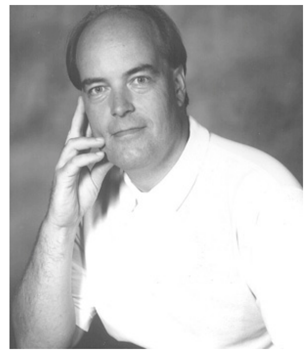
Practical Selection/Problems with SMT Adhesives

Bob Willis



Surface Mount Technology (SMT) first started with the introduction of mixed technology designs incorporating components mounted on the underside of the circuit board. This process is often called a "Type II" assembly incorporating conventional components, with SM components on the underside. "Type I" contains only SMT components, with a "Type III" containing conventional components and SM parts on both sides. These terms were coined by the IPC in the USA for many of their specifications.

The use of wave soldering technology, and with it components mounted on the underside, means the use of adhesives. Adhesive is used to hold the parts in place during placement, through the handling operations and finally through the soldering process. After soldering the adhesives are not required to provide any further function. In fact, if the material could completely disappear after wave soldering, this would be, in most cases, be an advantage.

The adhesives which have been used over the years have come in for a lot of criticism; poor dispensing, poor electrical characteristics, short storage and operating life. The materials have also been accused of causing considerable problems during the rework and repair of products. In most cases the criticism levelled has been partly the fault of process engineers not properly evaluating the materials and the suppliers for putting materials on the market without properly evaluating the formulations in real production environments. However, that has all changed and we now have stable materials for dispensing and stencil printing.

The choice of adhesives for effective manufacture is now a little more straightforward for engineering to assess. The choice of materials for mounting components is still quite wide if we consider the total range of adhesives available, but in most cases many of the available formulations can be discarded due to production requirements. Originally you could tell the make of the material by the color; red adhesives were produced by supplier "A" and yellow by supplier "B". Unfortunately that has changed as well so you need to investigate further what causes problems and who is the supplier.

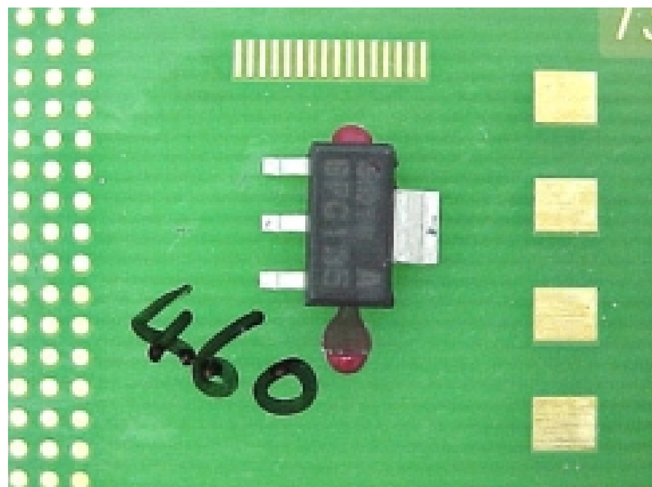
Lead-free can be an issue, the main reason being the control of the curing process. Often companies use their reflow process for curing but do not correctly reset the oven temperature. It may also be the case that they do not leave time for the oven to drop in temperature, this causes voiding.

The following are some of the adhesive characteristics which need to be evaluated by a process engineer:

Electrical properties
Dispensing
Adhesive strength
Slump/bleeding
Material compatibility
Cure time/temperature
Adhesive life
Outgassing

Today the use of one part systems is the norm due to the simplicity of supply and use in assembly. The one part adhesive systems come in epoxies, acrylates and cyanoacrylates but are not all used for SMT. When the material is selected process control on the assembly line is still a very important factor. The two methods for in process inspection are sheer strength and degree of spread, both can be evaluated using SPC (Statistical Process Control). It is of course necessary to first evaluate the material to establish control limits for production; if this is not done correctly SPC will not be beneficial. Control limits can easily be achieved with a simple process capability program. With the advancement of materials the ability of the production equipment has been called into question with many engineers moving away from the standard production line dispensers supplied to the more flexible higher accuracy systems supplied by the likes of Camelot and Asymtek Systems.

Many engineers evaluate adhesive strength without asking the first basic question, how strong does glue have to be for surface mount? Trials conducted by the author in the early 80's showed the actual force exerted on an SOIC16 during wave contact was less than 20 grams. So why do we lose components in the wave, on the floor, in the racking or trolley? Quit simply because they were never correctly bonded in the first place!!!



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Process monitored the degree of sheer force required to remove components after glue curing can be easily tested. Sheer strength measurement of scrap components mounted on the board edge prior to cure is a useful test. It can be used to determine correct cure cycle, limited glue dispense and contaminated components or circuit boards. The shear test may be conducted using components placed on the edge of the board or on the scrap area of a multi-panel. Adhesive is dispensed as part of the glue pattern with components placed in position specifically for this test. The board is put through the recommended curing operation and measurements are taken for shear force after the board has cooled to room temperature.

The test results obtained may be affected by the solder resist type, the copper preservative coatings on the PCB, the release compounds on the components, quantity of adhesive, component standoff height, adhesive quality and the speed and temperature of cure. As a basic guide the minimum shear strength that should be expected on an SOIC16 should be over 500 grams. Some suppliers do recommend torque testing which also works but shear was the first procedure used in the industry.

For in process inspection purposes it is also effective to provide a glue test pattern, the inspection staff can visually examine for stringing or the size of dot. Measurements may be taken of the diameter of the test dots with reference to limits which have already been defined using statistical techniques. The test pattern may also be used prior to adhesive cure for bond strength testing with scrap components.

An alternative method used by some manufacturers is an active test pattern which may be used as a visual test for accuracy or glue slump. The test pattern shown is used on glue stations with a two dot pattern. The pattern consists of three sets of dots each at right angles to the next, each with a different separation. In the test pattern one dot pattern is touching the next, in the second they are separated. In the case of variation in the process excessive glue would cause each dot pattern to merge, limited glue would show each dot pattern to be separated. The active test pattern has been successfully run on a number of pick and place systems and again provided simple, but effective quality control.

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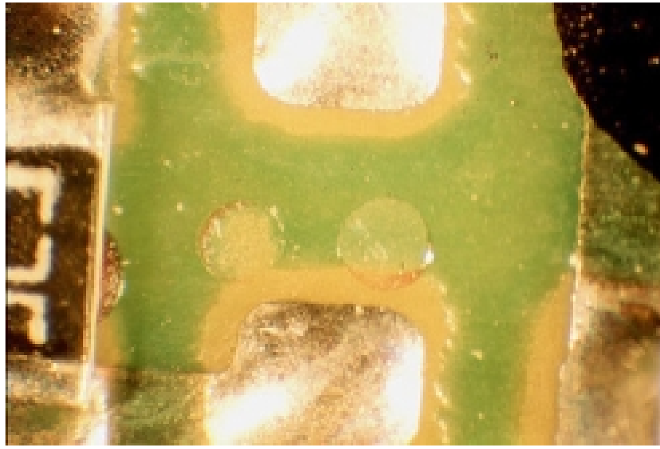
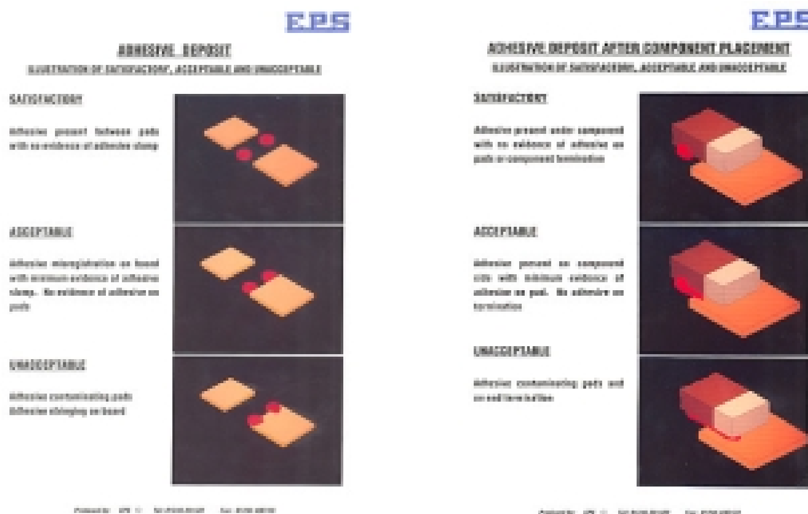


Example of component loss which is related to the adhesive's compatibility between the adhesive and the solder resist. Change in solder mask type from solvent to aqueous or degree of cure

Inspection standards are always necessary in production if test patterns are not appropriate. These must be based on the capability of the process and used as a reference for inspection as well as initial training programs. A reference sheet can be extremely useful when quality engineering are collecting SPC data, this guarantees that everyone is working to a common standard and the resulting statistical data is of some value. Examples of the inspection criteria is available on the author's website www.bobwillis.co.uk



Surface contamination or bleed is difficult to detect with some adhesive materials without surface analysis in a laboratory. The adhesive may affect soldering but not be readily visible on the surface of pads or component terminations. A simple method of evaluation is to dispense and cure dots of material under evaluation on to a small copper laminate sheet. The sheet of material may then be passed through a wave soldering process. The solder should fully wet the surface of the copper right up to the adhesive dot. There should be no evidence of copper visible as this would indicate adhesive contamination or bleed during curing.

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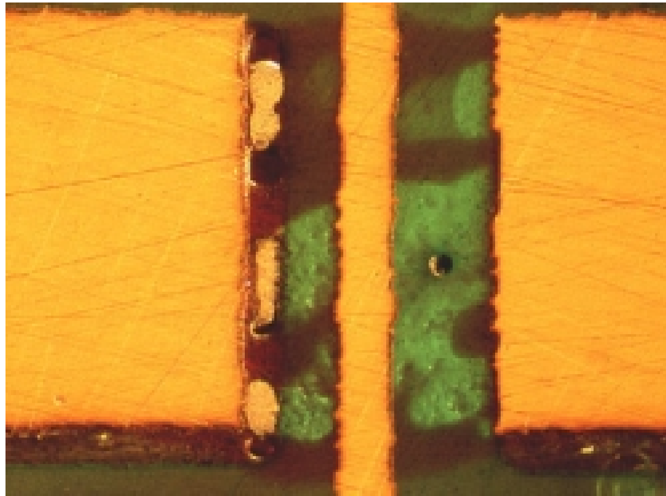
To investigate the degree of adhesive spread before and after component placement a thin glass microscope slide may be used. Dots of adhesive are dispensed onto the glass slide of a size appropriate for the components. The components are then placed and the glue cured as recommended by the supplier. After curing the underside the component can be examined for the degree of adhesive spread. This is a simple method to determine glue dot size and shows if the glue is likely to contact the component terminations.

The test samples also allow the curing to be assessed. If the adhesive is cured too fast voids may be present in the glue. The same can be said if the water content of the glue is high as it will result in void formation. This can be easily examined looking through the glass slide. Voids can lower the adhesive strength and may result in solder being trapped during wave soldering which will be a line stopper.



Microsection through the board under chip component. This shows the pads, adhesive and the solder shorting between the two pads and the track between pads.

Some people feel that the use of adhesive in mixed technology designs only cause problems like contamination of pad surfaces. This only occurs if the process is not in control. Adhesive can help to eliminate solder shorts during wave soldering and may be a real solution to difficult designs. During normal automatic dispense programs a dot may be placed between two terminations which always short and it only takes a few seconds to put into a glue program.

It makes a nice change to see glue solving rather than causing problems but remember that there are many good products in the industry so work with suppliers. When you have selected your adhesive, control the application process so its does not become a problem in your factory.

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Bob Willis is a process engineer working in the electronics industry, providing training, consultancy and process failure analysis on site for companies. Bob offers workshops on lead-free on site for customers, he has run lead-free production lines at exhibitions and also provides seminar and workshops worldwide. Bob will be running lead-free workshops for IPC & JEDEC in Germany and SMTA in US this year. For further information on lead-free training workshops, training materials and lead-free process support visit www.leadfreesoldering.com

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