Gluing Components

Where surface mount and traditional through-hole components are combined, it is necessary to use an adhesive to attach SM devices to the underside of the mixed technology board. Leaded components, having been inserted through holes in the board, are held in place mechanically while the board passes over a molten solder bath; unsecured SM devices under the board would just float off into the solder wave!

Adhesive placed between solder pads also secures the device to the board, and has the spin-off benefit that it will also provide a degree of strain relief for thermal mismatch between components and PCB.

Although solid preforms of adhesive are available, liquid glues are generally used. These can be applied to the board by screen/stencil printing, pin transfer, or syringe dispensing. After the device is placed, the wet adhesive must have sufficient wet, or 'green', strength to hold the device in position until cured. The cured adhesive must then have sufficient strength to hold the device to the board during the solder wave process.

Once the PCB has been soldered effectively, the hold-down function of the adhesive is complete as the soldered joints will be much stronger than the adhesive bond. However, the adhesive will still be present and so must not adversely affect the performance of the circuit in any way. In particular, the adhesive must maintain sufficient insulation properties to avoid electrical shorts, and it must not create long-term corrosion problems.

Correct selection and use of the adhesive can reduce assembly defects, particularly with the latest high-speed dispensing equipment. Recent developments have enabled a faster process and higher yields. However, this has only been possible by understanding and controlling the process surrounding the adhesive.

Practical glues

Glues are commonly applied by three methods:

- Screen printing: used in low to moderate volume production, but is only suitable for adhesives that do not dry rapidly on the screen and are thixotropic, to prevent slumping on the board after printing.
- Dispensing systems: effective at placement rates up to 20,000 – 40,000 components per hour, and is compatible with several types of adhesives. Different adhesive dot sizes can be easily applied by varying air pressure, pulse length, and needle diameter.
- Pin transfer is suitable for high volume production rates of up to 500,000 components per hour. An array of needles is dipped into an adhesive reservoir and then contacted with the board to place a large number of dots simultaneously.

An adhesive which is suitable for one of the above methods may not be suitable for the others. Ideally a chip-bonding adhesive should satisfy the following requirements:

- be simple and safe to store with a long shelf life
- flow easily onto the board
- give a consistent dot profile and size, without stringing or leaving tails if applied by dispenser or pin transfer
- not dry out rapidly if screen printed
- remain tacky on the board until the components have been placed
- cure quickly and easily without slumping
- resist the thermal shock (250–260°C) of the solder wave
- remain inert and non-corrosive to both the board and components before and after wave soldering, and have good electrical properties when cured
- be of an appropriate colour for visual and automated test and inspection

- allow components to be removed after desoldering
- remain safe and non-toxic throughout.

There are two main adhesive families in general use, epoxies and acrylics, although experiments have been carried out with both hot melt resin systems and hybrid urethanes.

Epoxies were the commonest of the first surface mount adhesives, developed from resin systems already in use in hybrid circuit assembly. Their positive and negative features are:

Positive:

- Excellent electrical and physical properties
- Outstanding adhesion to a wide range of substrates
- Excellent tolerance to wave soldering temperatures
- Soften sufficiently to allow components to be removed easily for repair
- Solvent free systems eliminate solvent bleed problems and ensure controlled rheological properties

Negative:

- Cure times can be too long for high volume production, although the temperature required is lower than for acrylics, and most can be cured at temperatures as low as 100°C
- Most single component epoxies are heat sensitive, and have to be stored under refrigerated conditions (5°C) to ensure maximum shelf life
- Two component epoxies are inconvenient to mix before use and once mixed may have a short pot life and

change their rheology over long production runs, possibly blocking application equipment.

Acrylic adhesives are however strong competitors:

- Adequate bond strengths with fair resistance to wave soldering temperatures
- Extremely stable single-component systems with 12-month shelf life at ambient temperature
- Can be quickly cured by heat and by UV radiation. A preliminary UV cure ensures very rapid fixturing of devices onto the board, and the bulk of the adhesive beneath the SMD is then cured by heat
- Are not always sufficiently thixotropic, and a preliminary UV cure is required to prevent ‘slumping’ or ‘flow out’ of the adhesive dot during curing
- Many acrylic adhesives are water-based and prone to premature drying, especially if screen printed
- Full UV curing systems require relatively hard radiation, and good shielding to protect personnel is essential.

Hybrid **urethane** adhesives are tough, non-corrosive and adaptable. They can be chemically engineered to be suitable for pin transfer, syringe dispensing or printing, and can be cured by heat or by relatively safe soft radiation. Highly thixotropic, these adhesives have excellent dot definition and the ability to give higher dots to improve contact on components with a greater stand-off height.

Contact-pressure adhesives, which are active long after application, could be applied to the board whenever convenient before component assembly, even by the PCB manufacturer.

Hot melt systems, in which an applicator heats and melts adhesive granules, are not yet established in the electronics industry, but have the potential to provide highly raised discrete dots with minimal slumping.

Work is being carried out on other **thermoplastic** adhesives, which are already being used successfully to attach substrates to packages, housings and main boards, even where there is a substantial CTE mismatch. Since there is no chemical reaction during or after bonding, these adhesives can be used in hermetically sealed units.

Thermoplastic performance is generally comparable to the thermosets, but the feature which sets them apart is that they soften on reheating, which allows easy rework. This feature is especially important with die-bonding on complex multi-chip modules (MCMs). Solvent-removable thermoplastics can also be used to bond bare die temporarily for test and burn-in, with the bond 'unglued' with a safe solvent which leaves no residue.

Glue dispensing

The ability to control dispensing determines whether or not a material is considered to be a satisfactory surface mount adhesive. The dot profile produced by a particular adhesive will be defined by its thixotropic recovery rate, viscosity at zero shear rate and surface tension. But it will also depend on non-adhesive parameters such as the wetting characteristic of the PCB surfaces.

Other factors that influence good dispensability and dot shape control are:

- dispense pressure
- pressure regulation
- time for which pressure is applied
- dwell time after dispense
- dispense needle size
- distance between needle and dispensing surface
- return height above the board between dots (Z height)
- adhesive viscosity
- adhesive temperature.

In practice, machine operation settings have to be established by process trials. Unfortunately, such settings are not universal for every adhesive grade because of different rheological characteristics. Simple substitution of one adhesive grade for another is not always possible without some tuning of the dispense machine settings.

Experience has shown that dispense nozzle cleanliness is perhaps the most common source of dispensing problems. Dot size inconsistency can often be traced back to partial clogging of the nozzle. Adhesive build-up can occur inside the nozzle and restrict flow. Partial curing of adhesives in the nozzle may occur if it is left for long periods in a warm environment. Changes to different adhesive grades can cause cross-contamination and nozzle blockage. For these reasons, it is essential to clean nozzles regularly and thoroughly.

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