4	curl	3/4	curl	5/16	flat
15		1 5/16	curl	5/8	curl	7/16	flat
16		1 9/16	flat	9/16	flat	1/2	flat
17		2	curl	9/16	flat	5/16	flat
18		1 3/16	curl	5/8	flat	1/2	flat
19		1 1/2	flat	5/8	curl	3/8	flat
20		1 7/16	curl			7/16	flat
21		1 7/16	curl			5/16	flat
22		1	curl			3/8	flat
23		1 1/2	curl			5/16	flat
24						5/16	flat

Attachment B SEM Procedure and Logs

ALION
SCIENCE AND TECHNOLOGY

TECHNICAL DOCUMENT COVER SHEET

CONTROLLED DOCUMENT

Document No: ALION-SPP-LAB-2352-24	Revision: 3	Page 1 of 14
Document Title: Optical or Scanning Electron Microscopic Examinations		
Project No: ALION-2352		
Project Name: GSI-191 Testing and Examination of Materials		
Client: Internal		

Document Purpose/Summary:

The purpose of this procedure is to identify the steps necessary to perform optical or scanning electron microscopic examinations of material samples.

Design Verification Method:

___ Design Review

___ Alternative Calculation

___ Qualification Testing

Professional Engineer (if required) Approval ___N/A___ Date _____

	Printed/Typed Name	Signature	Date
Prepared By:	Jan Bostelman	Jan Bostelman	4/5/06
Reviewed By:	W. Guerra	W. Guerra	4/5/06
Approved By:	D. F. Lincoln	D. F. Lincoln	4/5/06

Revision Log

PAGE(S) AFFECTED BY REVISION	REVISED, ADDED, OR DELETED	DESCRIPTION OF REVISIONS
All	Added	Original Issue
All	Revised	Rev 1 – Changed the procedure format to reflect current program format.
All	Revised	Rev 2 – Revised Procedure to include Business Unit Manager's approval as required by our QA program.
All	Revised	Rev 3 – Included Optical Microscopy to Material Measurements

1.0 Purpose

This procedure establishes the steps to be utilized to log in samples and process for performing Optical Microscopic or SEM measurements. It also establishes the means for recording measurement traceability. The purpose of this procedure is to provide a process that allows capturing of Optical Microscopic or SEM images for further measurement and statistical analyses.

2.0 Precautions

When handling fibrous insulation, personal involved must wear safety goggles, gloves, lab coat and a breathing filter mask. Don appropriate PPE identified per MSDS sheets for handling each sample (fibrous or particulate).

3.0 Application

3.1 This procedure applies to the receipt inspection of samples and recording of measurements for Optical Microscopic or SEM images.

3.2 Equipment and materials such as Optical Microscope or SEM holder, material handling equipment that are not directly associated with the measurement, acquisition or analysis of test data is exempt from the provisions of this procedure.

4.0 Procedure

4.1 Sample Shipments

To assure that samples are received such that the results of analyses are accurate and reliable, the appropriate documentation shall be retained in control files. These files will prove a readily accessible location for management and evaluation of all materials that support safety related analyses.

4.1.1 **Material Control Index**

A master material log shall be maintained that identifies all sample materials that are or will be used for Optical Microscopic or SEM imaging. Attachment 2 provides the Material Control Index Sample form. The file shall contain the following documentation as appropriate to its intended function:

- Purchase Order(s)
- Package Receipt Inspection documents
- Sample ID number to be logged into Alion material database
- Additional Information (i.e. macrophotographs of each bulk sample)

Attachment 2 provides a sample index that may be used to track the documentation in the material control file. One form will be prepared for each sample that is examined via Optical Microscopic or SEM process.

4.2 Receipt Inspection

This section prescribes the requirements for the receipt of sample materials. The Project Manager or Project Engineers are responsible for the implementation of this guideline. QA is responsible for verifying receipt inspection attributes when requested by the Project Manager/Project Engineers.

4.2.1 Material Receipt Report (MRR)

A MRR is initiated by the Project Engineer/Designee for all sample materials to be evaluated for the project. Applicable inspection attributes must be completed on the MRR by the Project Engineer/Designee. The MRR must be retained in the Equipment/Material Control file.

Attachment 3 provides a sample MRR format. It is issued to record the acceptability of material receipt. Of critical interest is to ensure that the sample packages were not damaged during shipment. All other information on the form is not applicable for SEM processing.

4.3 Sample Handling Process

4.3.1 Take Bulk Shipment Packages to appropriate Optical Microscope or SEM facility.

4.3.2 Record and Note if any packages are marked hazardous materials. Log this on Attachment 4. For Chain of Record Documentation. Record Shipper, date of receipt inspection, material received, material returned after evaluations complete.

4.3.3 Open shipment package in a laboratory hood with ventilation system in operation.

4.3.4 Observe condition of each sample provided in the shipment package. Note if any packages are breached that were sealed or condition of individual samples. Record observations on Attachment 3 for each individual sample. If individual samples are labeled by shipper, transfer that identification to Attachments 2 and 3 for consistency. If samples are not identified provide generic identification by material type and sample ID number.

4.3.5 Take macrophotographs of each individual sample and attach the images with Attachment 2 for each sample.

4.3.6 Record amount of sample taken from each individual sample for Optical Microscope or SEM evaluations. Record amount taken on Attachment 5. Each sample will have an attachment 5 log for traceability and control of sample.

4.3.7 Prepare Optical Microscope or SEM Holder, (for SEM only put double stick tape on each sample peg to hold a sample).

4.3.8 Note for SEM only-Place one sample on each sample peg. Note: allow space on specimen holder for calibrated grid or install calibrated grid in SEM chamber prior to measurements. If not performing SEM skip this step.

4.3.9 Take a photograph of Optical Microscope or SEM holder with samples. For SEM Only Record location of samples on SEM holder by drawing a figure and identifying the sample IDs on the figure. Identify the sample IDs on the image also. A photograph of the sample figure is to be included in the SEM report.

4.3.10 Perform startup process for Optical Microscope or SEM instrument per Optical/SEM Facility procedures.

4.3.11 Steps 4.3.12 through 4.3.29 are applicable to SEM instrument only. If not performing SEM go to step 4.3.30.

4.3.12 Once SEM instrument is ready ensure sample chamber is at atmospheric condition.

4.3.13 Open SEM chamber and insert SEM holder.

4.3.14 Pump down chamber to approximately 25 mPa **or** vacuum condition which does not cause charging of sample.

4.3.15 Set up beam scan speed for appropriate collection of SEM images.

4.3.16 Proceed to check calibrated grid block.

4.3.17 Check calibrated grid against SEM scaler. Record grid block data information in Attachment 6 and any relevant measurement. Several grid blocks can be utilized if Project Engineer desires.

4.3.18 Take image of grid with SEM scale bar turned on, record image for documentation and attach to attachment 6.

4.3.19 After recording image, confirm calibrated grid measurements and record Attachment 6.

4.3.20 Proceed to a sample specimen and began collecting SEM images.

4.3.21 Periodically check that samples are not charging.

4.3.22 Periodically check grid against SEM scaler.

4.3.23 Log sample ID on Attachment 1 data sheet. Record magnification, working distance, kV, image file name and date for each image collected for each individual sample.

4.3.24 Record an image at various magnifications. Record at least 3 images per sample at different magnifications. If sample is not charging. If sample is charging back off the vacuum such that sample is not charging and take at least 3 images. If sample charging precludes image collection will need to coat sample with either carbon tape or gold sputtering and perform high vacuum processing and repeat steps 3.3.21 through 3.3.24.

4.3.25 Document all images collected on Attachment 1 for each sample.

4.3.26 Once samples images are collected proceed to transfer collected images from SEM instrument to appropriate data storage devices (i.e. zip disks or CDs or equivalent).

4.3.27 Attach data collection storage device to project documentation.

4.3.28 Power down SEM instrument.

4.3.29 Put together a sample traveler package for each sample that contains Attachments 1, 2, 3, 4, 5 and 6 per sample. Transmit originals to project files.

4.3.30 The next steps are only applicable to performing Optical Microscopy.

4.3.31 Proceed to check calibrated grid block.

4.3.32 Check calibrated grid against Optical Microscope scaler if applicable. Record grid block data information in Attachment 6 and any relevant measurement. Several grid blocks can be utilized if Project Engineer desires.

4.3.33 Take image of grid with scale bar turned on if digital imaging is provided, record image for documentation and attach to attachment 6. If no digital imaging take a thermal scan or Polaroid image or photograph of grid scale. Provide as an attachment to Optical Microscopy Report.

4.3.34 After recording image, confirm calibrated grid measurements and record Attachment 6.

4.3.35 Proceed to a sample specimen and began collecting Optical images. Include images in Material Characteristic Report.

4.3.36 Periodically check grid against scaler if it is provided.

4.3.37 Log sample ID on Attachment 1 data sheet. Record magnification, image file name and date for each image collected for each individual sample.

4.3.38 Record an image at various magnifications. Record at least 3 images per sample at different magnifications.

4.3.39 Document all images collected on Attachment 1 for each sample.

4.3.40 Once samples images are collected proceed to transfer collected images from digital microscope instrument to appropriate data storage devices (i.e. zip disks or CDs or equivalent). If digital imaging not provided collect photographs or thermal scans.

4.3.41 Attach data collection storage device to project documentation.

4.3.42 Put together a sample traveler package for each sample that contains Attachments 1, 2, 3, 4, 5 and 6 per sample. Transmit originals to project files.

5.0 References

5.1 Geller Microanalytic Lab Certification for MRS-3XY

6.0 Quality Records

The current approved revision of this procedure (including attachments) shall be retained as a quality record in accordance with QAP 17.1 of the Alion QA program.

7.0 Associated Documents

7.1 None

8.0 Attachments

Attachment 1 – Optical Microscope or SEM Sample ID and Instrument Readings/Image File Name
Attachment 2 - Material Control Index
Attachment 3 - Material Receipt Report
Attachment 4 – Hazardous Material Chain of Command
Attachment 5 - Material Usage/Configuration Control Log
Attachment 6 –Optical Microscope or SEM Calibration Grid Information
Attachment 7– Damaged Packages or Samples

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Attachment I –

Optical Microscope or SEM Image Log
TXU Coatings

Sample ID#	Description	Date	Magnification	Voltage (kV) (N/A for Optical Microscope)	Working Distance (N/A for Optical Microscope)	Image File Name
06-06-07:01	upper	6/4/07	JWB 6/4/07 ~~10~~ 5X	N/A	N/A	upper 1
06-06-07:01	chips upper	6/4/07	5X	N/A	N/A	upper 2
06-06-07:01	chips upper	6/4/07	5X	N/A	N/A	upper 3
06-06-07:01	chips upper	6/4/07	5X	N/A	N/A	upper 4
06-06-07:01	chip upper	6/4/07	5X	N/A	N/A	upper 5
06-06-07:01	chips upper	6/4/07	5X	N/A	N/A	upper 6
MRS-3X4	grid	6/4/07	5X	N/A	N/A	grid 5x1
MRS-3X4	grid	6/4/07	5X	N/A	N/A	grid 5x2
MRS-3X4	grid	6/4/07	5X	N/A	N/A	grid 5x3
MRS-3X4	grid	6/4/07	5X	N/A	N/A	grid 5x4
MRS-3X4	grid	6/4/07	5X	N/A	N/A	grid 5x5
06-06-07:02	dust coating	6/4/07	5X	N/A	N/A	lower 1
06-06-07:02	dust	6/4/07	5X	N/A	N/A	lower 2
06-06-07:02	dust	6/4/07	5X	N/A	N/A	lower 3
06-06-07:02	dust	6/4/07	5X	N/A	N/A	lower 4
06-06-07:02	dust	6/4/07	5X	N/A	N/A	lower 5
MRS-3X4	grid	6/4/07	5X	N/A	N/A	grid 5x6
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	Bottoms 1
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	bottoms 2
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	bottoms 3
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	bottoms 4
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	bottoms 5
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	bottoms 6
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	bottoms 7
06-06-07:03	bottoms	6/4/07	5X	N/A	N/A	bottoms 8
MRS-3X4	grid	6/4/07	5X	N/A	N/A	grid 1
MRS-3X4	grid	6/4/07	10X	N/A	N/A	grid 0002
MRS-3X4	grid	6/4/07	10X	N/A	N/A	grid 0003
MRS-3X4	grid	6/4/07	10X	N/A	N/A	grid 0004
MRS-3X4	grid	6/4/07	10X	N/A	N/A	grid 0005
MRS-3X4	grid	6/4/07	10X	N/A	N/A	grid 0006

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Attachment I – TXU Coating Samples

Optical Microscope or SEM Image Log

	Sample ID#	Description	Date	Magnification	Voltage (kV) (N/A for Optical Microscope)	Working Distance (N/A for Optical Microscope)	Image File Name	
	MRS 3XY	grid	6/7/07	9.5X	20KV	12	grid6	
	MRS 3XY	grid	6/7/07	1,800X	20KV	12	grid7	
	MRS 3XY	grid	6/7/07	3,700X	20KV	12	grid8	
	MRS 3XY	grid	6/7/07	3,700X	20KV	12	grid9	
side	06-06-07:01	Upper chip	6/7/07	550X	20KV	13	ugreen1	greenchip
side	06-06-07:01	upper chip	6/7/07	150X	20KV	13	ugreen2	green chip
side	06-06-07:01	upper chip	6/7/07	150	20KV	13	ugreen3	green chip
side	06-06-07:01	upper chip	6/7/07	75X	20KV	13	ubeige1	beige chip
side	06-06-07:01	upper chip	6/7/07	75X	20KV	13	ubeige2	beige chip
side	06-06-07:01	upper chip	6/7/07	220X	20KV	13	ubeige3	beige chip
side	06-06-07:02	lower chip	6/7/07	250X	20KV	14	lgreen1	greenchip
side	06-06-07:02	lower chip	6/7/07	236X	20KV	14	lgreen2	greenchip
side	06-06-07:02	lower chip	6/7/07	160X	20KV	12	lbeige1	beige chip
side	06-06-07:02	lower chip	6/7/07	180X	20KV	13	lbeige2	beige chip
side	06-06-07:02	lower chip	6/7/07	85X	20KV	13	lbeige3	beige chip
	06-06-07:03	bottoms	6/7/07	65X	20KV	15	bottoms1	fine chips
	06-06-07:03	bottoms	6/7/07	65X	20KV	15	bottoms2	fine chips
	06-06-07:03	bottoms	6/7/07	65X	20KV	15	bottoms3	fine chips
	06-06-07:02	lower dust	6/7/07	65X	20KV	16	dust1	dust
	06-06-07:02	lower dust	6/7/07	300X	20KV	16	dust2	dust
	06-06-07:02	lower dust	6/7/07	300X	20KV	16	dust3	
	06-06-07:01	upper chip	6/7/07	65X	20KV	15	gfront1	front green
	06-06-07:01	upper chip	6/7/07	430X	20KV	15	gback1	back green
	06-06-07:01	upper chip	6/7/07	600X	20KV	15	bback1	back beige
	06-06-07:01	upper chip	6/7/07	65X	20KV	15	bfront1	front beig
	06-06-07:02	lower chip	6/7/07	65X	20KV	15	gbackl1	back green
	06-06-07:02	lower chip	6/7/07	65X	20KV	15	gfrontl1	front green
	06-06-07:02	lower chip	6/7/07	65X	20KV	15	bbackl1	back beig
	06-06-07:02	lower chip	6/7/07	65X	20KV	15	bfrontl1	front beige

Attachment 1 –

Optical Microscope or SEM Image Log

Sample ID#	Description	Date	Magnification	Voltage (kV) (N/A for Optical Microscope)	Working Distance (N/A for Optical Microscope)	Image File Name
06-06-07:01	green chip front upper	6/7/07	1000X	20KV	13	gfront1u
06-06-07:01	green chip back upper	6/7/07	550X	20KV	13	gback1u
06-06-07:01	beige chip back upper	6/7/07	190X	20KV	13	bback1u
06-06-07:01	beige chip front upper	6/7/07	4,500X	20KV	13	bfront1u
06-06-07:02	green chip back lower	6/7/07	1,000X	20KV	15	gback1l
06-06-07:02	green chip front lower	6/7/07	1,000X	20KV	15	gfront1l
06-06-07:02	beige chip back lower	6/7/07	1,000X	20KV	15	bback1l
06-06-07:02	beige chip front lower	6/7/07	1,000X	20KV	15	bfront1l
06-06-07:03	bottoms debris	6/7/07	1,000X	20KV	15	bott eds
06-06-07:02	dust from lower	6/7/07	1,000X	20KV	16	dust eds

Attachment 2 – Material Control Index

MATERIAL CONTROL INDEX

MATERIAL

Sample ID# (N/A for Material): 06-06-07:01

Component Description: Insulation Sample Upper Autoclave Debris (Paint Chips)

Document	Entered By:	Date:
Purchase Order # 5 0545815 6D2	JLB	6/4/07
Material Receipt Report 06-06-07:01	JLB	6/4/07
Calibration/Certification Documentation N/A		
Installation Specification/Description (N/A for Material) N/A		
Post Installation Test Report (N/A for Material) N/A		
Configuration Control Log (Attach to this index) NA		

Additional Documentation: Photographs

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 3 – Material Receipt Report 06-06-07:01.

SPECIFICATION. #	P. O. # / Sample ID #	QUALITY CLASSIFICATION
4464	50545815 6D2 06-06-07:01	NQA 1
ITEM/DESCRIPTION: Upper Autoclave Debris (Paint Chips)	SUPPLIER/VENDOR: K&L	STORAGE INSTRUCTIONS: None
INITIATED BY AND DATE: JLB 6/4/07	REVIEWED/APPROVED BY AND DATE: N/A	

RECEIVING INSPECTION REQUIREMENTS FOR SAFETY AND NON-SAFETY RELATED ITEMS	METHOD	N/A	PE or QA	DATE
A. VERIFY ITEM(S) ARE FREE OF DAMAGE CAUSED BY SHIPPING	I		JLB	6/4/07
B. VERIFY THE LEVEL OF PACKING HAS BEEN MAINTAINED	I		JLB	6/4/07
C. VERIFY IDENTIFICATION AND MARKINGS ARE AS SPECIFIED	I		JLB	6/4/07
D. VERIFY COATINGS AND PRESERVATIVES ARE AS SPECIFIED		✓	JLB	6/4/07
E. VERIFY PROTECTION COVERS & SEALS MEET THEIR INTENDED FUNCTION		✓	JLB	6/4/07
F. VERIFY INERT GAS BLANKET PRESSURE IS WITHIN SPECIFIED LIMITS		✓	JLB	6/4/07
G. VERIFY DESICCANT IS NOT SATURATED		✓	JLB	6/4/07
H. VERIFY ITEM(S) MEET SPECIFIED CLEANLINESS		✓	JLB	6/4/07
I. VERIFY ITEM(S) ARE FREE OF PHYSICAL DAMAGE	I		JLB	6/4/07
J. VERIFY DOCUMENTATION		✓	JLB	6/4/07
RECEIVING INSTRUCTIONS FOR SAFETY RELATED ITEMS NOT RELEASED BY PROJECT ENGINEERING				
A. VERIFY PHYSICAL PROPERTIES (SEE DOCUMENTATION)		✓	JLB	6/4/07
B. VERIFY DIMENSIONS/CONFIGURATION		✓	JLB	6/4/07
C. VERIFY WELD PREPARATIONS		✓	JLB	6/4/07
D. VERIFY WORKMANSHIP		✓	JLB	6/4/07
E. VERIFY LUBRICANTS/OILS		✓	JLB	6/4/07
F. VERIFY ELECTRICAL INSULATION		✓	JLB	6/4/07
UNIQUE INSPECTION REQUIREMENTS FOR ITEMS:				
A. VERIFY				
B. VERIFY				
C. VERIFY				
D. VERIFY				

ITEM DESCRIPTION SAMPLING USED: ☐ YES ☒ NO	TRACEABILITY NUMBER	QTY	SAMPLING TABLE	REMARKS/COMMENTS

I = Inspection, R = Review, W = Witness

All broken packages or damaged samples are to be noted in Attachment 7, and discussed with QA if a CAR should be written.

Jan Bostelman PE E-6692, NE

Attachment 2 – Material Control Index

MATERIAL CONTROL INDEX

MATERIAL

Sample ID# (N/A for Material): 06-06-07: 02

Component Description: Insulation Sample Lower Autoclave Debris (Paint Chips)

Document	Entered By:	Date:
Purchase Order # 8054581S 6D2	JLB	6/4/07
Material Receipt Report 06-06-07:02	JLB	6/4/07
Calibration/Certification Documentation N/A		
Installation Specification/Description (N/A for Material) N/A		
Post Installation Test Report (N/A for Material) N/A		
Configuration Control Log (Attach to this index) NA		

Additional Documentation: Photographs

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 3 – Material Receipt Report 06-06-07:02

SPECIFICATION. #	P. O. # Sample ID #	QUALITY CLASSIFICATION
4464	50545815 6D2 06-06-07:02	NQA1
ITEM/DESCRIPTION: Lower Autoclave Debris (Paint Chips)	SUPPLIER/VENDOR K+L	STORAGE INSTRUCTIONS None
INITIATED BY AND DATE: JLB 6/4/07	REVIEWED/APPROVED BY AND DATE: N/A	

RECEIVING INSPECTION REQUIREMENTS FOR SAFETY AND NON-SAFETY RELATED ITEMS	METHOD	N/A	PE or QA	DATE
A. VERIFY ITEM(S) ARE FREE OF DAMAGE CAUSED BY SHIPPING	I		JLB	6/4/07
B. VERIFY THE LEVEL OF PACKING HAS BEEN MAINTAINED	I		JLB	6/4/07
C. VERIFY IDENTIFICATION AND MARKINGS ARE AS SPECIFIED	I		JLB	6/4/07
D. VERIFY COATINGS AND PRESERVATIVES ARE AS SPECIFIED		✓	JLB	6/4/07
E. VERIFY PROTECTION COVERS & SEALS MEET THEIR INTENDED FUNCTION		✓	JLB	6/4/07
F. VERIFY INERT GAS BLANKET PRESSURE IS WITHIN SPECIFIED LIMITS		✓	JLB	6/4/07
G. VERIFY DESICCANT IS NOT SATURATED		✓	JLB	6/4/07
H. VERIFY ITEM(S) MEET SPECIFIED CLEANLINESS		✓	JLB	6/4/07
I. VERIFY ITEM(S) ARE FREE OF PHYSICAL DAMAGE	I		JLB	6/4/07
J. VERIFY DOCUMENTATION				
RECEIVING INSTRUCTIONS FOR SAFETY RELATED ITEMS NOT RELEASED BY PROJECT ENGINEERING				
A. VERIFY PHYSICAL PROPERTIES (SEE DOCUMENTATION)		✓	JLB	6/4/07
B. VERIFY DIMENSIONS/CONFIGURATION		✓	JLB	6/4/07
C. VERIFY WELD PREPARATIONS		✓	JLB	6/4/07
D. VERIFY WORKMANSHIP		✓	JLB	6/4/07
E. VERIFY LUBRICANTS/OILS		✓	JLB	6/4/07
F. VERIFY ELECTRICAL INSULATION		✓	JLB	6/4/07
UNIQUE INSPECTION REQUIREMENTS FOR ITEMS:				
A. VERIFY				
B. VERIFY				
C. VERIFY				
D. VERIFY				

ITEM DESCRIPTION SAMPLING USED: ☐ YES ☒ NO	TRACEABILITY NUMBER	QTY	SAMPLING TABLE	REMARKS/COMMENTS

I = Inspection, R = Review, W = Witness

All broken packages or damaged samples are to be noted in Attachment 7, and discussed with QA if a CAR should be written.

Jan Bockelman PE TE-6692 NE

Attachment 2 – Material Control Index

MATERIAL CONTROL INDEX

MATERIAL

Sample ID# (N/A for Material): 06-06-07:03

Component Description: Insulation Sample Debris from Bottom of Autoclave

Document	Entered By:	Date:
Purchase Order # 80545815 602	JLB	6/4/07
Material Receipt Report 06-06-07:03	JLB	6/4/07
Calibration/Certification Documentation N/A		
Installation Specification/Description (N/A for Material) N/A		
Post Installation Test Report (N/A for Material) N/A		
Configuration Control Log (Attach to this index) NA		

Additional Documentation: Photographs

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 3 – Material Receipt Report 06-06-07:03

SPECIFICATION. #	P.O. # Sample ID #	QUALITY CLASSIFICATION
4464	S0545815 6D2 06-06-07:03	NQA1
ITEM/DESCRIPTION: Debris from Bottom of Autoclave	SUPPLIER/VENDOR K+L	STORAGE INSTRUCTIONS None
INITIATED BY AND DATE: JLB 6/4/07	REVIEWED/APPROVED BY AND DATE: N/A	

RECEIVING INSPECTION REQUIREMENTS FOR SAFETY AND NON-SAFETY RELATED ITEMS	METHOD	N/A	PE or QA	DATE
A. VERIFY ITEM(S) ARE FREE OF DAMAGE CAUSED BY SHIPPING	I		JLB	6/4/07
B. VERIFY THE LEVEL OF PACKING HAS BEEN MAINTAINED	I		JLB	6/4/07
C. VERIFY IDENTIFICATION AND MARKINGS ARE AS SPECIFIED	I		JLB	6/4/07
D. VERIFY COATINGS AND PRESERVATIVES ARE AS SPECIFIED		✓	JLB	6/4/07
E. VERIFY PROTECTION COVERS & SEALS MEET THEIR INTENDED FUNCTION		✓	JLB	6/4/07
F. VERIFY INERT GAS BLANKET PRESSURE IS WITHIN SPECIFIED LIMITS		✓	JLB	6/4/07
G. VERIFY DESICCANT IS NOT SATURATED		✓	JLB	6/4/07
H. VERIFY ITEM(S) MEET SPECIFIED CLEANLINESS		✓	JLB	6/4/07
I. VERIFY ITEM(S) ARE FREE OF PHYSICAL DAMAGE	I		JLB	6/4/07
J. VERIFY DOCUMENTATION		✓	JLB	6/4/07
RECEIVING INSTRUCTIONS FOR SAFETY RELATED ITEMS NOT RELEASED BY PROJECT ENGINEERING				
A. VERIFY PHYSICAL PROPERTIES (SEE DOCUMENTATION)		✓	JLB	6/4/07
B. VERIFY DIMENSIONS/CONFIGURATION		✓	JLB	6/4/07
C. VERIFY WELD PREPARATIONS		✓	JLB	6/4/07
D. VERIFY WORKMANSHIP		✓	JLB	6/4/07
E. VERIFY LUBRICANTS/OILS		✓	JLB	6/4/07
F. VERIFY ELECTRICAL INSULATION		✓	JLB	6/4/07
UNIQUE INSPECTION REQUIREMENTS FOR ITEMS:				
A. VERIFY				
B. VERIFY				
C. VERIFY				
D. VERIFY				

ITEM DESCRIPTION SAMPLING USED: ☐ YES ☒ NO	TRACEABILITY NUMBER	QTY	SAMPLING TABLE	REMARKS/COMMENTS

I = Inspection, R = Review, W = Witness

All broken packages or damaged samples are to be noted in Attachment 7, and discussed with QA if a CAR should be written.

Jan Bostelman PE E-6642 NE

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 3 – Material Receipt Report 06-06-07:01

SPECIFICATION. #	P. O. # Sample ID #	QUALITY CLASSIFICATION
4464	SGS4S8IS 6D2 06-06-07:01	NQA1
ITEM/DESCRIPTION: Upper Autoclave Debris (Paint Chips)	SUPPLIER/VENDOR B+L/Alion	STORAGE INSTRUCTIONS None
INITIATED BY AND DATE: 6/6/07 JLB	REVIEWED/APPROVED BY AND DATE: N/A	

RECEIVING INSPECTION REQUIREMENTS FOR SAFETY AND NON-SAFETY RELATED ITEMS	METHOD	N/A	PE or QA	DATE
A. VERIFY ITEM(S) ARE FREE OF DAMAGE CAUSED BY SHIPPING	I		JLB	6/6/07
B. VERIFY THE LEVEL OF PACKING HAS BEEN MAINTAINED	I		JLB	6/6/07
C. VERIFY IDENTIFICATION AND MARKINGS ARE AS SPECIFIED	I		JLB	6/6/07
D. VERIFY COATINGS AND PRESERVATIVES ARE AS SPECIFIED		✓	JLB	6/6/07
E. VERIFY PROTECTION COVERS & SEALS MEET THEIR INTENDED FUNCTION		✓	JLB	6/6/07
F. VERIFY INERT GAS BLANKET PRESSURE IS WITHIN SPECIFIED LIMITS		✓	JLB	6/6/07
G. VERIFY DESICCANT IS NOT SATURATED		✓	JLB	6/6/07
H. VERIFY ITEM(S) MEET SPECIFIED CLEANLINESS		✓	JLB	6/6/07
I. VERIFY ITEM(S) ARE FREE OF PHYSICAL DAMAGE	I		JLB	6/6/07
J. VERIFY DOCUMENTATION		✓	JLB	6/6/07
RECEIVING INSTRUCTIONS FOR SAFETY RELATED ITEMS NOT RELEASED BY PROJECT ENGINEERING				
A. VERIFY PHYSICAL PROPERTIES (SEE DOCUMENTATION)		✓	JLB	6/6/07
B. VERIFY DIMENSIONS/CONFIGURATION		✓	JLB	6/6/07
C. VERIFY WELD PREPARATIONS		✓	JLB	6/6/07
D. VERIFY WORKMANSHIP		✓	JLB	6/6/07
E. VERIFY LUBRICANTS/OILS		✓	JLB	6/6/07
F. VERIFY ELECTRICAL INSULATION		✓	JLB	6/6/07
UNIQUE INSPECTION REQUIREMENTS FOR ITEMS:				
A. VERIFY				
B. VERIFY				
C. VERIFY				
D. VERIFY				

ITEM DESCRIPTION SAMPLING USED: ☐ YES ☒ NO	TRACEABILITY NUMBER	QTY	SAMPLING TABLE	REMARKS/COMMENTS

I = Inspection, R = Review, W = Witness

All broken packages or damaged samples are to be noted in Attachment 7, and discussed with QA if a CAR should be written.

Jan Bostelman PE E-6692 NE

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 3 – Material Receipt Report 06-06-07:02

SPECIFICATION. #	P. O. # / Sample ID #	QUALITY CLASSIFICATION
4464	50545815 LD2 06-06-07:02	NQA1
ITEM/DESCRIPTION: Lowes Autoclave Debris Paint Chips	SUPPLIER/VENDOR: K+L / Alion	STORAGE INSTRUCTIONS: None
INITIATED BY AND DATE: JLB 6/6/07	REVIEWED/APPROVED BY AND DATE: N/A	

RECEIVING INSPECTION REQUIREMENTS FOR SAFETY AND NON-SAFETY RELATED ITEMS	METHOD	N/A	PE or QA	DATE
A. VERIFY ITEM(S) ARE FREE OF DAMAGE CAUSED BY SHIPPING	I		JLB	6/6/07
B. VERIFY THE LEVEL OF PACKING HAS BEEN MAINTAINED	I		JLB	6/6/07
C. VERIFY IDENTIFICATION AND MARKINGS ARE AS SPECIFIED	I		JLB	6/6/07
D. VERIFY COATINGS AND PRESERVATIVES ARE AS SPECIFIED		✓	JLB	6/6/07
E. VERIFY PROTECTION COVERS & SEALS MEET THEIR INTENDED FUNCTION		✓	JLB	6/6/07
F. VERIFY INERT GAS BLANKET PRESSURE IS WITHIN SPECIFIED LIMITS		✓	JLB	6/6/07
G. VERIFY DESICCANT IS NOT SATURATED		✓	JLB	6/6/07
H. VERIFY ITEM(S) MEET SPECIFIED CLEANLINESS		✓	JLB	6/6/07
I. VERIFY ITEM(S) ARE FREE OF PHYSICAL DAMAGE	I		JLB	6/6/07
J. VERIFY DOCUMENTATION		✓	JLB	6/6/07
RECEIVING INSTRUCTIONS FOR SAFETY RELATED ITEMS NOT RELEASED BY PROJECT ENGINEERING				
A. VERIFY PHYSICAL PROPERTIES (SEE DOCUMENTATION)		✓	JLB	6/6/07
B. VERIFY DIMENSIONS/CONFIGURATION		✓	JLB	6/6/07
C. VERIFY WELD PREPARATIONS		✓	JLB	6/6/07
D. VERIFY WORKMANSHIP		✓	JLB	6/6/07
E. VERIFY LUBRICANTS/OILS		✓	JLB	6/6/07
F. VERIFY ELECTRICAL INSULATION		✓	JLB	6/6/07
UNIQUE INSPECTION REQUIREMENTS FOR ITEMS:				
A. VERIFY				
B. VERIFY				
C. VERIFY				
D. VERIFY				

ITEM DESCRIPTION SAMPLING USED: ☐ YES ☒ NO	TRACEABILITY NUMBER	QTY	SAMPLING TABLE	REMARKS/COMMENTS

I = Inspection, R = Review, W = Witness

All broken packages or damaged samples are to be noted in Attachment 7, and discussed with QA if a CAR should be written.

Jan Bockman PE 66692 NE

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 3 – Material Receipt Report 06-06-07:03

SPECIFICATION. #	P. O. # / Sample ID #	QUALITY CLASSIFICATION
4464	80545815 602 06-06-07:03	NQA1
ITEM/DESCRIPTION: Debris from Bottom of Autoclave	SUPPLIER/VENDOR: K+L/Alion	STORAGE INSTRUCTIONS: None
INITIATED BY AND DATE: JLB 6/6/07	REVIEWED/APPROVED BY AND DATE: N/A	

RECEIVING INSPECTION REQUIREMENTS FOR SAFETY AND NON-SAFETY RELATED ITEMS	METHOD	N/A	PE or QA	DATE
A. VERIFY ITEM(S) ARE FREE OF DAMAGE CAUSED BY SHIPPING	I		JLB	6/6/07
B. VERIFY THE LEVEL OF PACKING HAS BEEN MAINTAINED	I		JLB	6/6/07
C. VERIFY IDENTIFICATION AND MARKINGS ARE AS SPECIFIED	I		JLB	6/6/07
D. VERIFY COATINGS AND PRESERVATIVES ARE AS SPECIFIED		✓	JLB	6/6/07
E. VERIFY PROTECTION COVERS & SEALS MEET THEIR INTENDED FUNCTION		✓	JLB	6/6/07
F. VERIFY INERT GAS BLANKET PRESSURE IS WITHIN SPECIFIED LIMITS		✓	JLB	6/6/07
G. VERIFY DESICCANT IS NOT SATURATED		✓	JLB	6/6/07
H. VERIFY ITEM(S) MEET SPECIFIED CLEANLINESS		✓	JLB	6/6/07
I. VERIFY ITEM(S) ARE FREE OF PHYSICAL DAMAGE	I		JLB	6/6/07
J. VERIFY DOCUMENTATION		✓	JLB	6/6/07
RECEIVING INSTRUCTIONS FOR SAFETY RELATED ITEMS NOT RELEASED BY PROJECT ENGINEERING				
A. VERIFY PHYSICAL PROPERTIES (SEE DOCUMENTATION)		✓	JLB	6/6/07
B. VERIFY DIMENSIONS/CONFIGURATION		✓	JLB	6/6/07
C. VERIFY WELD PREPARATIONS		✓	JLB	6/6/07
D. VERIFY WORKMANSHIP		✓	JLB	6/6/07
E. VERIFY LUBRICANTS/OILS		✓	JLB	6/6/07
F. VERIFY ELECTRICAL INSULATION		✓	JLB	6/6/07
UNIQUE INSPECTION REQUIREMENTS FOR ITEMS:				
A. VERIFY				
B. VERIFY				
C. VERIFY				
D. VERIFY				

ITEM DESCRIPTION SAMPLING USED: ☐ YES ☒ NO	TRACEABILITY NUMBER	QTY	SAMPLING TABLE	REMARKS/COMMENTS

I = Inspection, R = Review, W = Witness

All broken packages or damaged samples are to be noted in Attachment 7, and discussed with QA if a CAR should be written.

J. Bostelman E-6692 PE NE

Attachment 4 – Hazardous Material Chain of Command

HAZARDOUS MATERIAL CHAIN OF COMMAND LOG

Material Description:
Origin of Material: ___

Method of Shipment No Hazardous Materials Used or Tested

Testing Activity	Sample ID	Quantity Received	Quantity Used	Date Used:	Quantity Returned to Material Control

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Attachment 5 – Material Usage/Configuration Control Log

USAGE/CONFIGURATION CONTROL LOG

Material Description: K+L Paint Coatings

Sample ID: 06-06-07:01 through 06-06-07:03

Origin of Material: K+L Initial Quantity: Unknown mass of distribution not provided

In-Service Date: NA

Shelf Life (N/A if not applicable): NA

Expiration Date (N/A if not applicable): NA

Testing Activity	Quantity Used:	Date Used:	Collected By:
SEM	1/8" x 1/8" chips (12)	6/7/07	JLB

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 6 – SEM Calibration Grid Information

Calibration Grid MRS-3XY Due Date 2/1/2008
Scale 2-25 micron
S/N R15-169

Calibration Grid_____
Scale_____

Calibration Grid_____
Scale_____

ALION SCIENCE AND TECHNOLOGY	Optical or Scanning Electron Microscopic Examinations			
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Attachment 7 - Damaged Packages or Samples (N/A this form in table column below if no damage noted)

Sample ID	Date	Description of Damage	Resolution if Required	QA Notification Date
N/A				

Project Engineer or Designee [signature]

Date: 6/17/07

Attachment C Calibration Grid and Coating Layer/Particle Diameter Measurements

Average Correction Factor:	112.07	(um/pixel)*Mag
Std. Dev. of Correction Factor:	2.40	(um/pixel)*Mag
Percent Std. Dev. of Cor. Fac.:	2.14	%
Median of Correction	112.41	

2

Image	Measurement	Distance (pixels)	Actual Distance (um)	Magnification (X)	Correction Factor (um/pixel*Mag)
grid8.tif	1	130	4	3700	113.85
grid8.tif	2	65	2	3700	113.85
grid8.tif	3	466	14	3700	111.16
grid8.tif	4	196	6	3700	113.27
grid8.tif	5	199	6	3700	111.56
grid8.tif	6	201	6	3700	110.45
grid8.tif	7	68	2	3700	108.82
grid8.tif	8	267	8	3700	110.86
grid8.tif	9	133	4	3700	111.28
grid8.tif	10	333	10	3700	111.11
grid8.tif	11	132	4	3700	112.12
grid8.tif	12	65	2	3700	113.85
grid8.tif	13	197	6	3700	112.69
grid8.tif	14	333	10	3700	111.11
grid8.tif	15	133	4	3700	111.28
grid8.tif	16	326	10	3700	113.50
grid8.tif	17	261	8	3700	113.41
grid8.tif	18	197	6	3700	112.69
grid8.tif	19	130	4	3700	113.85
grid8.tif	20	524	16	3700	112.98
grid8.tif	21	131	4	3700	112.98
grid8.tif	22	131	4	3700	112.98
grid8.tif	23	65	2	3700	113.85
grid8.tif	24	135	4	3700	109.63
grid8.tif	25	72	2	3700	102.78
grid5.tif	1	73	100	80	109.59
grid5.tif	2	144	200	80	111.11
grid5.tif	3	181	250	80	110.50
grid5.tif	4	216	300	80	111.11
grid5.tif	5	253	350	80	110.67
grid5.tif	6	290	400	80	110.34
grid5.tif	7	246	350	80	113.82
grid5.tif	8	210	300	80	114.29
grid5.tif	9	175	250	80	114.29
grid5.tif	10	140	200	80	114.29
grid5.tif	11	103	150	80	116.50
grid5.tif	12	71	100	80	112.68
grid5.tif	13	34	50	80	117.65
grid5.tif	14	72	100	80	111.11
grid5.tif	15	35	50	80	114.29
grid5.tif	16	71	100	80	112.68
grid5.tif	17	104	150	80	115.38
grid5.tif	18	140	200	80	114.29
grid5.tif	19	181	250	80	110.50
grid5.tif	20	109	150	80	110.09
grid5.tif	21	74	100	80	108.11
grid5.tif	22	36	50	80	111.11
grid5.tif	23	74	100	80	108.11
grid5.tif	24	106	150	80	113.21
grid5.tif	25	107	150	80	112.15

Image Name	Measurement Number	Pixel Distance (pixels)	Magnification (X)	Actual Distance (um)
bback1.tif	1	46.9	600	8.8
bback1.tif	2	16.6	600	3.1
bback1.tif	3	43.9	600	8.2
bback1.tif	4	53.5	600	10.0
bback1.tif	5	12.7	600	2.4
bback1.tif	6	41.7	600	7.8
bback1.tif	7	15.6	600	2.9
bback1.tif	8	86.7	600	16.2
bback1.tif	9	29.5	600	5.5
bback1.tif	10	17.8	600	3.3
bback1.tif	11	13.4	600	2.5
bback1.tif	12	169.4	600	31.6
bback1.tif	13	79	600	14.8
bback1.tif	14	101.6	600	19.0
bback1.tif	15	29.4	600	5.5
bback1.tif	16	28	600	5.2
bback1.tif	17	37.6	600	7.0
bback1.tif	18	39.2	600	7.3
bback1.tif	19	14.3	600	2.7
bback1.tif	20	30.4	600	5.7
bback1.tif	21	20	600	3.7
bback1.tif	22	21.2	600	4.0
bback1.tif	23	19.8	600	3.7
bback1.tif	24	16.8	600	3.1
bback1.tif	25	22.5	600	4.2
bback1.tif	26	32.8	600	6.1
bback1.tif	27	31.9	600	6.0
bback1.tif	28	29.5	600	5.5
bback1.tif	29	10.6	600	2.0
bback1.tif	30	48.7	600	9.1
bback1.tif	31	23.6	600	4.4
bback1.tif	32	73.2	600	13.7
bback1.tif	33	17.9	600	3.3
bback1.tif	34	20.2	600	3.8
bback1.tif	35	15	600	2.8
bback1.tif	36	11.2	600	2.1
bback1.tif	37	31.8	600	5.9
bback1.tif	38	49.7	600	9.3
bback1.tif	39	55.4	600	10.3
bback1.tif	40	17	600	3.2
bback1.tif	41	13.5	600	2.5
bback1.tif	42	41	600	7.7
bback1.tif	43	13.6	600	2.5
bback1.tif	44	14.1	600	2.6
bback1.tif	45	13.6	600	2.5
bback1.tif	46	69.3	600	12.9

bback1.tif	47	22	600	4.1
bback1.tif	48	17.2	600	3.2
bback1.tif	49	12.7	600	2.4
bback1.tif	50	27.3	600	5.1
bback1.tif	51	15.5	600	2.9
bback1.tif	52	34.2	600	6.4
bback1.tif	53	20	600	3.7
bback1.tif	54	18	600	3.4
bback1.tif	55	71.8	600	13.4
bback1.tif	56	44.9	600	8.4
bback1.tif	57	22	600	4.1
bback1.tif	58	281	600	52.5
bback1.tif	59	8.5	600	1.6
bback1.tif	60	14.3	600	2.7
bback1.tif	61	14.4	600	2.7
bback1.tif	62	10.6	600	2.0
bback1.tif	63	11.3	600	2.1
bback1.tif	64	36.1	600	6.7
bback1.tif	65	6.3	600	1.2
bback1.tif	66	32.5	600	6.1
bback1.tif	67	29.8	600	5.6
bback1.tif	68	10.8	600	2.0
bback1.tif	69	7.2	600	1.3
bback1.tif	70	49.3	600	9.2
bback1.tif	71	17.8	600	3.3
bback1.tif	72	17.9	600	3.3
bback1.tif	73	69.1	600	12.9
bback1.tif	74	20.6	600	3.8
bback1.tif	75	32.6	600	6.1
bback1.tif	76	19.7	600	3.7
bback1.tif	77	21.1	600	3.9
bback1.tif	78	69.3	600	12.9
bback1.tif	79	15	600	2.8
bback1.tif	80	21.1	600	3.9
bback1.tif	81	16.3	600	3.0
bback1.tif	82	17.5	600	3.3
bback1.tif	83	10	600	1.9
bback1.tif	84	22.8	600	4.3
bback1.tif	85	36.6	600	6.8
bback1.tif	86	10.6	600	2.0
bback1.tif	87	16.8	600	3.1
bback1.tif	88	22.2	600	4.1
bback1.tif	89	9.1	600	1.7
bback1.tif	90	25.1	600	4.7
bback1.tif	91	16	600	3.0
bback1.tif	92	31.8	600	5.9
bback1.tif	93	10	600	1.9

bback1.tif	94	15.3	600	2.9
bback1.tif	95	11.2	600	2.1
bback1.tif	96	42	600	7.8
bback1.tif	97	6.4	600	1.2
bback1.tif	98	5.4	600	1.0
bback1.tif	99	13.3	600	2.5
bback1.tif	100	15.6	600	2.9

Average Size (micron)	5.8

Median	3.8
Minimum	1.0
Maximum	52.5
Std. Dev.	6.5

Minimum dust	
	10.5
Maximum dust	
	167.8
%	
less than 25 micr	**22.0**
less than 50 micr	**57.0**
less than 75 micr	**80.0**
less than 100 mi	**88.0**
less than 150 mi	**98.0**
less than 200 mi	**100.0**
Dust1 Count	**100.0**
Median Size	**45.0**
Std Deviation	**34.2**

Image Name	Measurement Number	Pixel Distance (pixels)	Magnification (X)	Actual Distance (um)
dust1.tif	1	35	65	60.3
dust1.tif	2	11.2	65	19.3
dust1.tif	3	24.7	65	42.6
dust1.tif	4	11	65	19.0
dust1.tif	5	6.4	65	11.0
dust1.tif	6	24.6	65	42.4
dust1.tif	7	10.8	65	18.6
dust1.tif	8	38	65	65.5
dust1.tif	9	28.4	65	49.0
dust1.tif	10	6.1	65	10.5
dust1.tif	11	19.2	65	33.1
dust1.tif	12	42.2	65	72.8
dust1.tif	13	31.6	65	54.5
dust1.tif	14	15.1	65	26.0
dust1.tif	15	9.8	65	16.9
dust1.tif	16	31	65	53.5
dust1.tif	17	23.1	65	39.8
dust1.tif	18	30.4	65	52.4
dust1.tif	19	27.9	65	48.1
dust1.tif	20	21.8	65	37.6
dust1.tif	21	46	65	79.3
dust1.tif	22	21.6	65	37.2
dust1.tif	23	50.2	65	86.6
dust1.tif	24	25.3	65	43.6
dust1.tif	25	8	65	13.8
dust1.tif	26	22	65	37.9
dust1.tif	27	38.3	65	66.0
dust1.tif	28	23.8	65	41.0
dust1.tif	29	33.1	65	57.1
dust1.tif	30	20.6	65	35.5
dust1.tif	31	26.1	65	45.0
dust1.tif	32	42.7	65	73.6
dust1.tif	33	24.7	65	42.6
dust1.tif	34	35.6	65	61.4
dust1.tif	35	65.8	65	113.5
dust1.tif	36	29.7	65	51.2
dust1.tif	37	27.3	65	47.1
dust1.tif	38	55.2	65	95.2
dust1.tif	39	13.3	65	22.9
dust1.tif	40	18.1	65	31.2
dust1.tif	41	56	65	96.6
dust1.tif	42	26.1	65	45.0
dust1.tif	43	24.6	65	42.4
dust1.tif	44	23.1	65	39.8
dust1.tif	45	43.3	65	74.7
dust1.tif	46	59.4	65	102.4

dust1.tif	47	23	65	39.7
dust1.tif	48	11	65	19.0
dust1.tif	49	10.4	65	17.9
dust1.tif	50	19.1	65	32.9
dust1.tif	51	25.2	65	43.5
dust1.tif	52	42.2	65	72.8
dust1.tif	53	81.4	65	140.4
dust1.tif	54	49.7	65	85.7
dust1.tif	55	9.2	65	15.9
dust1.tif	56	23.2	65	40.0
dust1.tif	57	14	65	24.1
dust1.tif	58	17.9	65	30.9
dust1.tif	59	67.7	65	116.7
dust1.tif	60	51.5	65	88.8
dust1.tif	61	12.8	65	22.1
dust1.tif	62	30.3	65	52.2
dust1.tif	63	97.3	65	167.8
dust1.tif	64	13.5	65	23.3
dust1.tif	65	24.7	65	42.6
dust1.tif	66	38	65	65.5
dust1.tif	67	38.1	65	65.7
dust1.tif	68	54.3	65	93.6
dust1.tif	69	13.2	65	22.8
dust1.tif	70	23.3	65	40.2
dust1.tif	71	7.6	65	13.1
dust1.tif	72	11.1	65	19.1
dust1.tif	73	88.2	65	152.1
dust1.tif	74	28	65	48.3
dust1.tif	75	10.3	65	17.8
dust1.tif	76	24.7	65	42.6
dust1.tif	77	6.7	65	11.6
dust1.tif	78	26.7	65	46.0
dust1.tif	79	66.4	65	114.5
dust1.tif	80	22.2	65	38.3
dust1.tif	81	19.1	65	32.9
dust1.tif	82	79.5	65	137.1
dust1.tif	83	13.5	65	23.3
dust1.tif	84	43	65	74.1
dust1.tif	85	72.9	65	125.7
dust1.tif	86	43.1	65	74.3
dust1.tif	87	36.4	65	62.8
dust1.tif	88	35.5	65	61.2
dust1.tif	89	25.6	65	44.1
dust1.tif	90	56.4	65	97.2
dust1.tif	91	38.1	65	65.7
dust1.tif	92	23	65	39.7
dust1.tif	93	26.4	65	45.5

dust1.tif	94	62.1	65	107.1
dust1.tif	95	60	65	103.5
dust1.tif	96	9.5	65	16.4
dust1.tif	97	70	65	120.7
dust1.tif	98	43	65	74.1
dust1.tif	99	35.4	65	61.0
dust1.tif	100	13.4	65	23.1

Average Size (micron)	55.1

	Image Name	Measurement Number	Pixel Distance (pixels)	Magnification (X)	Actual Distance (um)
Minimum dust3	dust3.tif	1	477.78	300	178.5
7.2	dust3.tif	2	93.4	300	34.9
Maximum dust3	dust3.tif	3	116.5	300	43.5
178.5	dust3.tif	4	80.6	300	30.1
%	dust3.tif	5	106.1	300	39.6
37.5	dust3.tif	6	200.5	300	74.9
67.5	dust3.tif	7	144.6	300	54.0
95.0	dust3.tif	8	22.8	300	8.5
97.5	dust3.tif	9	60.1	300	22.5
97.5	dust3.tif	10	47.4	300	17.7
100.0	dust3.tif	11	19.2	300	7.2
	dust3.tif	12	55.8	300	20.8
40.0	dust3.tif	13	153.1	300	57.2
	dust3.tif	14	46.3	300	17.3
32.9	dust3.tif	15	31	300	11.6
30.9	dust3.tif	16	149.7	300	55.9
	dust3.tif	17	264.6	300	98.8
	dust3.tif	18	116.8	300	43.6
	dust3.tif	19	78.4	300	29.3
	dust3.tif	20	167.7	300	62.6
	dust3.tif	21	135	300	50.4
	dust3.tif	22	183.3	300	68.5
	dust3.tif	23	107.4	300	40.1
	dust3.tif	24	41.8	300	15.6
	dust3.tif	25	73	300	27.3
	dust3.tif	26	46.6	300	17.4
	dust3.tif	27	168.1	300	62.8
	dust3.tif	28	104.5	300	39.0
	dust3.tif	29	65.5	300	24.5
	dust3.tif	30	143.2	300	53.5
	dust3.tif	31	38.1	300	14.2
	dust3.tif	32	143.8	300	53.7
	dust3.tif	33	82.9	300	31.0
	dust3.tif	34	46.7	300	17.4
	dust3.tif	35	147	300	54.9
	dust3.tif	36	97.6	300	36.5
	dust3.tif	37	24.8	300	9.3
	dust3.tif	38	32.6	300	12.2
	dust3.tif	39	49.5	300	18.5
	dust3.tif	40	68.5	300	25.6

Average Size (micron)	39.5

	Image Name	Measurement Number	Pixel Distance (pixels)	Magnification (X)	Actual Distance (um)
Minimum dust2	dust2.tif	1	131.9	300	49.3
6.4	dust2.tif	2	84.1	300	31.4
Maximum dust2	dust2.tif	3	92.8	300	34.7
93.4	dust2.tif	4	36.7	300	13.7
	dust2.tif	5	53.7	300	20.1
32.5	dust2.tif	6	250	300	93.4
77.5	dust2.tif	7	92.2	300	34.4
95.0	dust2.tif	8	185.5	300	69.3
100.0	dust2.tif	9	138.1	300	51.6
100.0	dust2.tif	10	57.3	300	21.4
100.0	dust2.tif	11	128.8	300	48.1
	dust2.tif	12	150	300	56.0
40.0	dust2.tif	13	205.8	300	76.9
	dust2.tif	14	59.1	300	22.1
34.7	dust2.tif	15	93.1	300	34.8
19.9	dust2.tif	16	171.4	300	64.0
	dust2.tif	17	58.7	300	21.9
	dust2.tif	18	29.7	300	11.1
	dust2.tif	19	119.2	300	44.5
	dust2.tif	20	51.6	300	19.3
	dust2.tif	21	128.2	300	47.9
	dust2.tif	22	133.5	300	49.9
	dust2.tif	23	43.4	300	16.2
	dust2.tif	24	100.8	300	37.7
	dust2.tif	25	96.8	300	36.2
	dust2.tif	26	114.8	300	42.9
	dust2.tif	27	143.2	300	53.5
	dust2.tif	28	161.4	300	60.3
	dust2.tif	29	75.6	300	28.2
	dust2.tif	30	136.9	300	51.1
	dust2.tif	31	36.1	300	13.5
	dust2.tif	32	63.3	300	23.6
	dust2.tif	33	132	300	49.3
	dust2.tif	34	120.1	300	44.9
	dust2.tif	35	84.9	300	31.7
	dust2.tif	36	17	300	6.4
	dust2.tif	37	20.1	300	7.5
	dust2.tif	38	88.8	300	33.2
	dust2.tif	39	91.7	300	34.3
	dust2.tif	40	22.7	300	8.5

Average Size (micron)	37.4

All Dust Binning

	Minimum Size		
	6.4		
	Maximum Size		
Microns	**178.5**	Counts	
<10	**3.3**	**6.0**	
<25	**27.8**	**50.0**	
<50	**63.9**	**115.0**	
<75	**86.7**	**156.0**	
<100	**92.8**	**167.0**	
<150	**98.3**	**177.0**	
<200	**100**	**180.0**	
<42.5	**50.0**	**90.0**	Median
Counts	**180**		

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
lbeige1.tif	1	226.4	160	158.6
lbeige1.tif	2	243.4	160	170.5
lbeige1.tif	3	248.1	160	173.8
lbeige1.tif	4	257.9	160	180.6
lbeige1.tif	5	257.8	160	180.6
lbeige1.tif	6	243.8	160	170.8
lbeige1.tif	7	244.1	160	171.0
lbeige1.tif	8	248.3	160	173.9
lbeige1.tif	9	248.7	160	174.2
lbeige1.tif	10	256	160	179.3
lbeige1.tif	11	268.3	160	187.9
lbeige1.tif	12	274.6	160	192.3
lbeige1.tif	13	288.5	160	202.1
lbeige1.tif	14	288.1	160	201.8
lbeige1.tif	15	284.1	160	199.0
lbeige1.tif	16	289.7	160	202.9
lbeige1.tif	17	252.7	160	177.0
lbeige1.tif	18	249.3	160	174.6
lbeige1.tif	19	253	160	177.2
lbeige1.tif	20	293.6	160	205.7
	Dark Layer Average (µm)		**182.7**	13.5
lbeige1.tif	21	93.1	160	65.2
lbeige1.tif	22	95.9	160	67.2
lbeige1.tif	23	99.4	160	69.6
lbeige1.tif	24	96.3	160	67.5
lbeige1.tif	25	101.2	160	70.9
lbeige1.tif	26	104.2	160	73.0
lbeige1.tif	27	105.7	160	74.0
lbeige1.tif	28	85.7	160	60.0
lbeige1.tif	29	87.6	160	61.4
lbeige1.tif	30	99.3	160	69.6
lbeige1.tif	31	104.7	160	73.3
lbeige1.tif	32	89.5	160	62.7
lbeige1.tif	33	90.1	160	63.1
lbeige1.tif	34	99.7	160	69.8
lbeige1.tif	35	102.5	160	71.8
lbeige1.tif	36	87.9	160	61.6
lbeige1.tif	37	76.1	160	53.3
lbeige1.tif	38	83	160	58.1
lbeige1.tif	39	89.4	160	62.6
lbeige1.tif	40	103.2	160	72.3
	Light Layer Average (µm)		**66.4**	5.8

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
lbeige2.tif	1	369.2	180	229.9
lbeige2.tif	2	369.2	180	229.9
lbeige2.tif	3	373.9	180	232.8
lbeige2.tif	4	381.4	180	237.5
lbeige2.tif	5	374.2	180	233.0
lbeige2.tif	6	378.3	180	235.5
lbeige2.tif	7	376.2	180	234.2
lbeige2.tif	8	381.1	180	237.3
lbeige2.tif	9	374.3	180	233.1
lbeige2.tif	10	372.1	180	231.7
lbeige2.tif	11	369.8	180	230.3
lbeige2.tif	12	357.2	180	222.4
lbeige2.tif	13	340.9	180	212.3
lbeige2.tif	14	315.8	180	196.6
lbeige2.tif	15	285.6	180	177.8
lbeige2.tif	16	260	180	161.9
lbeige2.tif	17	225.6	180	140.5
lbeige2.tif	18	231.3	180	144.0
lbeige2.tif	19	230.9	180	143.8
lbeige2.tif	20	240.2	180	149.6
	Dark Layer Average (µm)		**205.7**	37.4
lbeige2.tif	21	119.1	180	74.2
lbeig2.tif	22	118.4	180	73.7
lbeig2.tif	23	126.9	180	79.0
lbeig2.tif	24	138.9	180	86.5
lbeig2.tif	25	141.4	180	88.0
lbeig2.tif	26	134	180	83.4
lbeig2.tif	27	131.7	180	82.0
lbeig2.tif	28	116.1	180	72.3
lbeig2.tif	29	119.8	180	74.6
lbeig2.tif	30	113.6	180	70.7
lbeig2.tif	31	127.8	180	79.6
lbeig2.tif	32	124.5	180	77.5
lbeig2.tif	33	111.2	180	69.2
lbeig2.tif	34	117.1	180	72.9
lbeig2.tif	35	146.1	180	91.0
lbeig2.tif	36	161	180	100.2
lbeig2.tif	37	170.2	180	106.0
lbeig2.tif	38	183.4	180	114.2
lbeig2.tif	39	168.2	180	104.7
lbeig2.tif	40	171.1	180	106.5
	Light Layer Average (µm)		**85.3**	13.9

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
lbeige3.tif	1	121.5	85	160.2
lbeige3.tif	2	126.9	85	167.3
lbeige3.tif	3	132.9	85	175.2
lbeige3.tif	4	140.2	85	184.9
lbeige3.tif	5	143.2	85	188.8
lbeige3.tif	6	138.7	85	182.9
lbeige3.tif	7	142.4	85	187.8
lbeige3.tif	8	141.2	85	186.2
lbeige3.tif	9	143.9	85	189.7
lbeige3.tif	10	159	85	209.6
lbeige3.tif	11	146.9	85	193.7
lbeige3.tif	12	151.6	85	199.9
lbeige3.tif	13	144.1	85	190.0
lbeige3.tif	14	137.1	85	180.8
lbeige3.tif	15	130.4	85	171.9
lbeige3.tif	16	123.5	85	162.8
lbeige3.tif	17	132.2	85	174.3
lbeige3.tif	18	133.7	85	176.3
lbeige3.tif	19	145.9	85	192.4
lbeige3.tif	20	156.6	85	206.5
	Dark Layer Average (µm)		**184.1**	13.3
lbeige3.tif	22	83.5	85	110.1
lbeige3.tif	23	81.3	85	107.2
lbeige3.tif	24	86.7	85	114.3
lbeige3.tif	25	80.6	85	106.3
lbeige3.tif	26	82.4	85	108.6
lbeige3.tif	27	84	85	110.8
lbeige3.tif	28	90	85	118.7
lbeige3.tif	29	82.2	85	108.4
lbeige3.tif	30	81.4	85	107.3
lbeige3.tif	31	80.3	85	105.9
lbeige3.tif	32	86.3	85	113.8
lbeige3.tif	33	93.2	85	122.9
lbeige3.tif	34	85.7	85	113.0
lbeige3.tif	35	65.9	85	86.9
lbeige3.tif	36	54.7	85	72.1
lbeige3.tif	37	40.3	85	53.1
lbeige3.tif	38	58.5	85	77.1
lbeige3.tif	39	49.3	85	65.0
lbeige3.tif	40	37.1	85	48.9
lbeige3.tif			85	0.0
	Light Layer Average (µm)		**92.5**	22.8

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
ubeige1.tif	1	124.3	75	185.7
ubeige1.tif	2	124.6	75	186.2
ubeige1.tif	3	137.9	75	206.1
ubeige1.tif	4	140.4	75	209.8
ubeige1.tif	5	132.2	75	197.5
ubeige1.tif	6	130.6	75	195.2
ubeige1.tif	7	125.2	75	187.1
ubeige1.tif	8	123.8	75	185.0
ubeige1.tif	9	123.7	75	184.8
ubeige1.tif	10	120	75	179.3
ubeige1.tif	11	123.6	75	184.7
ubeige1.tif	12	113.8	75	170.1
ubeige1.tif	13	114.3	75	170.8
ubeige1.tif	14	112.4	75	168.0
ubeige1.tif	15	100.7	75	150.5
ubeige1.tif	16	104.6	75	156.3
ubeige1.tif	17	98.8	75	147.6
ubeige1.tif	18	115.1	75	172.0
ubeige1.tif	19	108.4	75	162.0
ubeige1.tif	20	114.4	75	171.0
	Dark Layer Average (µm)		**178.5**	17.1
ubeige1.tif	21	139.7	75	208.8
ubeige1.tif	22	145.6	75	217.6
ubeige1.tif	23	145.8	75	217.9
ubeige1.tif	24	134.8	75	201.4
ubeige1.tif	25	126.8	75	189.5
ubeige1.tif	26	125.9	75	188.1
ubeige1.tif	27	136.2	75	203.5
ubeige1.tif	28	122.8	75	183.5
ubeige1.tif	29	142.3	75	212.6
ubeige1.tif	30	149.9	75	224.0
ubeige1.tif	31	159.2	75	237.9
ubeige1.tif	32	150.2	75	224.4
ubeige1.tif	33	143.4	75	214.3
ubeige1.tif	34	139.8	75	208.9
ubeige1.tif	35	141.3	75	211.1
ubeige1.tif	36	162.3	75	242.5
ubeige1.tif	37	160.9	75	240.4
ubeige1.tif	38	159	75	237.6
ubeige1.tif	39	148.4	75	221.8
ubeige1.tif	40	129.8	75	194.0
	Light Layer Average (µm)		**214.0**	17.6

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
ubeige3.tif	1	290.6	220	148.0
ubeige3.tif	2	289	220	147.2
ubeige3.tif	3	307.2	220	156.5
ubeige3.tif	4	311.1	220	158.5
ubeige3.tif	5	315.6	220	160.8
ubeige3.tif	6	352.2	220	179.4
ubeige3.tif	7	327.1	220	166.6
ubeige3.tif	8	337.4	220	171.9
ubeige3.tif	9	343.4	220	174.9
ubeige3.tif	10	343.7	220	175.1
ubeige3.tif	11	357.3	220	182.0
ubeige3.tif	12	364.6	220	185.7
ubeige3.tif	13	369.5	220	188.2
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
	Dark Layer Average (µm)		**168.8**	13.7
ubeige3.tif	14	489.5	220	249.4
ubeige3.tif	15	512.1	220	260.9
ubeige3.tif	16	485.8	220	247.5
ubeige3.tif	17	454.5	220	231.5
ubeige3.tif	18	427.1	220	217.6
ubeige3.tif	19	430.2	220	219.2
ubeige3.tif	20	381.7	220	194.4
ubeige3.tif	21	344.8	220	175.7
ubeige3.tif	22	328.1	220	167.1
ubeige3.tif	23	306.5	220	156.1
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
ubeige3.tif				
	Light Layer Average (µm)		**211.9**	36.9

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
ugreen1.tif	1	544	550	110.9
ugreen1.tif	2	552	550	112.5
ugreen1.tif	3	554	550	112.9
ugreen1.tif	4	569	550	115.9
ugreen1.tif	5	570	550	116.1
ugreen1.tif	6	576	550	117.4
ugreen1.tif	7	574	550	117.0
ugreen1.tif	8	579	550	118.0
ugreen1.tif	9	567	550	115.5
ugreen1.tif	10	566	550	115.3
ugreen1.tif	11	565	550	115.1
ugreen1.tif	12	564	550	114.9
ugreen1.tif	13	561	550	114.3
ugreen1.tif	14	561	550	114.3
ugreen1.tif	15	551	550	112.3
ugreen1.tif	16	538	550	109.6
ugreen1.tif	17	537	550	109.4
ugreen1.tif	18	525	550	107.0
ugreen1.tif	19	526	550	107.2
ugreen1.tif	20	541	550	110.2
ugreen1.tif	21	569	550	115.9
ugreen1.tif	22	558	550	113.7
ugreen1.tif	23	558	550	113.7
ugreen1.tif	24	556	550	113.3
ugreen1.tif	25	555	550	113.1
ugreen1.tif	26	564	550	114.9
ugreen1.tif	27	563	550	114.7
ugreen1.tif	28	571	550	116.4
ugreen1.tif	29	579	550	118.0
ugreen1.tif	30	583	550	118.8
ugreen1.tif	31	584	550	119.0
ugreen1.tif	32	600	550	122.3
ugreen1.tif	33	548	550	111.7
ugreen1.tif	34	540	550	110.0
ugreen1.tif	35	547	550	111.5
ugreen1.tif				
ugreen1.tif				
ugreen1.tif				
ugreen1.tif				
ugreen1.tif				
	Average Thickness (µm)		**114.1**	3.4

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
ugreen2.tif	1	129.2	150	96.5
ugreen2.tif	2	129	150	96.4
ugreen2.tif	3	126	150	94.1
ugreen2.tif	4	126	150	94.1
ugreen2.tif	5	123	150	91.9
ugreen2.tif	6	132	150	98.6
ugreen2.tif	7	134	150	100.1
ugreen2.tif	8	135	150	100.9
ugreen2.tif	9	140	150	104.6
ugreen2.tif	10	146	150	109.1
ugreen2.tif	11	147	150	109.8
ugreen2.tif	12	147	150	109.8
ugreen2.tif	13	148	150	110.6
ugreen2.tif	14	144	150	107.6
ugreen2.tif	15	139	150	103.9
ugreen2.tif	16	140	150	104.6
ugreen2.tif	17	139	150	103.9
ugreen2.tif	18	136	150	101.6
ugreen2.tif	19	136	150	101.6
ugreen2.tif	20	135	150	100.9
ugreen2.tif	21	134	150	100.1
ugreen2.tif	22	135	150	100.9
ugreen2.tif	23	134	150	100.1
ugreen2.tif	24	132	150	98.6
ugreen2.tif	25	135	150	100.9
ugreen2.tif	26	138	150	103.1
ugreen2.tif	27	138	150	103.1
ugreen2.tif	28	138	150	103.1
ugreen2.tif	29	144	150	107.6
ugreen2.tif	30	144	150	107.6
ugreen2.tif	31	144	150	107.6
ugreen2.tif	32	142	150	106.1
ugreen2.tif	33	141	150	105.3
ugreen2.tif	34	143	150	106.8
ugreen2.tif	35	141	150	105.3
ugreen2.tif	36	143	150	106.8
ugreen2.tif	37	145	150	108.3
ugreen2.tif	38	142	150	106.1
ugreen2.tif	39	145	150	108.3
ugreen2.tif	40	146	150	109.1
ugreen2.tif	41	146	150	109.1
ugreen2.tif	42	144	150	107.6
ugreen2.tif	43	143	150	106.8
ugreen2.tif	44	141	150	105.3
ugreen2.tif	45	140	150	104.6
ugreen2.tif	46	141	150	105.3
ugreen2.tif	47	143	150	106.8
ugreen2.tif	48	140	150	104.6
ugreen2.tif	49	137	150	102.4
ugreen2.tif	50	139	150	103.9
	Average Thickness (µm)		**103.8**	

4.4

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
ugreen3.tif	1	150	150	112.1
ugreen3.tif	2	152	150	113.6
ugreen3.tif	3	153	150	114.3
ugreen3.tif	4	153	150	114.3
ugreen3.tif	5	152	150	113.6
ugreen3.tif	6	152	150	113.6
ugreen3.tif	7	148	150	110.6
ugreen3.tif	8	149	150	111.3
ugreen3.tif	9	152	150	113.6
ugreen3.tif	10	148	150	110.6
ugreen3.tif	11	149	150	111.3
ugreen3.tif	12	148	150	110.6
ugreen3.tif	13	148	150	110.6
ugreen3.tif	14	145	150	108.3
ugreen3.tif	15	147	150	109.8
ugreen3.tif	16	146	150	109.1
ugreen3.tif	17	144	150	107.6
ugreen3.tif	18	145	150	108.3
ugreen3.tif	19	144	150	107.6
ugreen3.tif	20	144	150	107.6
ugreen3.tif	21	148	150	110.6
ugreen3.tif	22	144	150	107.6
ugreen3.tif	23	144	150	107.6
ugreen3.tif	24	146	150	109.1
ugreen3.tif	25	150	150	112.1
ugreen3.tif	26	153	150	114.3
ugreen3.tif	27	153	150	114.3
ugreen3.tif	28	152	150	113.6
ugreen3.tif	29	151	150	112.8
ugreen3.tif	30	140	150	104.6
ugreen3.tif	31	140	150	104.6
ugreen3.tif	32	149	150	111.3
ugreen3.tif	33	153	150	114.3
ugreen3.tif	34	151	150	112.8
ugreen3.tif	35	151	150	112.8
ugreen3.tif	36	156	150	116.6
ugreen3.tif	37	160	150	119.5
ugreen3.tif	38	155	150	115.8
ugreen3.tif	39	156	150	116.6
ugreen3.tif	40	155	150	115.8
ugreen3.tif	41	160	150	119.5
ugreen3.tif	42	156	150	116.6
ugreen3.tif	43	155	150	115.8
ugreen3.tif	44	156	150	116.6
ugreen3.tif	45	160	150	119.5
ugreen3.tif	46	163	150	121.8
ugreen3.tif	47	156	150	116.6
ugreen3.tif	48	156	150	116.6
ugreen3.tif	49	156	150	116.6
ugreen3.tif	50	154	150	115.1
	Average Thickness (µm)		**112.8**	

lgreen1.tif	Dark	1	113.2	250	50.7
lgreen1.tif	Dark	2	113	250	50.7
lgreen1.tif	Dark	3	113.1	250	50.7
lgreen1.tif	Dark	4	111	250	49.8
lgreen1.tif	Dark	5	111.8	250	50.1
lgreen1.tif	Dark	6	107.9	250	48.4
lgreen1.tif	Dark	7	108.8	250	48.8
lgreen1.tif	Dark	8	103.7	250	46.5
lgreen1.tif	Dark	9	103.9	250	46.6
lgreen1.tif	Dark	10	103.7	250	46.5
lgreen1.tif	Dark	11	101	250	45.3
lgreen1.tif	Dark	12	104.8	250	47.0
lgreen1.tif	Dark	13	103.8	250	46.5
lgreen1.tif	Dark	14	113.7	250	51.0
lgreen1.tif	Dark	15	132.1	250	59.2
lgreen1.tif	Dark	16	133	250	59.6
lgreen1.tif	Dark	17	127.9	250	57.3
lgreen1.tif	Dark	18	126.8	250	56.8
lgreen1.tif	Dark	19	131.9	250	59.1
lgreen1.tif	Dark	20	135.8	250	60.9
lgreen2.tif	Dark	1	177.7	230	86.6
lgreen2.tif	Dark	2	173.5	230	84.5
lgreen2.tif	Dark	3	169.6	230	82.6
lgreen2.tif	Dark	4	170.3	230	83.0
lgreen2.tif	Dark	5	172	230	83.8
lgreen2.tif	Dark	6	182.6	230	89.0
lgreen2.tif	Dark	7	183.2	230	89.3
lgreen2.tif	Dark	8	189.6	230	92.4
lgreen2.tif	Dark	9	195.6	230	95.3
lgreen2.tif	Dark	10	202.1	230	98.5
lgreen2.tif	Dark	11	199.6	230	97.3
lgreen2.tif	Dark	12	210	230	102.3
lgreen2.tif	Dark	13	217.9	230	106.2
lgreen2.tif	Dark	14	194.5	230	94.8
lgreen2.tif	Dark	15	195.2	230	95.1
lgreen2.tif	Dark	16	205.6	230	100.2
lgreen2.tif	Dark	17	210.6	230	102.6
lgreen2.tif	Dark	18	170.5	230	83.1
lgreen2.tif	Dark	19	179.7	230	87.6
lgreen2.tif	Dark	20	183.1	230	89.2
				Average	71.9
				Median	71.8
				Minimum	45.3
				Maximum	106.2
				StdDev	21.5

Paint Chip Lengths

Lower Autoclave

Chip Number	No. 23 >1"		No. 19 .5-1"		No. 24 <.5"
1	1.125	flat	1	curl	0.4375
2	1.125	curl	0.8125	curl	0.4375
3	1.25	flat	0.625	flat	0.4375
4	1.0625	curl	0.75	curl	0.5
5	2	curl	0.8125	flat	0.4375
6	1.375	curl	0.875	flat	0.3125
7	1.8125	curl	0.8125	flat	0.4375
8	3.625	curl	0.875	flat	0.4375
9	1.875	flat	1	flat	0.4375
10	1.75	curl	1	flat	0.4375
11	1.25	flat	1	curl	0.4375
12	1.875	curl	0.625	flat	0.5
13	1.125	curl	0.5625	flat	0.375
14	1.75	curl	0.75	curl	0.3125
15	1.3125	curl	0.625	curl	0.4375
16	1.5625	flat	0.5625	flat	0.5
17	2	curl	0.5625	flat	0.3125
18	1.1875	curl	0.625	flat	0.5
19	1.5	flat	0.625	curl	0.375
20	1.4375	curl			0.4375
21	1.4375	curl			0.3125
22	1	curl			0.375
23	1.5	curl			0.3125
24					0.3125

Lower Autoclave Size Distribution Groupings

Chip Number	>1" Flat	>1"Curl	.5-1"Flat	.5-1"Curl	<.5"
1	1.125	1.125	0.625	1	0.4375
2	1.25	1.0625	0.8125	0.8125	0.4375
3	1.875	2	0.875	0.75	0.4375
4	1.25	1.375	0.8125	1	0.5
5	1.5625	1.8125	0.875	0.75	0.4375
6	1.5	3.625	1	0.625	0.3125
7		1.75	1	0.625	0.4375
8		1.875	0.625		0.4375
9		1.125	0.5625		0.4375
10		1.75	0.5625		0.4375
11		1.3125	0.5625		0.4375
12		2	0.625		0.5
13		1.1875			0.375
14		1.4375			0.3125
15		1.4375			0.4375
16		1			0.5
17		1.5			0.3125
18					0.5
19					0.375
20					0.4375
21					0.3125
22					0.375
23					0.3125
24					0.3125
Average Length	1.43	1.61	0.74	0.79	0.41
Median Length	1.38	1.44	0.72	0.75	0.44
Minimum Length	1.13	1.00	0.56	0.63	0.31
Maximum Length	1.88	3.63	1.00	1.00	0.50
StdDev	0.28	0.61	0.17	0.16	0.07
Number	6	17	12	7	24

Upper Autoclave

Chip Number	No. 17 >1"		No. 25 .5-1"		No. 43 .25-.5"
1	2.0625	flat	0.9375	curl	0.5
2	3	curl	1	curl	0.5
3	2.1875	curl	0.8125	curl	0.5
4	2.1875	curl	0.75	curl	0.375
5	2.625	curl	0.75	flat	0.5
6	1.875	curl	0.8125	flat	0.3125
7	1.75	flat	0.9375	curl	0.5
8	1.0625	flat	0.625	flat	0
9	1.5625	flat	0.625	curl	0.5
10	1.25	curl	0.75	flat	0.4375
11	1.75	flat	0.8125	flat	0.375
12	1.3125	curl	0.625	flat	0.5
13	1.375	curl	0.8125	curl	0.3125
14	1.125	flat	0.8125	flat	0.5
15	1.0625	flat	0.625	flat	0.3125
16	1.0625	curl	0.6875	flat	0.3125
17	1.0625	flat	0.625	flat	0.4375
18			0.625	flat	0.4375
19			0.625	flat	0.4375
20			0.5625	flat	0.375
21			0.5625	flat	0.375
22			0.5625	flat	0.375
23			0.5625	flat	0.4375
24			0.5	curl	0.375
25			0.75	flat	0.5
26					0.5
27					0.4375
28					0.3125
29					0.25
30					0.375
31					0.3125
32					0.3125
33					0.4375
34					0.375
35					0.375
36					0.3125
37					0.375
38					0.4375
39					0.3125
40					0.375
41					0.25
42					0.3125
43					0.375
44					0.375

Upper Autoclave Size Distribution Groupings

Chip Number	>1" Flat	>1"Curl	.5-1"Flat	.5-1"Curl	<.5"
1	2.0625	3	0.75	0.9375	0.5
2	1.75	2.1875	0.8125	1	0.5
3	1.0625	2.1875	0.625	0.8125	0.5
4	1.5625	2.625	0.75	0.75	0.375
5	1.75	1.875	0.8125	0.9375	0.5
6	1.125	1.25	0.625	0.625	0.3125
7	1.0625	1.3125	0.8125	0.8125	0.5
8	1.0625	1.375	0.625	0.5	0.5
9		1.0625	0.6875		0.4375
10			0.625		0.375
11			0.625		0.5
12			0.625		0.3125
13			0.5625		0.5
14			0.5625		0.3125
15			0.5625		0.3125
16			0.5625		0.4375
17			0.75		0.4375
18					0.4375
19					0.375
20					0.375
21					0.375
22					0.4375
23					0.375
24					0.5
25					0.5
26					0.4375
27					0.3125
28					0.25
29					0.375
30					0.3125
31					0.3125
32					0.4375
33					0.375
34					0.375
35					0.3125
36					0.375
37					0.4375
38					0.3125
39					0.375
40					0.25
41					0.3125
42					0.375
43					0.375
Average Length	1.43	1.88	0.67	0.80	0.40
Median Length	1.34	1.88	0.63	0.81	0.38
Minimum Length	1.06	1.06	0.56	0.50	0.25
Maximum Length	2.06	3.00	0.81	1.00	0.50
StdDev	0.40	0.67	0.09	0.17	0.08
Number	8	9	17	8	43

Optical Microscopy Measurements for Upper and Lower Autoclave (Chips < 0.125")

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
upper1.tif	1	217.7	5	194.4
upper1.tif	2	303.4	5	270.9
upper1.tif	3	343.5	5	306.7
upper1.tif	4	161.6	5	144.3
upper1.tif	5	184.3	5	164.5
upper1.tif	6	832.9	5	743.6
upper1.tif	7	574.2	5	512.7
upper1.tif	8	185.2	5	165.4
upper1.tif	9	249.6	5	222.9
upper1.tif	10	436	5	389.3
upper2.tif	1	750	5	669.6
upper2.tif	2	752.6	5	671.9
upper2.tif	3	604.3	5	539.5
upper2.tif	4	613.4	5	547.7
upper2.tif	5	810.2	5	723.4
upper2.tif	6	694.2	5	619.8
upper2.tif	7	263	5	234.8
upper2.tif	8	391.2	5	349.3
upper2.tif	9	733.6	5	655.0
upper2.tif	10	543.1	5	484.9
upper0003.tif	1	217.3	5	194.0
upper0003.tif	2	1846.8	5	1648.9
upper0003.tif	3	190.7	5	170.3
upper0003.tif	4	257.3	5	229.7
upper0003.tif	5	626.2	5	559.1
upper0003.tif	6	481	5	429.5
upper0003.tif	7	362.2	5	323.4
upper0003.tif	8	627.1	5	559.9
upper0003.tif	9	206.6	5	184.5
upper0003.tif	10	122.6	5	109.5
upper0004.tif	1	148.1	5	132.2
upper0004.tif	2	105.1	5	93.8
upper0004.tif	3	299.8	5	267.7
upper0004.tif	4	212.8	5	190.0
upper0004.tif	5	90.5	5	80.8
upper0004.tif	6	235	5	209.8
upper0004.tif	7	202.7	5	181.0

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
upper0004.tif	8	155.6	5	138.9
upper0004.tif	9	62.3	5	55.6
upper0004.tif	10	75.2	5	67.1
upper0005.tif	1	543.7	5	485.4
upper0005.tif	2	206	5	183.9
upper0005.tif	3	498.1	5	444.7
upper0005.tif	4	165.7	5	147.9
upper0005.tif	5	809.8	5	723.0
upper0005.tif	6	314.7	5	281.0
upper0005.tif	7	284.9	5	254.4
upper0005.tif	8	118.18	5	105.5
upper0005.tif	9	263.1	5	234.9
upper0005.tif	10	413.3	5	369.0
upper0006.tif	1	687.5	5	613.8
upper0006.tif	2	253.8	5	226.6
upper0006.tif	3	684.3	5	611.0
upper0006.tif	4	642.4	5	573.6
upper0006.tif	5	558	5	498.2
upper0006.tif	6	306.2	5	273.4
upper0006.tif	7	777.1	5	693.8
upper0006.tif	8	466.7	5	416.7
upper0006.tif	9	1068.9	5	954.3
upper0006.tif	10	598.1	5	534.0
lower0002.tif	1	53.9	5	48.1
lower0002.tif	2	32.4	5	28.9
lower0002.tif	3	57.8	5	51.6
lower0002.tif	4	22.8	5	20.4
lower0002.tif	5	42.4	5	37.9
lower0002.tif	6	45.9	5	41.0
lower0002.tif	7	30.1	5	26.9
lower0002.tif	8	34.7	5	31.0
lower0002.tif	9	51.8	5	46.2
lower0002.tif	10	41	5	36.6
lower0002.tif	11	33.2	5	29.6
lower0002.tif	12	24.1	5	21.5
lower0002.tif	13	49.5	5	44.2
lower0002.tif	14	42.5	5	37.9
lower0002.tif	15	55	5	49.1

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
lower0002.tif	16	53	5	47.3
lower0002.tif	17	55.9	5	49.9
lower0002.tif	18	30	5	26.8
lower0002.tif	19	51	5	45.5
lower0002.tif	20	46.5	5	41.5
lower0002.tif	21	28.6	5	25.5
lower0002.tif	22	32.2	5	28.7
lower0002.tif	23	29.7	5	26.5
lower0002.tif	24	24.8	5	22.1
lower0002.tif	25	21	5	18.7
lower0002.tif	26	13	5	11.6
lower0002.tif	27	42.4	5	37.9
lower0002.tif	28	27.7	5	24.7
lower0002.tif	29	33.8	5	30.2
lower0002.tif	30	57.1	5	51.0
lower0002.tif	31	20.2	5	18.0
lower0002.tif	32	49.1	5	43.8
lower0002.tif	33	81.6	5	72.9
lower0002.tif	34	52.2	5	46.6
lower0002.tif	35	30.1	5	26.9
lower0002.tif	36	41.5	5	37.1
lower0002.tif	37	46.5	5	41.5
lower0002.tif	38	21.1	5	18.8
lower0002.tif	39	40.4	5	36.1
lower0002.tif	40	27.5	5	24.6
lower0002.tif	41	36.1	5	32.2
lower0002.tif	42	15.5	5	13.8
lower0002.tif	43	31.2	5	27.9
lower0002.tif	44	34.1	5	30.4
lower0002.tif	45	30.8	5	27.5
lower0002.tif	46	26.8	5	23.9
lower0002.tif	47	18.4	5	16.4
lower0002.tif	48	24.2	5	21.6
lower0002.tif	49	39.5	5	35.3
lower0002.tif	50	28.5	5	25.4
lower0003.tif	1	26.9	5	24.017193
lower0003.tif	2	54.2	5	48.391518
lower0003.tif	3	40.7	5	36.33828
lower0003.tif	4	21.4	5	19.106614

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
lower0003.tif	5	25	5	22.320811
lower0003.tif	6	48.3	5	43.123807
lower0003.tif	7	23.7	5	21.160129
lower0003.tif	8	129.2	5	115.35395
lower0003.tif	9	33.4	5	29.820603
lower0003.tif	10	174.2	5	155.53141
lower0003.tif	11	55	5	49.105784
lower0003.tif	12	71.6	5	63.926803
lower0003.tif	13	64.6	5	57.676976
lower0003.tif	14	97.1	5	86.69403
lower0003.tif	15	103.8	5	92.676007
lower0003.tif	16	36.2	5	32.320534
lower0003.tif	17	82.6	5	73.747959
lower0003.tif	18	108.7	5	97.050886
lower0003.tif	19	78	5	69.64093
lower0003.tif	20	21.4	5	19.106614
lower0003.tif	21	80.8	5	72.140861
lower0003.tif	22	38.8	5	34.641899
lower0003.tif	23	51.8	5	46.24872
lower0003.tif	24	53.2	5	47.498686
lower0003.tif	25	71.8	5	64.105369
lower0003.tif	26	29.4	5	26.249274
lower0003.tif	27	134.8	5	120.35381
lower0003.tif	28	56.9	5	50.802166
lower0003.tif	29	25.5	5	22.767227
lower0003.tif	30	18	5	16.070984
lower0003.tif	31	10	5	8.9283244
lower0003.tif	32	28.3	5	25.267158
lower0003.tif	33	18.4	5	16.428117
lower0003.tif	34	13	5	11.606822
lower0003.tif	35	78.2	5	69.819497
lower0003.tif	36	54.1	5	48.302235
lower0003.tif	37	105.3	5	94.015256
lower0003.tif	38	93.3	5	83.301267
lower0003.tif	39	42.4	5	37.856095
lower0003.tif	40	14.1	5	12.588937
lower0003.tif	41	29.2	5	26.070707
lower0003.tif	42	31.8	5	28.392072
lower0003.tif	43	26.9	5	24.017193

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (μM)
lower0003.tif	44	46	5	41.070292
lower0003.tif	45	73.6	5	65.712468
lower0003.tif	46	21.1	5	18.838764
lower0003.tif	47	8.5	5	7.5890757
lower0003.tif	48	23.3	5	20.802996
lower0003.tif	49	30	5	26.784973
lower0003.tif	50	14.3	5	12.767504
lower000.tif	1	34.4	5	30.713436
lower0004.tif	2	122.7	5	109.55054
lower0004.tif	3	66.2	5	59.105507
lower0004.tif	4	35.8	5	31.963401
lower0004.tif	5	74.2	5	66.248167
lower0004.tif	6	422.4	5	377.13242
lower0004.tif	7	96.2	5	85.890481
lower0004.tif	8	192	5	171.42383
lower0004.tif	9	161.2	5	143.92459
lower0004.tif	10	98.1	5	87.586862
lower0004.tif	11	193.5	5	172.76308
lower0004.tif	12	102	5	91.068909
lower0004.tif	13	125.2	5	111.78262
lower0004.tif	14	101.2	5	90.354643
lower0004.tif	15	75	5	66.962433
lower0004.tif	16	229.3	5	204.72648
lower0004.tif	17	64.4	5	57.498409
lower0004.tif	18	117.7	5	105.08638
lower0004.tif	19	102.3	5	91.336759
lower0004.tif	20	42.4	5	37.856095
lower0004.tif	21	98.7	5	88.122562
lower0004.tif	22	45.5	5	40.623876
lower0004.tif	23	145.7	5	130.08569
lower0004.tif	24	43	5	38.391795
lower0004.tif	25	161.4	5	144.10316
lower0004.tif	26	33.1	5	29.552754
lower0004.tif	27	53	5	47.320119
lower0004.tif	28	28.4	5	25.356441
lower0004.tif	29	46.5	5	41.516708
lower0004.tif	30	83.4	5	74.462225
lower0004.tif	31	78.6	5	70.17663
lower0004.tif	32	155.1	5	138.47831

Image	Measurement #	Pixel Distance (pixels)	Magnification	Thickness (µM)
lower0004.tif	33	22.8	5	20.35658
lower0004.tif	34	34.1	5	30.445586
lower0004.tif	35	64.9	5	57.944825
lower0004.tif	36	57.3	5	51.159299
lower0004.tif	37	37.4	5	33.391933
lower0004.tif	38	188.2	5	168.03107
lower0004.tif	39	49.4	5	44.105922
lower0004.tif	40	22.8	5	20.35658
lower0004.tif	41	87.1	5	77.765705
lower0004.tif	42	36.1	5	32.231251
lower0004.tif	43	19.2	5	17.142383
lower0004.tif	44	54.2	5	48.391518
lower0004.tif	45	65.1	5	58.123392
lower0004.tif	46	86	5	76.78359
lower0004.tif	47	53	5	47.320119
lower0004.tif	48	31.8	5	28.392072
lower0004.tif	49	35.5	5	31.695552
lower0004.tif	50	40	5	35.713298
lower0005.tif	1	295.6	5	263.92127
lower0005.tif	2	71.1	5	63.480386
lower0005.tif	3	146.5	5	130.79995
lower0005.tif	4	293.2	5	261.77847
lower0005.tif	5	213.4	5	190.53044
lower0005.tif	6	222.9	5	199.01235
lower0005.tif	7	446.8	5	398.91753
lower0005.tif	8	174.2	5	155.53141
lower0005.tif	9	243.1	5	217.04757
lower0005.tif	10	233.5	5	208.47637
lower0005.tif	11	314	5	280.34939
lower0005.tif	12	174.8	5	156.06711
lower0005.tif	13	126	5	112.49689
lower0005.tif	14	305.8	5	273.02816
lower0005.tif	15	292.5	5	261.15349
lower0005.tif	16	242.2	5	216.24402
lower0005.tif	17	180	5	160.70984
lower0005.tif	18	169.8	5	151.60295
lower0005.tif	19	398.1	5	355.43659
lower0005.tif	20	42.8	5	38.213228

Attachment D

Alion Reviewer Checklist

ALION SCIENCE AND TECHNOLOGY

TECHNICAL DOCUMENT REVIEW CHECKLIST

Document Number: ALION-REP-TXU-4464-02 **Rev.:** 0

Document Title: TXU Paint Chip Characterization

CRITERIA	COMMENTS	INITIALS and DATE
Document was prepared and formatted consistent with governing procedure and is fully legible.	Yes	DPD 10/30/07
Title of the document is consistent with contents.	Yes	DPD 10/30/07
The objectives of the work are consistent with the project objectives and are clearly described.	Yes	DPD 10/30/07
Any acceptance criteria identified are reasonable.	Yes	DPD 10/30/07
The technical approach is clearly defined and appropriate for the stated objectives.	Yes	DPD 10/30/07
The technical basis is either fully described or appropriately referenced.	Yes	DPD 10/30/07
Technical inputs are clearly defined, identified, and appropriately referenced.	Yes	DPD 10/30/07
Any codes, standards, and regulatory requirements are clearly defined, identified, and appropriately referenced.	Yes	DPD 10/30/07
Any assumptions made are clearly defined and adequately justified, or flagged for further verification as appropriate.	Yes	DPD 10/30/07
All mathematical derivations specify all mathematical steps necessary for the Reviewer to clearly understand the conclusions.	N/A	DPD 10/30/07
Have adjustment factors, uncertainties and empirical correlations used in the analysis been correctly applied?	Yes	DPD 10/30/07
Any computer programs used are clearly identified as to name, version #, and verification status.	N/A	DPD 10/30/07
Any computer programs used are appropriate for their intended use.	N/A	DPD 10/30/07
The calculations/analyses are clearly presented and are consistent with the stated technical approach, design inputs, and assumptions.	Yes	DPD 10/30/07
Where results rely on computer calculations, the work clearly references the supporting computer runs, and the input and output listings are provided.	N/A	DPD 10/30/07
Where computer calculations are used, appropriate analysis parameters are used.	N/A	DPD 10/30/07
Analytical steps in the analyses can be verified without recourse to the originator.	Yes	DPD 10/30/07
The results presented are reasonable.	Yes	DPD 10/30/07
The conclusions presented are reasonable.	Yes	DPD 10/30/07
Any acceptance criteria identified have been met.	N/A	DPD 10/30/07
Revision history, if applicable, clearly documents revisions.	N/A	DPD 10/30/07
Appropriate quality requirements, including choice of governing procedure, have been identified.	Yes	DPD 10/30/07
Where appropriate, applicable construction and operating experience has been considered.	N/A	DPD 10/30/07
Where appropriate, the specified parts, equipment, and processes are suitable for the required application.	Yes	DPD 10/30/07

ALION SCIENCE AND TECHNOLOGY

TECHNICAL DOCUMENT REVIEW CHECKLIST

Document Number: ALION-REP-TXU-4464-02 **Rev.:** 0

Document Title: TXU Paint Chip Characterization

CRITERIA	COMMENTS	INITIALS and DATE
Where appropriate, specified materials are compatible with each other and the design environmental conditions to which they will be exposed.	N/A	DPD 10/30/07
Where appropriate, adequate maintenance features and requirements are specified.	N/A	DPD 10/30/07
Where appropriate, accessibility and other design provisions are adequate for performance of routine maintenance and repair.	N/A	DPD 10/30/07
Where appropriate, adequate accessibility is provided to perform the in-service inspection required during system life.	N/A	DPD 10/30/07
Where appropriate, design considered radiation exposure to the public and plant personnel.	N/A	DPD 10/30/07
Where appropriate, adequate handling, storage, cleaning, and shipping requirements have been specified.	N/A	DPD 10/30/07
Where appropriate, adequate identification requirements have been specified.	Yes	DPD 10/30/07

Add additional line items below as required

CRITERIA	COMMENTS	INITIALS and DATE

Notes:

1. An entry of "N/A" requires an explanation in the "Comments" block.
2. Preparer may add additional line items as necessary in the blank boxes provided.