TITLE: THE EFFECT OF SOLDER PASTE VOLUME ON SURFACE MOUNT ASSEMBLY SELF-ALIGNMENT

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ABSTRACT

In the surface mount assembly, the inconsistency in solder paste volume and the placement of the component play a vital role in the movement of the chip components when they go through the reflow soldering process. These movements may lead to common assembly defects such as overhanging, tilting, nonwetting, and tombstoning. Components to be assembled in surface mount assembly have self-alignment nature. It is driven by the total internal energy including gravitational energy, surface tension energy, etc. in the molten solder attributed to various factors. The factors include 1) solder paste composition, surface energy, gravity; 2) process variations such as solder paste volume, solder paste location, the difference of solder paste volume on the two ends of the component, and components placement location and orientation; 3) design parameters such as pad dimensions, pad-to-pad spacing, and surface finish.

In this research, energy-based three-dimensional models were created to predict solder joint final shapes. Three types of passive chip components are chosen for the modelling examples to investigate the component self-alignment performance during the reflow soldering process. By nature, the molten solder being a bulk fluid always tends to minimize its internal energy towards mechanical equilibrium and causes the component to move to the state of minimal energy. This movement leads the component to self-align. Thus, by creating energy minimization models, we can simulate the process of component self-alignment and predict the solder joint final shape (profile), terminal location and orientation of the component.

An extensive number of experimental studies were performed to develop a data-driven prediction model. The passive components were placed with intended misplacements and their positions was measured before and after soldering. A wide range of surface mount assembly imperfections were considered and intentionally designed for our study to achieve a powerful dataset and better convergence. The predicted component movement from the experimental study was then compared with the simulated component movement for validation.