Circuits Assembly

Optoelectronics Development at Universal Instruments SMT Laboratory

The SMT Laboratory was founded in 1987 with the basic goal of providing competent technical support and process development for our customers' electronic manufacturing needs. DEK Printing Machines and Vitronics Soltec, our sister companies, also maintain SMT process engineers in the laboratory to provide support for their customers. The laboratory contains two complete automated production lines with all associated production related equipment for the assembly of all conventional SMT components as well as Flip Chip in package and Flip Chip on board. The lab provides substantial failure analysis capabilities with a broad array of non-destructive and destructive analytical techniques. In addition to its role as a customer support facility the SMT Laboratory serves as a research entity funded largely by the Area Array Consortium. The latter was first founded by Universal Instruments' SMT Laboratory in 1991 as the Ultra-Fine Pitch Consortium and has supported the development of TAB, UFP QFP, BGA, CSP, WSP and Flip Chip Attach technologies. Aside from this the SMT Laboratory has also conducted development efforts in areas related to Pin-In-Paste and 0201 components. As a result, substantial support is available for our customers in all of the above areas.

Funded by the Area Array Consortium we have now also started building up a research effort on optoelectronics packaging. Our overall aim is here to help bring this technology to the level of high volume, automated manufacturing common in microelectronics packaging today. Aside from efforts on optical fiber handling, AuSn soldering, optical coupling and alignment, as well as some product specific developments, one major emphasis of our initial program is on the use of adhesives in optoelectronics packaging. This has some obvious potential advantages for automated manufacturing, but also a variety of concerns and limitations.

Problem

Among the many concerns unique to optoelectronics applications are numerous effects of adhesive deposition control and materials properties on optical alignment. One customer reported an unexpectedly rapid loss of alignment of a component on an optical bench in a specific commercial product during thermal excursions. Part of this problem varied with time and/or history and variations in degree of severity between parts in the same lot suggested process control problems as well.

Problem Solved

Supposedly, the product had been designed taking effects of the expansion and compliance of adhesive layers predicted by Finite Element Modeling into account. However, experiments showed constrained epoxy layers becoming increasingly anisotropic in gaps below 100µm where chains started orienting themselves preferentially in-plane. Reducing the layer thickness from 4 mil to 1 mil led to increases of a factor of 6 in the in-plane modulus and half an order of magnitude in the out-of-plane thermal expansion coefficient. The latter means that the thin layer would expand at least as much, while the former would enhance thermal mismatch induced warpage of the optical bench beyond that predicted by FEM. While such effects would account for differences between predicted and observed behavior it was, however, shown that some of the problems with the above product must be related to irrecoverable (plastic) relaxation effects. Not surprisingly, the plastic flow properties were also found to depend strongly on adhesive thickness. In general, the sensitivity of all the relevant properties to constraint is strongly materials dependent. All of this could be accounted for by basing product design and materials selection on properties measured for realistic configurations, as opposed to relying on supplier data sheets.

Even more importantly the present exercise also revealed the sensitivity of the optical alignment to adhesive location and volume. Pressing one of the components into an adhesive during active alignment the adhesive would wet up the sides forming fillets which varied with adhesive volume and location. Modeling showed asymmetric fillets on opposite sides tilting the optical axis of the component by up to a degree for a couple of degree centigrade of temperature change. This would explain a clear variability of the final products and demonstrates the need for improved control of the deposition of the nano-liter adhesive volumes involved. Luckily, an ongoing investigation of the fundamentals of one of the few approaches relevant for automated production in this regime, pin transfer, has already allowed for considerable optimization in terms of the combination of materials and process parameters. Expectations are that sufficient control to ensure high yields for the present product will be achievable soon.

Additional information on the laboratory and Consortium research efforts may be obtained at www.UIC.com.