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METHODOLOGY FOR EVALUATION OF SOLDER PASTE STENCIL NANO-COATINGS' EFFICIENCY AND ECONOMIC BENEFITS

Abstract— In terms of cost, weight, volume and reliability, present methods of production of traditional electronic assemblies have practically reached limitations. Surface mounting (SMT) technology enables more reliable assemblies to be manufactured with a lower weight, volume and expense.

Innovative materials and processes would be required for surface mount technology to remain in close touch with other parts of the electronics industry. Nano-coating systems have been developed by various manufacturers to solder paste printing to solve these problems. The benefits include decreased underside washing, reduced bridges, improved solder paste removal and increased efficiency.

How will performance be evaluated and more likely to be adopted with many nanotechnologies already on the market?

This paper provides a systematic methodology for evaluation of solder paste stencil nano-coatings' efficiency and economic benefits. All of them will be examined and measured, for example under-side washing, bridging, performance transfer by SAR's, solder pulp geometry, post-press cleaning and coating abrasion resistance. The current coatings will be contrasted with the results. An economic impact debate will be included in the current and future design of SMTs.

Keywords Nano-coating, stencil, transfer efficiency, underside cleaning, bridging, solder paste release.

EXPERIMENTAL METHODOLOGY

Four stencil nano-coatings were evaluated and compared to an uncoated stencil as a baseline. For the purposes of this paper, the coatings were named A, B, C and D and the uncoated stencil was named U. Several criteria were used to evaluate the function and performance of each coating. The function of nano-coatings can be separated into two categories: surface function and aperture function. Surface function was evaluated through measurement of contact angle, underside cleaning, and bridging performance. Aperture function was evaluated by solder paste release measured as transfer efficiency. The robustness or durability of the coatings was evaluated through mechanical abrasion and chemical testing. The methodology for each criterion is explained below. Contact angle is a measurement of the hydrophobicity or lipophobicity of a surface. Hydrophobicity literally means water fearing, and lipophobicity means oil fearing. Nano- coatings must provide the benefits of hydrophobicity and oleophobic. Solder paste fluxes are more like oil than water in terms of polarity, but can have the properties of both. The nano-coating must provide the benefit of "fluxophobicity." The main function of a nano-coating is to cause the solder paste to de-wet and to release from the stencil. Contact angle is one way to gage the "fluxophobic" ability of a nano-coating.

Contact angle was measured using a goniometer and two different liquids. Deionized water was used to measure the hydrophobicity of the nano-coatings. N-hexadecane was used to measure the oleophobicity of the nano-coatings. The contact angle increases as the liquid de-wets from the surface. High contact angles indicate desirable de-wetting performance.

Cleaning the underside of the stencil is a standard practice in the solder paste printing process. Cleaning is typically done on a cycle after a certain number of prints. The frequency of cleaning is dictated by the solder paste, the print parameters, the stencil, the circuit board, and the technology used. In this experiment, evaluation of the underside of the stencil was done visually after 20 prints with no cleaning.

Bridging is a common issue, and is becoming more common especially as components become smaller and pitch becomes tighter. One source of bridging is the tendency for solder paste to stick to the under-side of the stencil. The solder paste is then transferred to the next circuit board printed, causing bridging. The test board used for this evaluation includes a pattern which detects bridging. This pattern was also used for evaluation of solder paste brick profile through the course of 20 prints.

Solder paste release is a key to the success of the solder paste printing process. The goal of the printing process is to put the desired amount of solder paste into the correct place on the circuit board. In this evaluation, solder paste release was evaluated through measurement of solder paste volume and calculation of transfer efficiency. Transfer efficiency is defined as follows.

TE (%) = (volume of solder paste printed) ÷ (volume of stencil aperture) x 100%

Transfer efficiency was measured in BGA arrays with surface area ratios (SAR) of 0.575 in the 0.5 mm BGA and0.500 in the 0.4 mm BGA.

Twenty boards were printed with each stencil and solder paste volume was measured. Average transfer efficiency was calculated for each

SAR. Robustness was evaluated through the use of an ASTM abrasion test D2486 [1].

Chemical resistance was evaluated by adding a variety of chemicals to the scrub testing pad. The contact angle was measured after each type of test. A reduction in contact angle is the indicator that the coating is wearing and losing efficacy.

Surface Function – Contact Angle

Contact angle measurements were made multiple times and average values are reported here (Table 2).

Table 2: Contact Angle on Nano-coatings

Coating	Contact Angle DI water (deg)	Contact Angle n-Hexadecane (deg)
Coating A	103	60
Coating B*	101	66
Coating C*	109	70
Coating D	105	64
Uncoated (U)	54	9

All of the coatings tested significantly improve contact angle when compared to an uncoated stencil. Multiple lots of coatings B and C were tested and found to give inconsistent performance. In summary, the increase in contact angle as compared to an uncoated stencil displays the desired properties of hydrophobicity and oleophobicity.

-Surface Function – Underside Cleaning

Underside cleaning was evaluated after a run of 20 consecutive solder paste prints with no cleaning during the run. The bottom of the stencil was inspected.

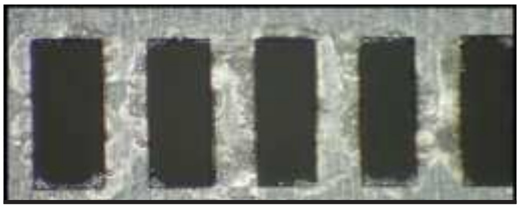	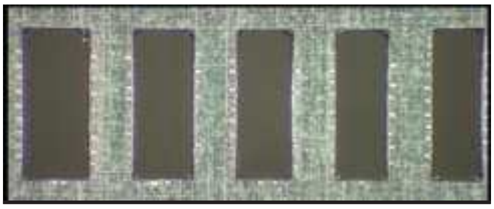
Fig. 2. Bottom Side of an Uncoated Stencil After 20 Prints	**Fig. 3.** Bottom Side of a Nano-Coated Stencil After 20 Prints

The uncoated stencil shows solder paste adhering between the apertures (Fig. 2). After 20 prints, solder paste is not present on the nano-coated stencil bottom (Fig. 3). All of the nano-coatings tested (A, B, C, and D) displayed the same performance in this test.

CONCLUSIONS

Similar performance in some areas and variations in others were evaluated by nano-coatings. The cost to apply most nano-coatings is negligible when compared to the potential savings in cleaning materials, solder paste waste, yield improvements and avoidance of rework. If an increase in transfer efficiency is desired, then this can be achieved through the use of certain coatings. The user should be aware of the benefits and negative impacts when making a decision to use a nano-coating.

ACKNOWLEDGMENT

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REFERENCES

1. ASTM D2486, “Standard Test Methods for Scrub Resistance of Wall Paints”, Reapproved 2012.