CLEANING LABORATORY EVALUATION SUMMARY

SCL #:	1996
DateRun:	06/01/1996
Experimenters:	Olantuji Lawal
ClientType:	Electronics Manufacturer
ProjectNumber:	Project #1
Substrates:	Plastic, Electronics
PartType:	Coupon
Contaminants:	Fluxes
Cleaning Methods:	
Analytical Methods:	Goniometry
Purpose:	Compatibility of Low VOC Coat w/ Solder Mask

Experimental Procedure:

A Report on Compatibility of Low VOC Conformal Coat with a Soldering Mask (A Research Project for Electronics Manufacturer) Conducted at the Surface Cleaning Lab (Toxics Use Reduction Institute, MA)

Compatibility may be defined as a collection of materials when used together, to meet or exceed well acceptable, post-assembly inspection criteria (1). The objective of the research is to properly match the conformal coating surface tension and solder mask surface energy (wetting tension). Surface energy is an important factor in determining the wettability of a substrate by a liquid cleaning solution. In general, the higher the substrate surface energy, the easier it is too wet. The combination of a low-surface-energy liquid and a high-surface-energy substrate leads to good wettability (2). Poor wetting of the solder mask, staining, excessive flux residue etc, can significantly impact the cost and efficiency of the assembly process. So minimizing or eliminating these defects can be accomplished by ensuring that the solder mask and conformal coat are compatible.

There were six different samples used, consisting of samples A, B, C, D, E and F. The substrate surface energies were estimated by measuring the contact angles of four standard liquids on the surface. A Contact Angle Goniometer was used to estimate the surface energies of the substrates by measuring the contact angles of four standard liquids on the surface. The liquids used were formamide, NMP, Triethanol Amine and Glycerol. The selected liquids have surface energies ranging from 40.05 dynes/cm to 63.4 dynes/cm and the critical surface energy was determined for each surface. Three different samples were used, one was as received from the manufacturer, the second was cleaned in a terpene system and the third was baked for three hours at 300 C after terpene cleaning. The substrate is considered wetted by the liquid when the contact angle, theta, is less than zero degrees. This angle is representative of the wettability of the substrate vis-a-vis the liquid in a given atmosphere, because theta is related to surface energies by:
sv = 1vcos theta + s1 -- (1)
Where sv, v and s1 are the surface energies, respectively between the substrate and the gas phase, the liquid and the gas phase, the solid and the liquid.

Results:

The cosine of the contact angle [cos theata] measured using the Contact Angle Goniometer was plotted against the surface tension for the four liquids. The result yielded approximately straight lines which were fitted with linear regressions. The surface tension at which the line intercepts at cos theta is equal to one, is defined as the critical surface tension (CST). The critical surface tension of a substrate is the highest surface tension a liquid can have and still completely wet the substrate. Figure 1-6 represent the relationship between the cosine of the contact angle [cos theta] and the critical surface tension. Table-1 shows the values of the CST obtained for six samples.

Table 1 Critical Surface tension (Dynes/cm)

Samples	As received	Cleaned	Baked
A	32	33	34
B	38	35	33
C	33	36	34
D	30	32	29
E	34	32	37
F	35	36	37

Legend
Sample A------------3241G
Sample B-------------Hysol
Sample C------------3241G
Sample D-------Macumask
Sample E-------------Taiyo
Sample F--------------Ciba

MILSPEC/E2C SOLDERMASK STUDY SUMMARY OF RESULTS (1)					
MASK	DEWET	ADHESION	BUBBLES	SCORE	RANK
HYSOL	1.2	0.8	1.9	3.9	1
3241G*					
UNPRIMED	2.4	1.2	3	6.5	2
TAIYO	1.3	2	3.5	6.8	3
3241G*					
PRIMED	0.4	3.6	3.5	7.5	4
CIBA	1	4.3	3.4	8.7	5
MACUMASK	2.3	4.7	2.6	9.6	6
3241M	1	4.8	4.7	10.5	7
(1) Rating based on a scale of 0 (best) to 5 (worst) per category per board. *Enthone DSR-3241 presently in use. Conap AD 1146 primer.					

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Summary:

Conclusion:

The surface energy values obtained for all the substrates range from 29 dynes/cm to 38 dynes/cm. The surface tension of the conformal coat is 34 dynes/cm. It is generally known that compatibility depends on the surface tension of the conformal coat and surface energy of soldering mask. The two energies have to be properly matched because mismatch can result in dewetting of the liquid conformal coat from the solder mask surface. A higher level of compatibility can be achieved if the wetting tension of the solder mask is significantly higher than the surface tension of the conformal coat. The substrate with CST values greater than 34 dynes/cm wets and may be considered to be compatible with the conformal coat, while those with CST values less than 34 dynes/cm dewet and may be considered non-compatible. Sample B, for as received sample, has a CST value of 38 dynes/cm and 36 dynes/cm for terpene cleaned sample. These may be considered compatible. Sample F for the sample as received, cleaned with terpene, and baked respectively have values of 35 dynes/cm, 36 dynes/cm and 37 dynes/cm, and they may also be considered compatible. However, though these samples were considered compatible with the conformal coat, the wetting tension values were closed to the surface energy of the conformal coat. Dewetting of the coat may result if there is contamination of the mask.
The best result is achieved if the wetting tension of the substrate is significantly higher by reasonable margin. Poor wetting of the substrate, high ionics, bridging, staining, excessive flux residues may cause the wetting tension value to drop and can severely impact the cause and efficiency of the soldering process.

REFERENCES

(1) Lavidolts et. al., 1995/96, Compatibility of PWB Coatings with Assembly Processes and Materials. Electronic Patching and Production, 1996.
(2) Yamamoto et. al., 1995, Modification of Surface Energy, Dry Etching and Organic film Removal Using Atmospheric-Pressure Pulsed-Corona Plasma. IEEE Transactions on Industry Applications, Vol 31, No. 3 May/June 1995.
(3) Naslain R, et. al., 1989, Wetting Improvement of Carbon or Silicon Carbide by Aluminum Alloys based

on a K2ZrF6 Surface Treatment: Applications to Composite Material Casting. Journal of Material Science 1989.