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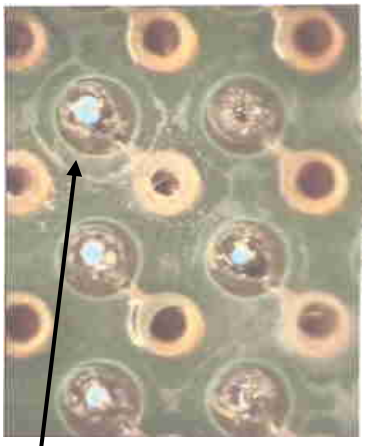
White Residue below BGA Components: Is it good or bad?

BGAs present a cleaning challenge, and visible white residues often indicate that the cleaning process is not up to par.

Foresite Inc.


Moderate White Residue

PROBLEM DESCRIPTION

The purpose of this study was to determine the process residues remaining under the micro BGA's with ball counts above 1000 i/o and water soluble flux after water and saponified cleaning on boards. Visible white residue was present on the surface of the board in the area where the BGA was attached. Our goal was to determine the best cleaning protocol for the boards.

These residues appear as solder paste flux residues in and around the areas of the BGA after cleaning. The IPC 610 C inspection criteria states that these residues are a rejection criteria unless proven to be benign.

Process History

Chemistries: Solder paste: Water Soluble, run in nitrogen (full tunnel). Saponifier#1 at 5% from Vendor A and Saponifier #2 at 5% from Vendor B (both commercially available materials) cleaned in a standard in-line aqueous cleaner at 135 F wash temperature. Boards were both fabricated using a LPI soldermask and Entek 106A OSP board finish. An AirVac Workstation was used to remove all the BGA components. The BGA board area and the component were tested in the same extraction bag. All IC testing was performed per the IPC TM-650 2.3.28 Ion Chromatography test method.

Ion Chromatography Results

all values are ug/in2	Ion Chromatography				Visuals
Sample Description	**Cl^-**	**Br^-**	**SO_4^{2-}**	**WOA**	**Below BGA**
Assemblies Cleaned Saponifier #1					
Micro BGA #1 >1000 I/O	**6.21**	**11.44**	**0.00**	**15.39**	Minimal White Residue
Micro BGA #2 >1000 I/O	**5.99**	**10.69**	**0.00**	**15.69**	Moderate White Residue
Micro BGA #3 >1000 I/O	**5.98**	**11.99**	**0.00**	**14.58**	Minimal White Residue
Assemblies Cleaned Saponifier #2					
Micro BGA #1 >1000 I/O	**1.31**	**1.74**	**0.00**	**4.39**	No White Residue
Micro BGA #2 >1000 I/O	**1.08**	**1.49**	**0.00**	**4.11**	No White Residue
Micro BGA #3 >1000 I/O	**1.15**	**1.81**	**0.00**	**4.57**	No White Residue
Assemblies Cleaned DI water only					
Micro BGA #1 >1000 I/O	**9.89**	**19.35**	**0.00**	**37.15**	Very Heavy White Residue
Micro BGA #2 >1000 I/O	**11.28**	**20.47**	**0.00**	**39.24**	Very Heavy White Residue
Micro BGA #3 >1000 I/O	**10.47**	**19.84**	**0.00**	**33.69**	Very Heavy White Residue
Reference OSP Bare Board	**1.35**	**1.08**	**0.00**	**0.00**	No Visuals
Assembly Prior to any cleaning	**29.67**	**84.33**	**0.00**	**128.30**	Heavy flux Residues
Foresite Recommended Limits for Water Solubles	**<6.0**	**<9.0**	**<3.0**	**<15**	

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Data Review

The assemblies were extracted just in the area of the BGA. The boards were cleaned using three different cleaning protocols, water only, saponifier #1 and saponifier #2. The bare board establishes the foundational cleanliness of the assemblies. Prior to cleaning, the assembly showed typical water-soluble flux residues. The white residue seen below the BGA packages is the remaining flux residue after cleaning. This residue reacts with the water to leave a visible white residue. The level of ionic residues seen is directly related to the remaining flux residues.

The level of chloride, bromide and WOA for the 'Water Cleaned Only' assemblies was high and posed a great risk for electrical leakage and electromigration problems based on Foresite's experience and established cleanliness limits. The difference between the two saponifiers showed that saponifier #2 removed more flux residues ionically and visually. Saponifier #1 and 'Water Cleaned Only' processes left high levels of flux residue on the surface of the board below the BGA component. Saponifier #2 removed all the visual flux residues and reduced the ionic levels to well below our recommended levels. Using Saponifier #2 at 5% with a standard in-line aqueous cleaning system at typical production rates cleans very well.

CONCLUSIONS – ANSWER TO YOUR QUESTIONS

1. What is the nature of the residue remaining under the micro BGA >1000's? How much? Is it good or bad?

- Flux residues with water-soluble flux activators that are conductive and corrosive if left on in large enough quantities are detrimental.
- If you can see it, it appears to be high enough to be a concern (with water soluble fluxes only, not No Clean flux residues).
- In the WSF case, it is bad and must be removed. If above our recommended limits, these levels can be harmful because they leave conductive residues that absorb ambient moisture and allow stray voltage effects to occur.

2. What process recommendations would you make to increase our ability to remove these residues using saponifier #1?

- Increase the concentration and maintain a wash temperature of 140 F.
- We would recommend running with lower pressures in the pre-wash and wash sections at a slower belt speed, and also evaluate the use of saponifier #2.
- Pre-wash and Wash pressures should be set at 35 and 30 psi top and bottom respectively, and belt speeds of 3.0 ft/min.

Summary Conclusions

The cleaning challenge of a high I/O microBGA with a low standoff under standard aqueous (Water Only) cleaning techniques produced a product that left visual residues and ionic levels well above our cleanliness limits for good electrical performance. Both the 'Water Only Cleaned' and Saponifier #1 cleaned group showed a high level of chloride, bromide and WOA residues along with the visible flux residues. It appears that not all saponifiers are created equal. The saponifier #2 showed great visual and ionic cleaning performance. The risk of leakage or electromigration problems is minimal to none at this level of cleanliness for Saponifier #2. White residue below a microBGA, when using a water-soluble flux is a sign of poorer cleaning and can pose a risk of electromigration and electrical leakage. Further testing using SIR is currently planned after the process optimization.