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Conveyorized Photoresist Stripping Replacement for Flex Circuit Fabrication

Federal Manufacturing & Technologies

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KCP-613-8239

Published October 2007

Final Report

Approved for public release; distribution is unlimited.

Prepared under prime contract DE-ACO4-01AL66850 for the
United States Department of Energy

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A prime contractor with the United States
Department of Energy under Contract Number
DE-AC04-O1AL66850

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Honeywell

KCP-613-8239
Distribution Category UC-42

CONVEYORIZED PHOTORESIST STRIPPING REPLACEMENT FOR FLEX CIRCUIT FABRICATION

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Abstract

A replacement conveyorized photoresist stripping system was characterized to replace the ASI photoresist stripping system. This system uses the qualified ADF-25c chemistry for the fabrication of flex circuits, while the ASI uses the qualified potassium hydroxide chemistry. The stripping process removes photoresist, which is used to protect the copper traces being formed during the etch process.

Summary

ASI went out of business some years ago and rising maintenance costs began to rival the cost of a new stripping system. A decision was made to replace the ASI stripping system. The Chemcut stripping system duplicates the functions of the ASI system but includes enhanced control, rinsing, and conveyor systems.

Qualification activities included comparing peel strengths of laminated test panels, photoresist stripping speeds, and the removal of resist between the two stripping systems.

This study demonstrates that the Chemcut photoresist stripper meets or exceeds production requirements for flex circuit fabrication.

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Discussion

Scope and Purpose

This evaluation was done to qualify a replacement stripping system used to remove photoresist from the copper surfaces of flex circuits.

Activity

<u>Photoresist Stripping Process</u>

Both the ASI machine and the Chemcut machine have a stripping chamber followed by rinses and a dryer. The two machines differ in two ways. The chemical used in the ASI process is potassium hydroxide while that in the Chemcut process is ADF-25c. ADF-25c was approved for use in EER 20031565SA Revision 2. The second difference is the rinsing process. Currently, the ASI process uses a two chamber cascade rinse and a high pressure rinse chamber while the Chemcut process uses a three-chamber cascade rinse.

<u>Stripping Speeds</u>

The ASI conveyor speed for a copper panel with DuPont Multimaster115mmi photoresist is typically set at 2.5 to 3.0 feet per minute. The Chemcut conveyor speed for the same panel type was typically set at 2.0 to 2.5 feet per minute.

The ASI conveyor speed is typically set at 4.0 to 4.5 feet per minute for an aluminum panel with DuPont Multimaster115mmi photoresist. The Chemcut conveyor speed for aluminum panels is the same as the conveyor speed for the copper panel (2.0 to 2.5 feet per minute).

The advantage of same copper and aluminum conveyor set points is a less likely chance for errors to occur when setting the conveyor speeds. Another advantage to the Chemcut machine is that the viewing glass has not been etched by the chemical usage. This allows the user to verify where the photoresist is being removed from the panels in the stripping chamber, also known as the breakpoint.

<u>RO Pan Dip</u>

Stripped panels were dipped into hot RO water to expose any unremoved photoresist. Any photoresist not removed by the stripping system would turn a bright blue. Ten panels were run through each stripping machine and then dipped into a pan of hot RO water. After being dipped into the pan of water, the Chemcut panels only showed two particles of unremoved photoresist under the size of 1 millimeter square. The ASI panels also had two particles under the size of 1 millimeter. However, the ASI panels also yielded four photoresist particles of about 5 millimeters.

Peel Strength Samples

Peel Strength tests were performed to compare the amount of force necessary to delaminate a cable after lamination. From each stripping machine, 10 sets of two panels were laminated together for both 1 oz copper and 1 mil aluminum. Three peel strength samples were then taken from each set of panels.

Statistical analysis of the peel test data was performed to determine the significance of the data. Both the ASI and Chemcut stripping process exhibited Cp and Cpk values greater than 1.0 for both aluminum and copper. A Cp/Cpk value that is greater than one indicates that the process is in control.

The greater the Cp, the tighter the distribution. For both copper and Aluminum, the ASI had a higher Cp, or a tighter distribution. While the ASI machine's Cp may be higher, three sigma from the mean leaves the Chemcut machine with higher peel strengths for both the copper and aluminum. For the Chemcut machine, the copper and aluminum three sigma from the mean gives peel strengths of 3.175 lb/in and 2.693 lb/in, respectively. The ASI copper and aluminum values were only 3.101 lb/in and 1.534 lb/in, respectively.

The data and the statistical analysis can be found in Appendix A.

Rollers and Leader Boards

The material used for the panels that were processed through both of the stripping systems was double sided 1 oz copper with 1 mil kapton and double sided 1 mil aluminum with 1 mil kapton. When processed on the ASI stripping system, both the copper and aluminum panels had to be run with leader boards to allow the panels to progress through the system without becoming entangled or marred by roller marks. In contrast, the Chemcut stripping system transported the parts easily with no leader boards and slight to no roller marks.

Conclusion

After reviewing the results of this study, the Chemcut photoresist stripping system is equivalent to or better than the ASI photoresist stripping system. Further characterization is currently under way to optimize the settings for Dupont Multimaster115 mmi photoresist on copper and aluminum, and also Dupont Multimaster120 mmi photoresist and the double application of photoresist.

Appendix

Statistical Analysis

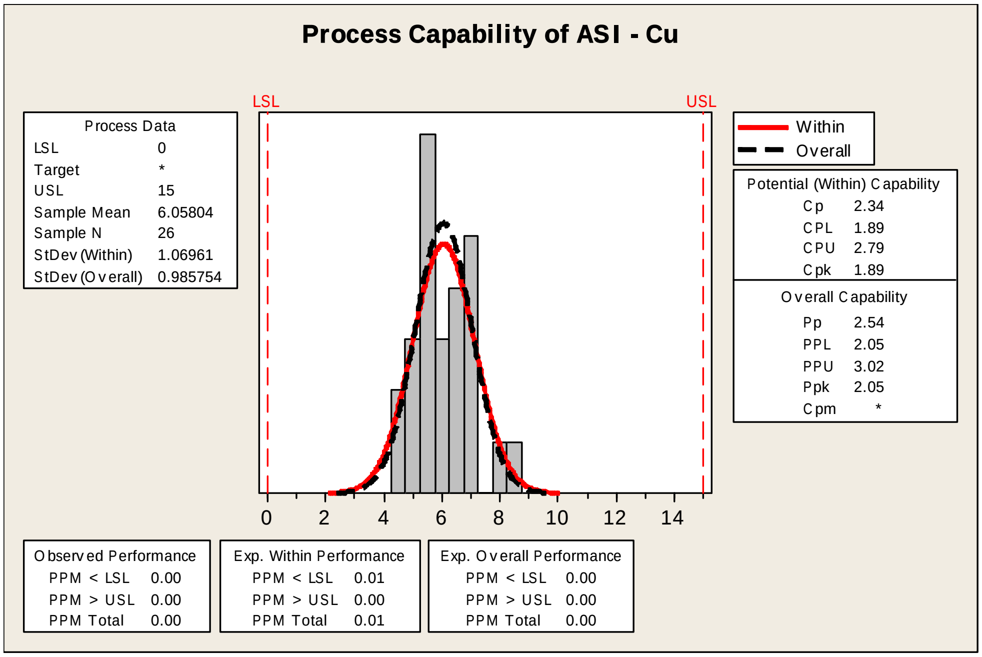
Table A1, below, contains peel strength values for both copper and aluminum panels that were processed using the Chemcut and ASI stripping machines used in the statistical analysis.

	ChemCut - Al	ASI - Al	ChemCut - Cu	ASI - Cu
1	6.32	2.46	7.08	4.68
2	7.08	2.65	3.66	
3	5.18	2.71	6.60	4.80
4	5.42	2.69	6.41	6.01
5	6.23	3.32	10.34	
6	3.87	4.01	6.14	6.39
7	4.44	2.73	7.38	
8	5.21	2.59	5.91	6.46
9	5.74	2.79		
10	6.50	2.39	6.87	6.95
11	6.38	3.07	7.29	5.42
12	6.81	2.51	9.11	5.09
13	6.51	2.93	7.27	6.52
14	5.88	2.82	6.97	6.90
15	5.17	2.40	7.17	4.58
16	5.00	2.43	8.57	4.90
17	3.80	1.86	7.84	7.86
18	4.61	2.39	7.18	5.98
19	5.17	2.56	8.38	6.83
20	5.26	2.48	6.80	5.28
21	5.16	2.77	6.37	6.41
22	4.91	3.16	7.24	7.07
23	5.44	2.73	8.01	5.68
24	4.84	2.24	6.52	5.59
25	3.92	2.90	9.00	6.18
26	4.45	2.89	7.38	5.41
27	4.80	2.46	7.02	5.64
28	4.75	2.95	8.00	6.93
29	5.54	2.81	7.32	5.49
30	4.72	2.36	11.29	8.47
Sample Count:	30	30	30	30
Average:	5.30	2.70	7.42	6.06
Standard Deviation:	0.862	0.386	1.402	0.976

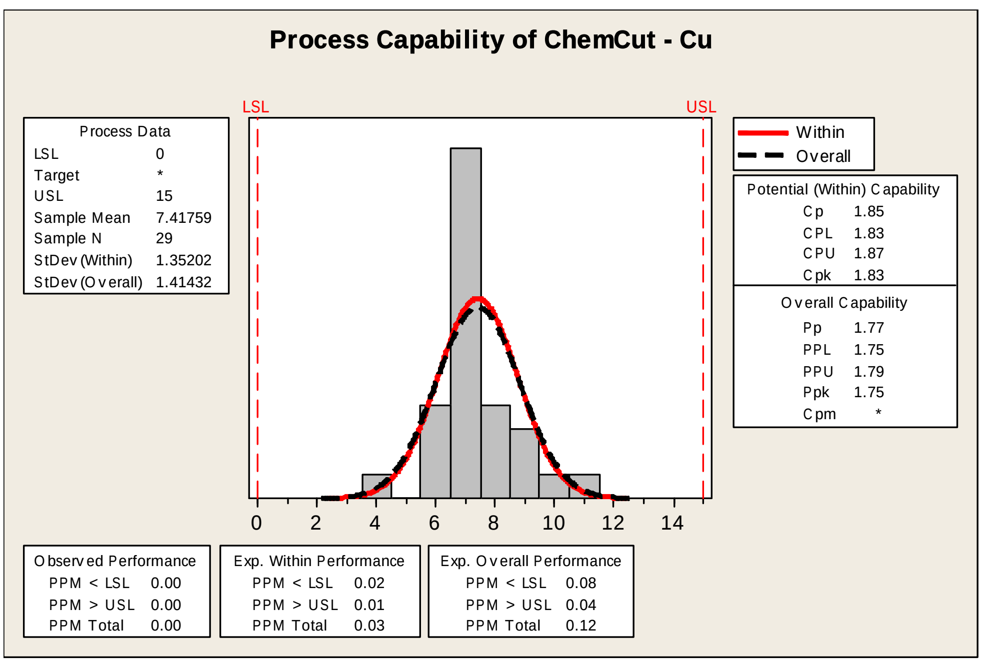
Table A1 - Peel Strength Data

Note: The missing data points are from peel strength samples that failed to produce data.

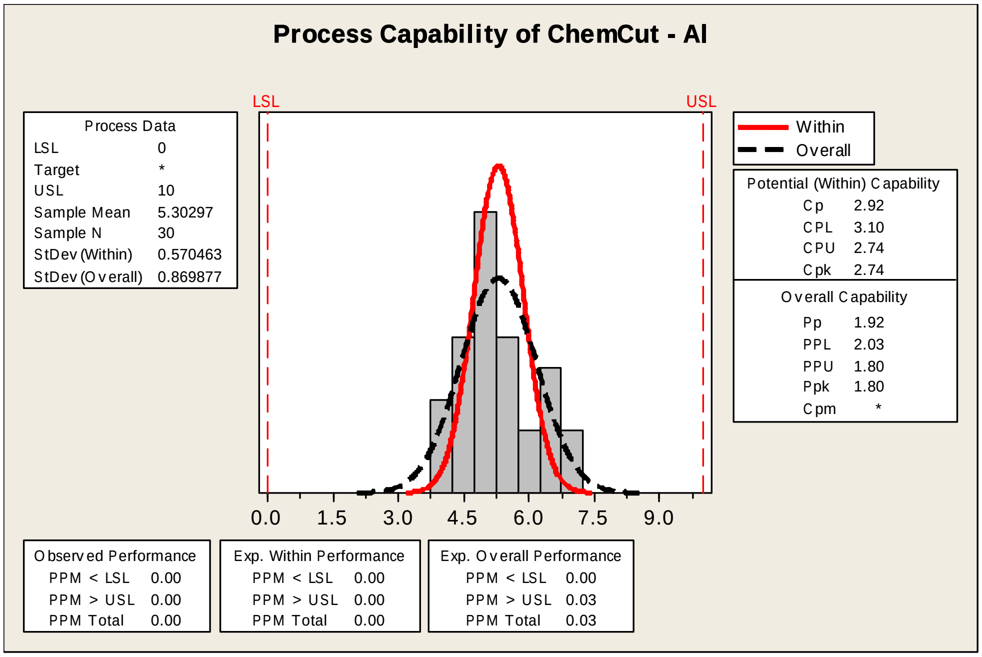
A capability study was performed in MiniTab with the above data. It provided the following graphs, along with the mean, standard deviation, Cp, and Cpk values included in the margins of the graphs.



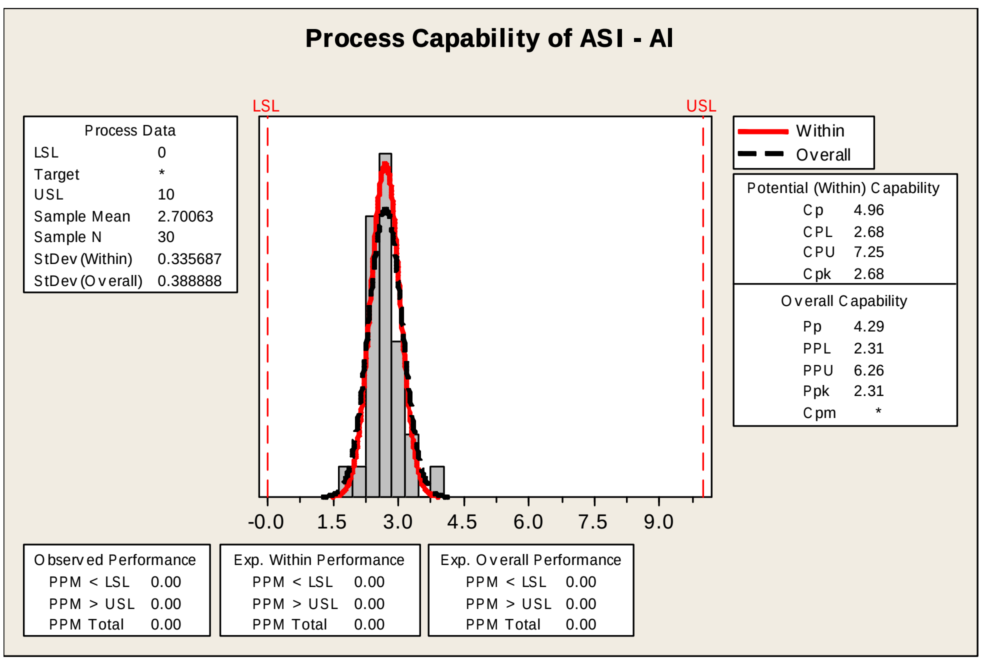
Graph A1 - Copper run through the ASI



Graph A2 - Copper run through the Chemcut



Graph A3 - Aluminum run through the Chemcut



Graph A4 - Aluminum run through the ASI