Cleaning High-power Electronics

A CLOSED-LOOP SOLVENT-BASED APPROACH

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To prevent malfunctions in high-power electronics, flux residues must be removed from flip chip components prior to subsequent processes. As a result, integrating a suitable cleaning application into the manufacturing process of flip chip components is often required. Solvent-based applications have re-emerged, and with that an overall process solution is necessary. Previous solvent-based processes required ozone-depleting chemicals or flammable/combustible solvents requiring multiple rinsing steps and long drying cycles. However, recent advancements, including a novel single solvent-based process, set out to eliminate all aforementioned shortcomings.

THE SHORT STORY

Flux residues must be be removed from flip chip components prior to subsequent processes to prevent malfunctions in high-power electronics. Solvent-based applications have reappeared on the scene, requiring a green process solution. One single-solvent based process may do the trick.

One cleaning process was developed to replace vapor degreasing applications. Its principle relies on a single solvent system of sufficient polarity to give a bulk resistivity range of 1 to 100 MΩ-cm. This automated, self-monitoring closed-loop wash, rinse, and dry process uses spray-under immersion dynamics to enhance the performance of the cleaning agent. The cleaning process can also be assisted with ultrasonic energy if required. Unique to this process, the solvent, or solvent blend, is renewed by passing the flux-bearing solvent across special ion exchange resins selected for organic solvent compatibility. The regeneration operates on the same principle as DI water resins.

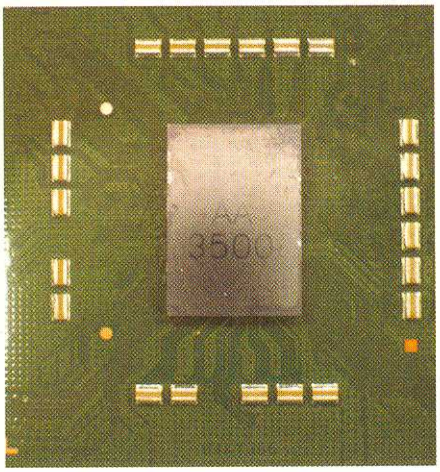

FIGURE 1. 11.5 mm x 11.5 mm flip chip test vehicle.

The process activates spray-under immersion cleaning jets and continuously monitors the resistivity of the solution. The cleaning cycle continues until the resistivity slope nears zero, indicating complete removal of the flux residues. The cleaning solvent automatically re-routes to the resin bed, which removes flux contaminants from the solution until bulk resistivity returns to high resistivity. The solution is then drained and the parts are dried automatically with clean, dry air or nitrogen. This water-free, self-monitored process provides fast residue-free drying for high-power cleaning applications. In addition, a small footprint, sealed tank meeting new VOC requirements, and low chemical and power consumption make it a very "green" process.

The solvent system designed for use with this series of test was specifically formulated to dissolve a large variety of residues, provide low surface tension, flash point above 100°F, have a right resistivity range, and dry residue free.

The resistivity of the solution and the ionic level of the solution are correlated mathematically by the following equation:

$$\frac{1}{R} = A + (B * \sqrt{C})$$

The constants A and B are determined empirically for each solvent/blend by plotting 1/R versus the ionic concentration. A is the Y axis intercept and B is the slope of the line generated. The cleaning system uses this equation to measure and automatically adjust the cleaning process.

Initial tests were designed to verify clean-ability of water soluble and RMA fluxes in tight spaces. A 11.5 ×11.5-mm flip chip vehicle was selected to evaluate a high I/O structure (Figure 1).

Multiple test vehicles were then prepared with water-soluble flux as well as

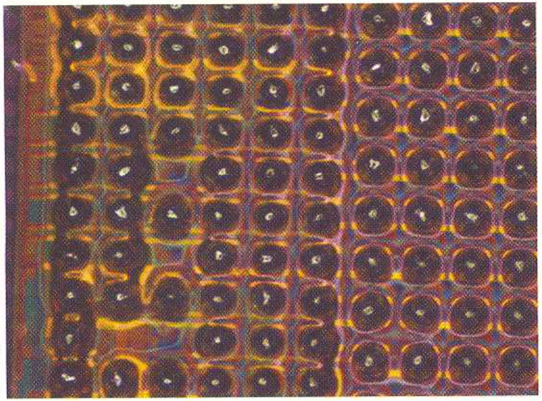

FIGURE 2. Test vehicle showing residues before cleaning.

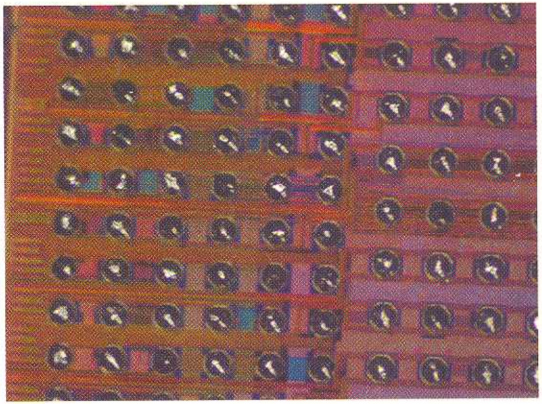

FIGURE 3. New solvent completely removed the residues.

the RMA flux (Figure 2). To measure the effectiveness of the process, testing was completed with IPA as well as with a novel solvent technology. Both cleaning agents proved to be fully compatible with the automatic regeneration system. Flip chips soldered with water-soluble fluxes remained partially removed or untouched when cleaned with IPA; as well as when they were soldered with RMA flux residues. An increase in cleaning cycle time slightly improved the cleaning results. When using similar parameters with the new solvent solution, all the water-soluble, as well as the RMA flux residues, could be fully removed under all flip chips (Figure 3).

Conclusion

Experimental data confirms the removability of water soluble and RMA flux residues from underneath low standoff flip chip components using a novel solvent system. It also confirmed the solvent-based cleaning process can be used to clean water soluble and RMA flux residues from closely spaced microelectronic components without requiring a subsequent rinsing step. This system can meet updated VOC requirements, and greatly minimize solvent consumption and waste streams. **AP**

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