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Solder Paste Overview

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SOLDER PASTE APPLICATIONS
POSSIBLE CAUSES AND PROCESSING CONSIDERATIONS

I. Placing solder paste material unto stencil or screen should exhibit good fluidity and some gripping (wetting) of stencil surface.

Stiffness of Material

- ➢ The paste material needs to be gently mixed to achieve some change in rest viscosity to be ready for screening. Experienced operators are typically good judges of this operation. Material just may require more stirring.
- ➢ This is equally true of paste in cartridges too. Air pressures and transverse speeds of the printer must be optimized to provide the proper change from rest viscosity.
- ➢ Some material movement back and forth with a spatula while on the stencil can help reduce paste stiffness.
- ➢ Solder paste may be cold. We recommend refrigerated storage between 35 - 50 °F (20 – 10 °C). However, the paste needs to be at room temperature so that printing can be accomplished. Plan ahead so that material reaches operating temperature.
- ➢ Used solder paste (from previous day or prior time) may be over the hill. It is natural to try to save solder paste. Some users because of their high usage can remove paste from the stencil and store it well sealed and see limited viscosity change. If this is the situation, one must recognize when the useful life has been exhausted.
- ➢ Surface of paste in jar dried. All solder pastes are shipped with an inner seal, which is push down to the surface of the material. This inner seal must be kept in surface contract when put away for storage

Moisture absorption

- ➢ We recommend refrigerated storage between 35° and 50 °F. However, if paste is exposed to air at any temperature below that of operating, moisture (water) can affix to the surface. This gets folded in to the paste when stirring it. The most positive way to avoid this is to open paste at operating temperature only.

Thinness of Material (too fluid)

- ➢ The paste material needs to be gently mixed to achieve some change in rest viscosity to be ready for screening. Experienced operators are typically good judges of this operation. All solder paste shear thins (viscosity becomes lower). If too much energy is imparted during the mixing, if air gets entrapped, if moisture gets folded in, viscosity can get adversely affected.
- ➢ The use of vibration or orbit motion devices to somehow mix or soften the paste (hasten refrigerator to RT) are not to be used in conjunction with our solder paste. There may be more change in viscosity than desired.

Not wetting stencil (material sliding on stencil)

- ➢ Various films can exist on stencils. A new stencil maybe coated with a protectorant. Some stencil cleaning units may leave an undesirable film over the surface. Even storage conditions may be such that stencil develop an unacceptable film. If this is suspected a good rule of thumb is to clean thoroughly the stencil with IPA and a lint free wipe.

II. The solder paste's rolling action in front of the squeegee is key to filling the stencil cavities and the continuance of uniform printing behaviors.

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Lack of rolling action

- If this occurs with initial paste introduction to the stencil. Please check with conditions listed under stiffness of material.
- Also with initial paste introduction stencil cleanliness should be considered.

Lack of rolling action (cont.)

- The squeegee travel speed may be too rapid to allow for paste to adhere to stencil (paste slides on stencil). Slower squeegee speeds should be evaluated.
- The volume of paste may be inadequate as well as uniformly distributed in front of squeegee.
- The downward force vector of the squeegee is too low and needs to be increased.
- The attack angle of the squeegee does not establish enough of a downward force vector on the material.

Rolling action is too much

- The volume of paste is more than desired. The larger material movements have been suspected for increased shear thinning of paste. Slow squeegee speeds should be look into.
- The downward force vector of the squeegee maybe too great and should be reduced.

III. Paste transfer to board now becomes a combination of stencil, paste, printer set-up, and the environment.

Stencils

- The design of stencils have been advancing today for fine pitch and high lead count devices, many choices exist.
- Here are some considerations for stencils:
- The aperture size, The length (L), width (W) and foil thickness (T) selected for the ideal material volume needed to be transferred.
- The true configuration of the aperture cavity as generated and the smoothness(frictional influence) and taper of the aperture wall
- Aspect ratio = width/ length & Area ratio = length X width /2 X thickness X (length + width)
- These two ratios determine whether the paste will form on the board as intended or partially stick to the aperture walls. The use of these ratio and published information relates part pitch consideration to a maximum recommended stencil thickness.
- The positional accuracy of the stencil pattern to that of the board.
- The physical strength (tensile value) of the stencil material to facilitate lift off from board after printer cycle.

Too much material transferred

- Aperture size design selection incorrect or stencil fabrication poor.
- The stencil life is being used up and the stencil has stretched.

Insufficient paste transferred

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- A clogged or closed up aperture.
- Designed wrong or fabricated incorrectly.
- The Area Ratio for selection of Thickness was overlooked, Stencil thickness may be too large.
- Stencil materials and their method of fabrication also has influence over results. The choices that exist are chemical etching, laser-cut processing, and electro form. Likewise, we have an as produced sidewall surface, or it can be electropolished to enhance side wall smoothness.

Solder Paste

- This is typically a fixed commodity. The choice of a flux family generally is fixed by the end user of the assembly, but if this is not the case then it falls into the choice of what best fits the existing equipment. Four different mesh ranges of particle sizes exist. The most compromising is -325 +500, because it accommodates the one fine pitch part that typically is found on an assembly.

Screen Printers

- There exists a whole array of machines on the market from the simple to very sophisticated. Although positioning ability is important to the user, its role with solder paste is small. Mechanical integrity is of extreme importance. If a parameter is set, it must be held. The more the printer reduces the amount of operator interfacing. The more likely the results will be consistent and repeatable. As the degree of sophistication increases, the more predictable the outcome will be.

Room Environment

- In general, this area is easily over looked, because changes can be very gradual. Comfortable room conditions of 40 - 50% relative humidity and 70 - 75°F seem reasonable. But common sense must prevail, if a screen printer is trapped between reflow units and has been running all day, temperature and air moisture may have influence on the solder paste or solder paste processing.

IV. With careful observation of the as screened product or even the reflowed product, we can related possible causes and what attributes to look into at the printing operation. Since screen printing is the first step in a series of operation to have successful performance, overall proper control of printing is crucial.

Uniformity of print volume across whole board An examination of equal pad geometries (for identical components, and consistent to squeegee travel direction) should have characteristically the same volume of paste being deposited.

- The supporting surface plane for printed circuit board (substrate) does not agree with the plane of stencil or squeegee or vice versa.
- The printed circuit board varies too much in thickness or has some characteristic on the resting side, which changes the plane of PCB to printer system.
- The method of holding down the printed circuit board varies or changes as squeegee transverses the board surface.
- The top side of printed circuit board has a characteristic that lifts stencil up from the plane of PCB to the printer system.

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- The squeegees effective pressure changes over the length of travel due to system parallelism.
- Artwork of geometries was not consistent, fabrication of stencil was poor, or appertures are not completely opened. (may occur also from being damaged or dirty).
- The squeegee pressure did not form gasket tight seal between PCB and the stencil.

An important visual aid, is that the squeegee wiped surface at end of stroke should be visually equal over the entire printed circuit board area.

- The solder paste in contact with the squeegee should extend about 1/2 inch beyond pattern.
- The travel of the squeegee needs to be safely beyond the print transfer pattern. The smaller one can control this to be, the less shear thinning will be imparted to the solder paste. (3/4 inch seems practical)

Alignment of the stencil to printed circuit board

- Misalignment can lead to solder balls on the final reflowed product. If solder spheres touch various board coatings, they may attach themselves during reflow to the point they cannot be washed off. Typically solder spheres coalease to each other during reflow, this is aided by the thermal influence of the intended pad geometry. However, if the solder paste is not close enough to the pad, some spheres become ophraned under parts or held by flux.
- Misalignment of solder paste and/or misalignment of components to intended pads has influence on generating the tomb stone defects (also called draw bridge, Manhattan, Stone Henge effect)

Volume of solder Paste

- One must learn the volume of solder paste to be used with their particular situations. Size of board (area); The paste volume transferred to board. Type of squeegee; Width of squeegee; run rate of the assembly line. It takes approximately 350 grams of solder paste for a typical 8 x 10" PCB.
- A starting volume approaching a rolling bead ahead of the squeegee of 3/4 inch should be good, because the paste will start sticking to the squeegee holders, the squeegee itself and other surfaces (dissipates).
- A running bead of 3/8 inch is most desirable and should be controlled to that volume by solder paste additions matching the line consumption.
- The larger beads are suspected for a shear thinning influence (viscosity lowering). Also greater amount of paste is available to evaporate solvents or to absorb moisture by folding in air under high humidity conditions.
- The smaller beads set up situations of not adequately filling stencil apertures causing print voids
- The size of the bead is directly responsible for solder paste now direction at stencil level. Ideally, the most vertical flow (normal to surface) fills aperture with no residue directional influence (zero stresses).

Role of the squeegee system

- We shall confine our comments to the double squeegee system single stroke dual directional printing.
- Hand stenciling is an art. Hand stenciling is known to generate higher than desire shear stress on the solder pastes, which leads to viscosity deterioration.

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- Rubber and plastic squeegee of high durometer values (90-110) are used successfully. This compliant squeegee material allows for PCB thickness variations to be better accommodated. The vivid edge under downward forces to achieve intimate contact to the PCB causes wear which must be always watched.
- On a microscopic basis, when downward pressures are significant, the squeegee edge can protrude into the aperture cavity and scoop out solder paste (generating a thinner print than planned). This phenomenon is also recalled scavenging.
- The sharpness of the edge of these compliant materials starts out sharp and vivid. As this edge rounds out (wears away), the solder paste surface in the fill cavity get dragged in the direction of the squeegee travel.
- Metal squeegees have become prominent because of their stiffness factor and the thinnest (a finite size to the shearing edge).
- The stiffness factor eliminates the scooping or scavenging of solder pastes from even the largest of pads. This also lends itself to more uniform deposition of fine pitch patterns.
- On the same token, any dent (high spot) on the stencil could possible raise the squeegee momentary generating a print abnormally.

V. Part placement operation needs to be watch as it has influence over some defects.

Influence of placement accuracy

- Component alignment to the center lines of pads involved relates to unsolders as well as shorts.
- Small skew angles between parts, and deposited solder pads also affects the visual shapes and quality.

Influence of unequal forces placement

- Ideally, we wish that each end of the component has been pushed downward the same amount into the solder paste pad volume.
- The rapid fire operations of some high speed placement units not even engage the paste volume sufficiently (never pushed into the paste, just laid on top). This may be more true of hand placement.
- Push and slide of components into the solder paste pads has negative outcomes too.

VI. Having a defect free thermal profile, requires much work and considerations for paste requirements, amount of mass (or component density), thermal absorbing rates of components, and the method of heating.

Paste considerations

- The initial warming, preheat or initial temperature rising rate need to be controlled. We wish for a controlled exhausting of volatiles without out particle explusion or general flowout of solder paste volume. We wish it to dry in place and shrink together.
- The plateau or soak zone must be to the prescribe time and temperature so that the selected activators carry out their function properly.

Component considerations

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- The ramping up and cooling down rates must not exceed structural strength of the components.
- Heavier mass components normally define the thermal profile. Very light mass components may require thermal shielding.

Assembly considerations

- The component density should be spread uniformly across the whole assembly.
- Tall (big) parts shadow (block) thermal energy to smaller parts. Situation like this should be avoided where and when possible.
- The mass of the assembly, the distribution of assemblies, and the number of assemblies thru the reflow unit all define the necessary thermal profile needed.