Adhesive Backed Plastic Stencils vs Mini Metal Stencils

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Ever since there has been a widespread usage of surface mount parts, the trend of continued shrinkage of devices with ever finer pitches has continued to challenge PCB assemblers for the rework of same. Todays' pitches are commonly 0.5 to 0.4mm with packages of tiny outline sizes, 5 -10mm square, making the rework of such devices a challenge. In addition to the handling and inspection challenges comes the board density. Spacing to neighboring components continues to be compressed so the rework techniques should not damage neighboring components.

The objective of any rework process is to duplicate as closely as possible the original manufacturing process while not disturbing neighboring components while still meeting the original specifications and assembly criteria of the PCB . For the rework of a given BGA/area array device this is typically accomplished by using a miniature version of the original printing SMT stencil albeit for the site location only. That being the process that will be characterized in this study, there are two basic types of stencils which can be used to print solder paste onto the PCB. In one case the miniature rework stencil is a shrunken version of the SMT stencil being made from stainless steel with the same thickness of the original stencil as well as the same aperture configuration. In the other configuration the rework stencil is made from a flexible plastic film and is adhesive-backed.

The miniature metal stencil, while matching the original SMT printing stencil, has several shortcomings with respect to the rework printing process. This technique, while perfectly capable for most SMT boards, has fallen out as preferred and capable method for several reasons. With the tighter spacing between components these "mini" metal stencils are too large for modern board layouts as there needs to be an oversized area compared to the print area for the holding and supporting of the stencil. In addition, the finer pitches and pad sizes makes it difficult , even for the most skilled rework technicians, to perfectly print in a single pass the correct volume of solder paste onto the PCB. With ever-thining stencils due to lower paste volume requirements these metal stencils are easily bent or damaged during cleaning or squeeging meaning that it is difficult to retain a co-planarity with the PCB. The lack of co-planarity causes solder paste to squirt out from underneath the stencil. These problems make the miniature metal stencils less suitable today for the deposition of solder paste during rework.

The plastic film stencils (Figure 1) have taken over where the mini metal stencils have left off. They offer up some distinct advantages based on the user complaints over their mini metal stencil counterparts. Their repositionable adhesive backing allows the user to move the stencil around creating micro fine alignments on the PCB after the macro adjustments. In addition, the adhesive helps insure co-planarity with the PCB even if the board is slightly warped. The sticky backing also allows the user to use multiple swipes with the squeegee in order to insure the apertures are "filled up" completely. The flexible nature of the stencil allows for the stencil to be used in very tight areas which need to be printed prior to rework. These stencil designs even allow for “flaps” to be built in to the stencil design and prevent solder paste from being pushed outside of the rework area requiring further clean-up. For these and other ereasons the adhesive-backed plastic film stencil is now the preferred rework stencil.

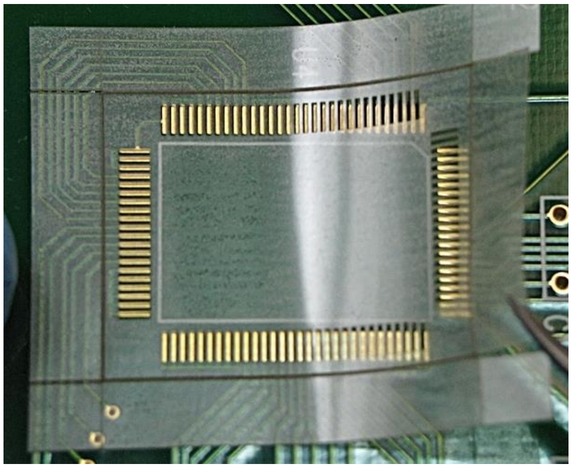

Figure 1- Adhesive-backed mylar stencil used for rework

The purpose of this study is compare and contrast the printing behavior of these two stencil types by analyzing the results of the print transfer efficiency and solder paste deposition.

Method

In order to determine the effectiveness of the two stencil types and determine the consistency of each type several selective site printing trials were performed and the subsequent solder paste height volume and transfer efficiency was calculated. There were 25 printing trial sets completed for both the metal and plastic film stencils. The board that was site selectively solder paste printed was unpopulated

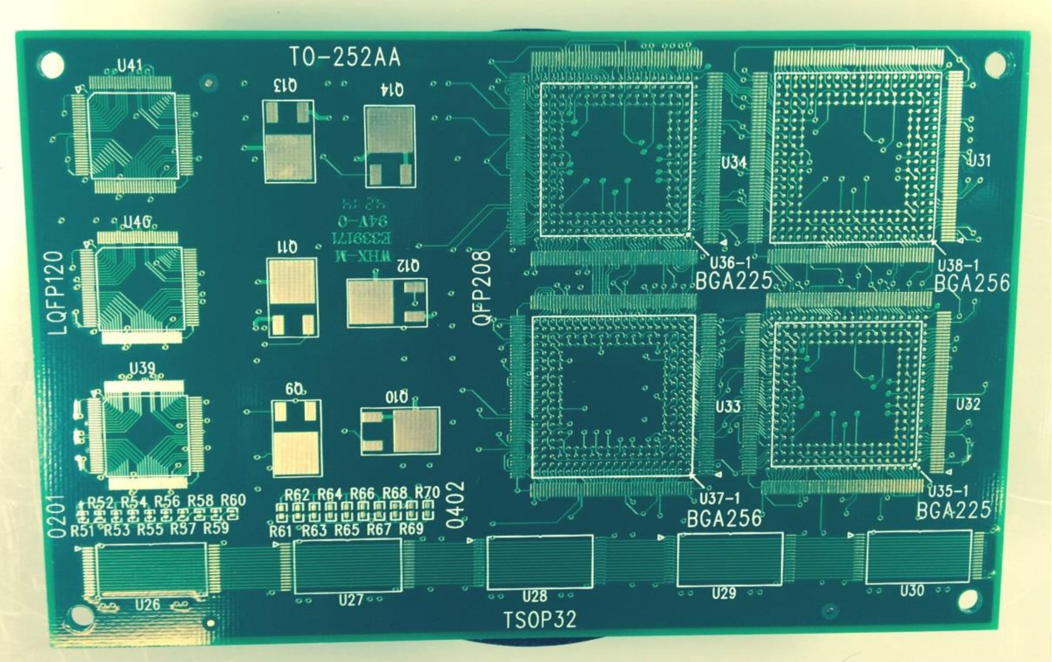

Figure 2- Printed circuit board used for printing study

with a nickle gold finish (Figure 2). Site location U32 was chosen as the rework site location and is a 256 IO , 1.27mm pitch 37x37mm perimeter array patterned device. Each of the IO pads is 0.27mm x 0.27mm. The miniature metal rework stencil (Figure 3) used was a 5mil thick stencil. The second group of printing was completed using a 5 mil thick mylar stencil (Figure 4) with repositionable adhesive backing.

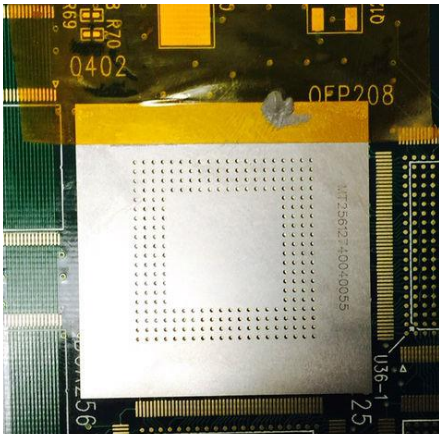

Figure 3- Mini metal used for rework

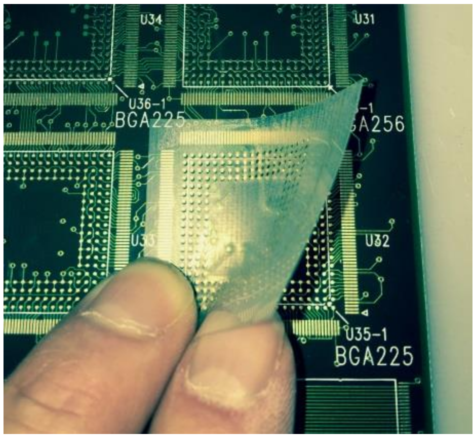

Figure 4- Adhesive-backed mylar rework stencil

Board holders were used to “entrap” the PCB set up for printing so was to make sure the set up was consistent. First the board was placed in to the board holders. For the miniature metal prints the “foil only" metal stencil was placed onto the PCB and taped at the top edge of the stencil so as to be able to lift up the metal stencil after printing. Solder paste in the form of a lead free SAC 305 Type 4 Alpha Type OM-338 no-clean solder paste was used for printing. After printing and measuring the site location and squeegee were cleaned with isopropyl alcohol. In the case of the plastic mylar film stencil it was a 5 mil thick stencil (film plus adhesive) which was peeled of the release liner and then placed over the apertures and slowly moved around for the final micro adjustments aligning the stencil over the pads. After printing (Figure 5) the stencil is carefully removed and discarded.

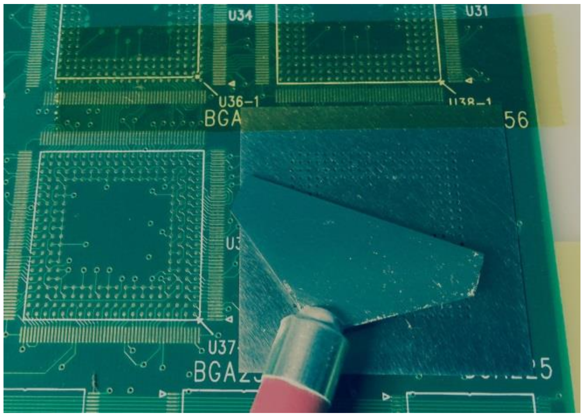

Figure 5- Mini Squeegee used to roll solder paste through rework stencils

After each printing cycle an SPI measuring system measured the solder paste volume and solder paste "brick" height at each of the pad locations. After initial calibration the ASC AV862 (Figure 6) offline semi-automated measuring system from ASC. This system used GERBER data as input information in order to find the location of each of the solder pads. After this set up the camera scans each of the locations that it recognizes as having solder paste and measures the height and volume amongst seven parameters per pad location. These results were then tabulated and graphed.

Figure 6- ASC AV862 Offline SPI Inspection System

Results

Figures 7 and 8 are the box and whisker plots of the solder paste height for both the plastic adhesive-backed film and miniature micro stencils respectively. The data clearly shows that dispersion of solder paste heights is greater using the miniature metal stencil printing process versus the plastic film stencils. This is further illuminated in Figures 9 an 10 which are the respective X XbarS charts for the miniature metal and plastic film adhesive backed stencils respectively. The upper control band of the mini metal stencil printing trials is 1.0mils while it is only 0.4mils for the plastic stencil.

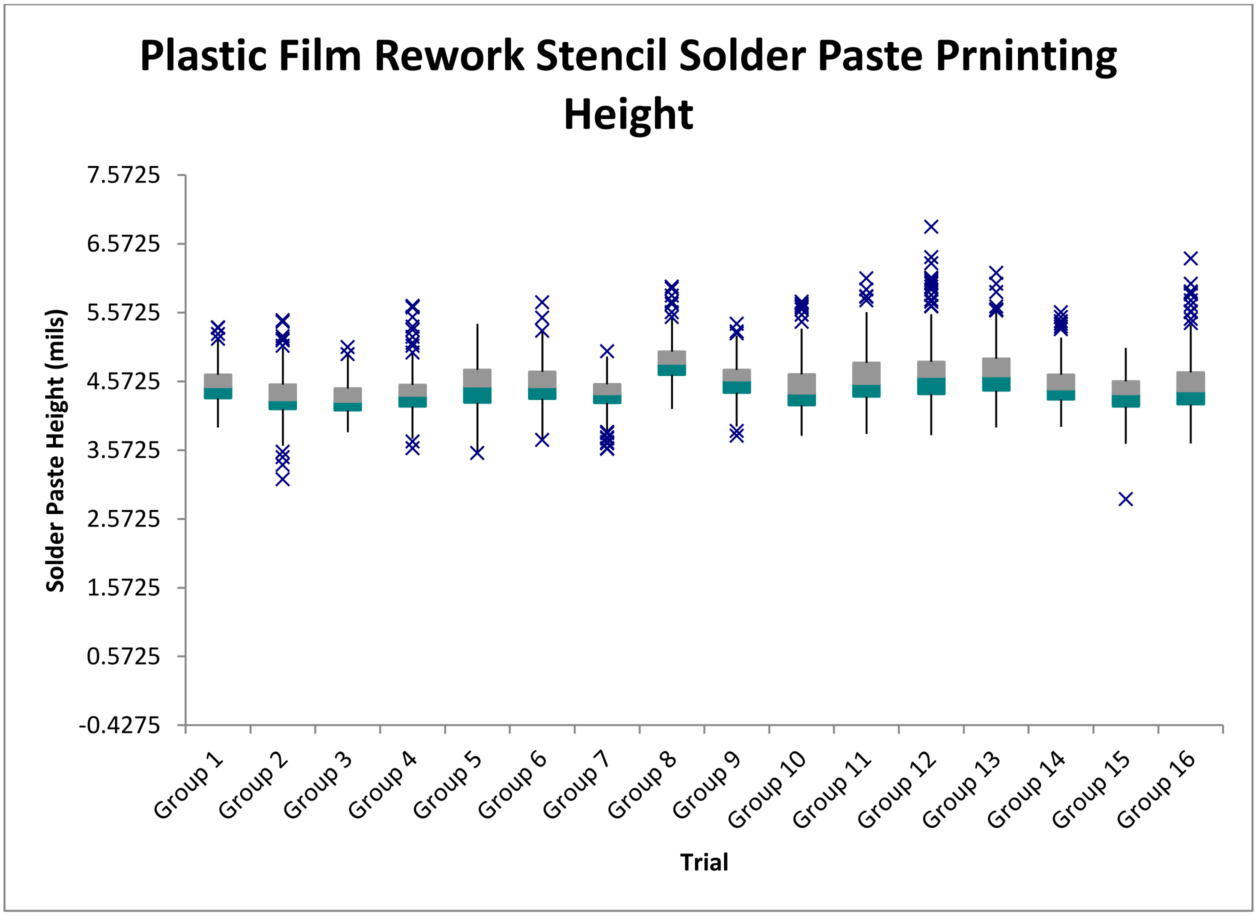

Figure 7- Box and whisker plot for plastic film adhesive-backed rework stencil for solder paste height trials

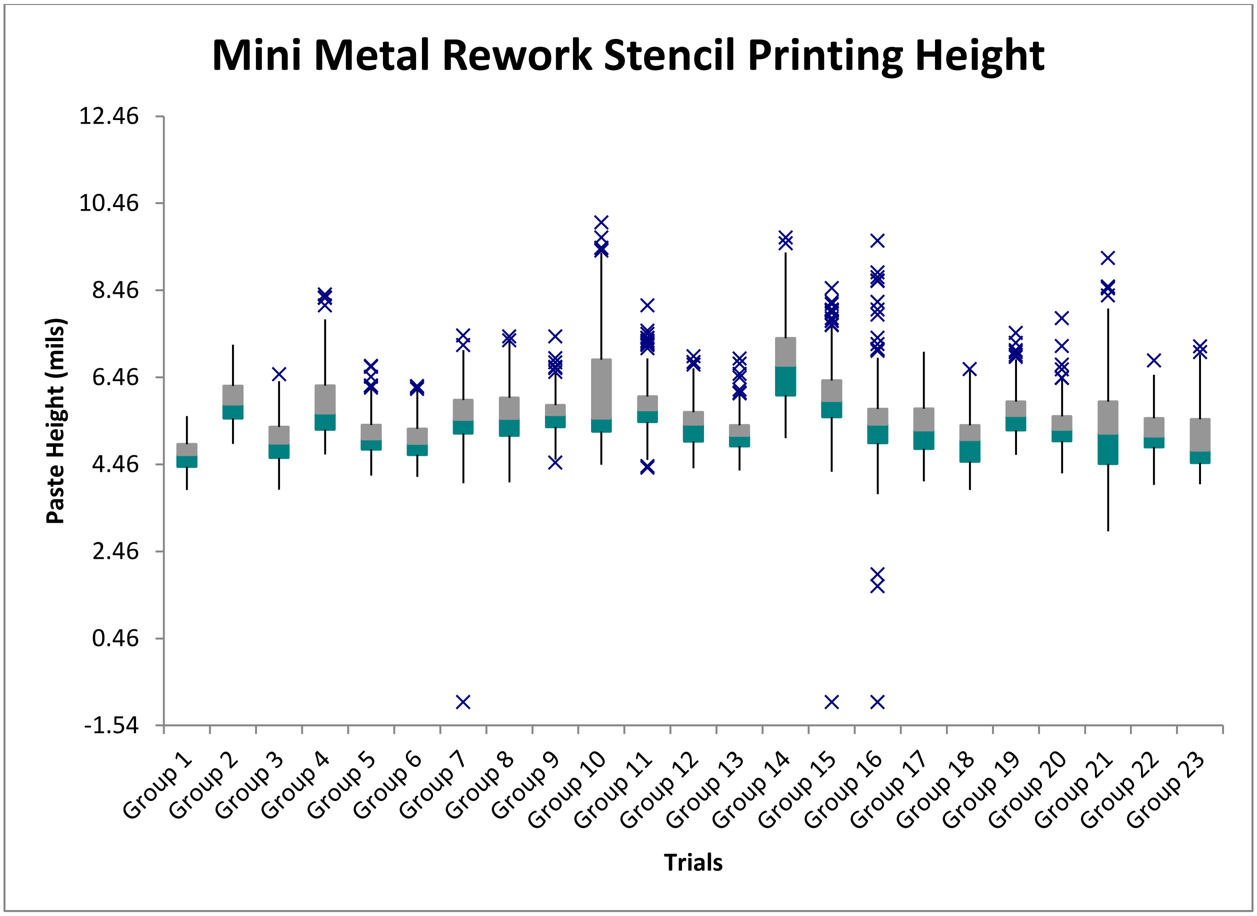

Figure 8- Box and whisker plot for mini metal rework stencil for solder paste height trials

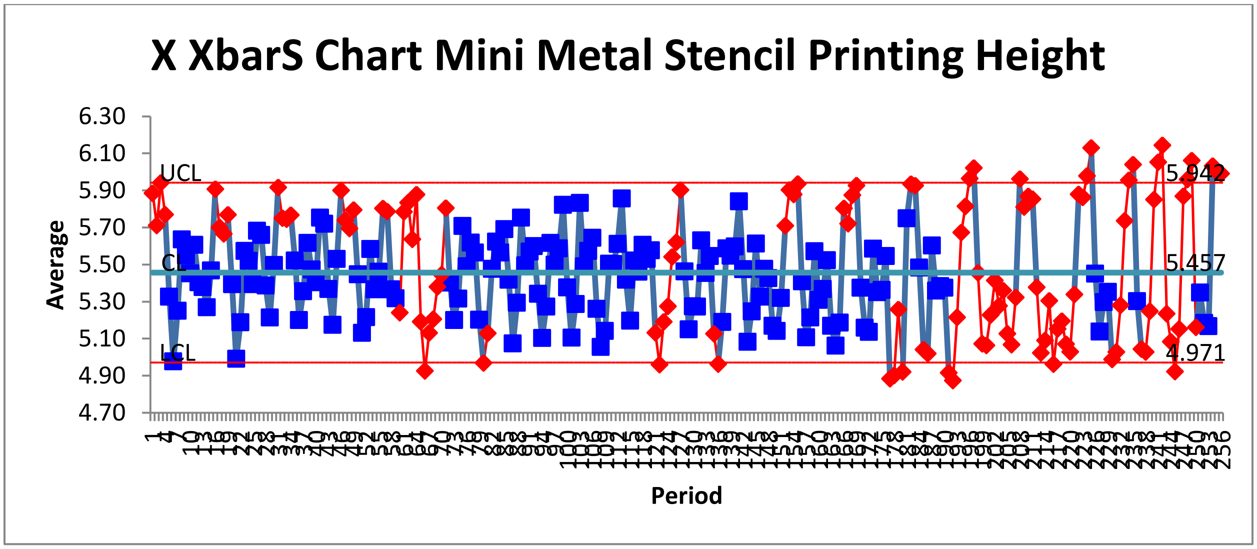

Figure 9 X Xbars chart for mini metal stencil printing height

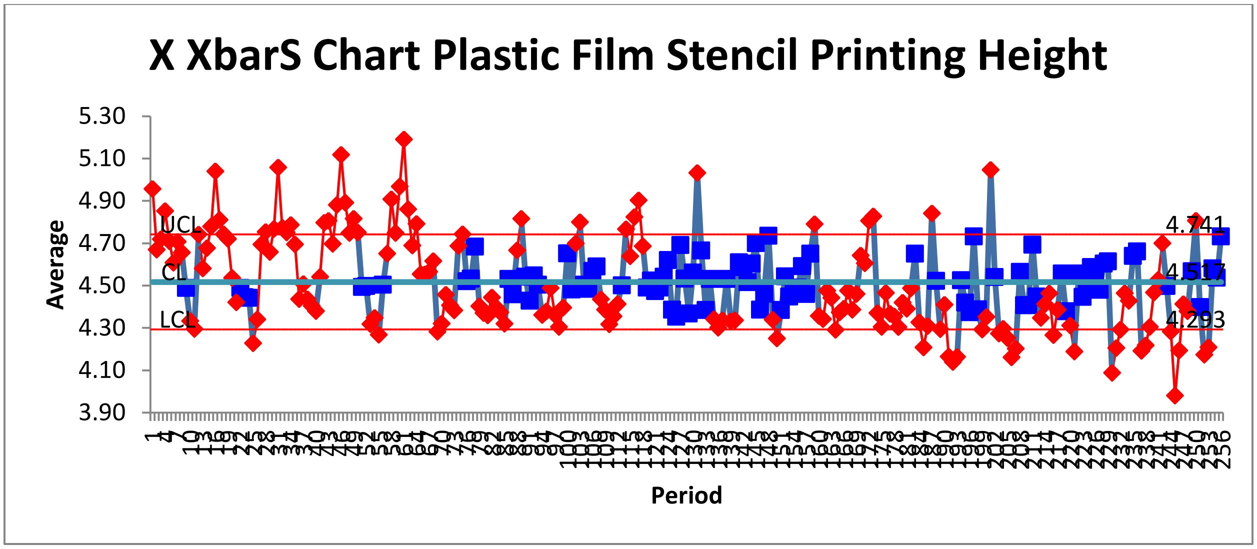

Figure 10- X Xbars chart for plastic film adhesive-backed stencil printing height

The mean values of the measured solder paste volume were nearly the same with the plastic film adhesive-backed stencil at 2090.94 mils^3 and the metal rework stencil at 2,083.96 mils^3. However the dispersion in the data as pointed out in the standard deviation for the populations (Metal rework stencil had a standard deviation of 650.06 mils^3 and the plastic film stencil of 211.54 mils^3) and the box whisker plots as depicted in Figures 11 and 12 visually reaffirm this picture. These values can be compared against the theoretical volume of 2,148.23 mils^3 for the apertures making the transfer efficiency of over 97% on average for both stencil groups.

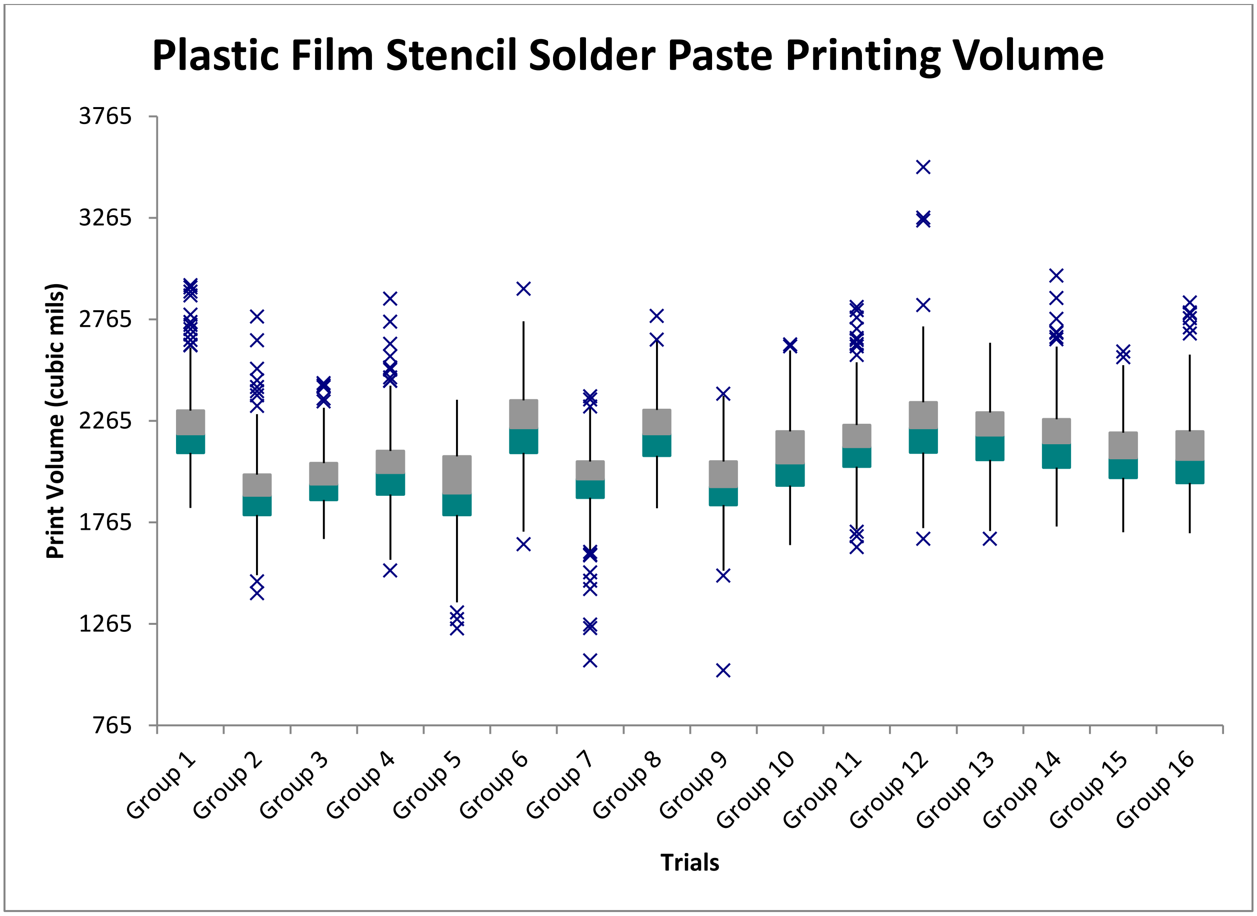

Figure 11- Box and whisker plot for plastic film adhesive-backed rework stencil for solder paste height trials

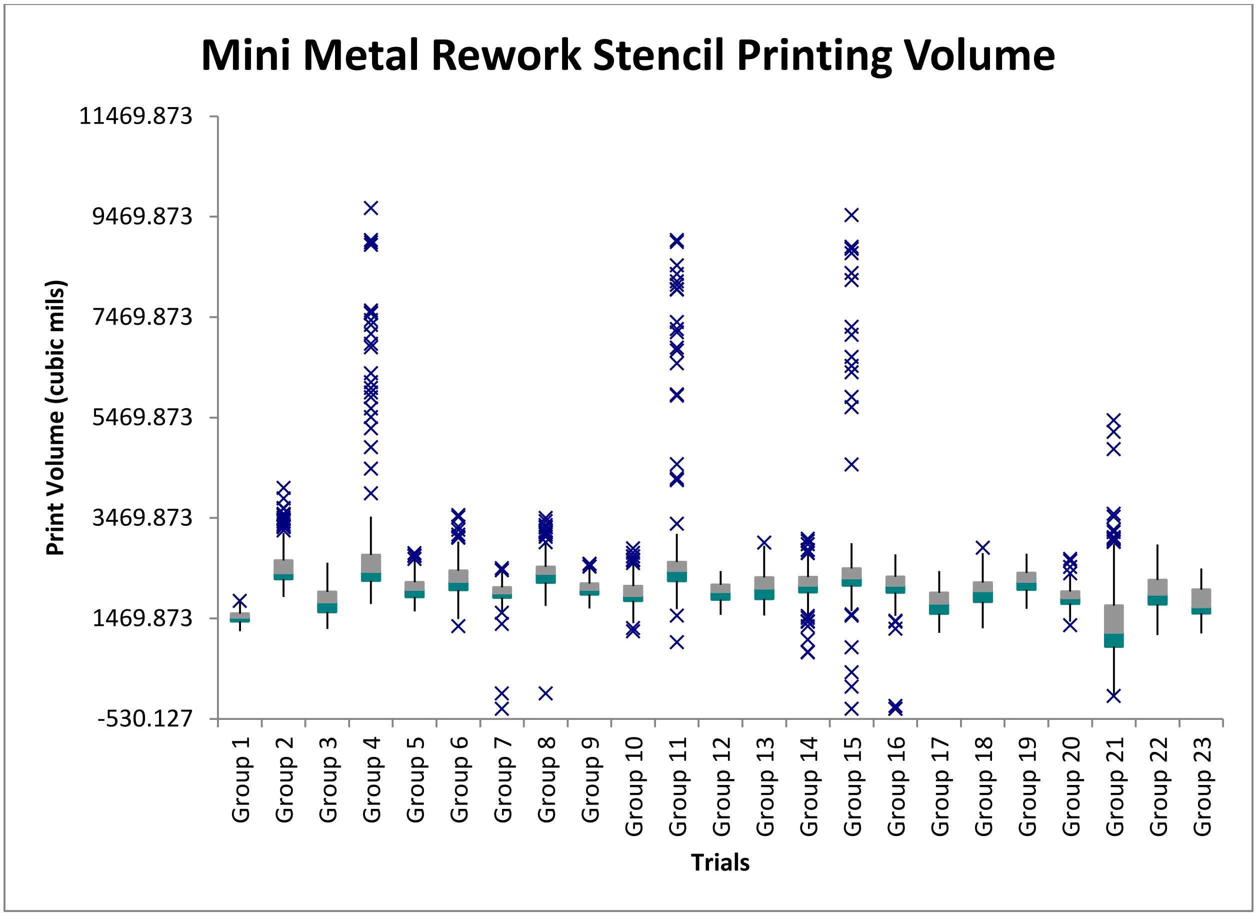

Figure 12- Box and whisker plot for mini metal rework stencil for solder paste height trials

Conclusion

The print height using the plastic film adhesive-backed stencil is more consistent and repeatable compared with the more "traditional" miniature metal rework stencil. This can be linked to the process of printing using the adhesive backing of the plastic film stencil as it keeps the solder paste from squirting out from underneath the stencil while also preventing it from shifting around during the print cycle. The adhesive version of the stencil also allows for multiple print passes to make sure that the apertures are filled up. Subsequent prints of the mini metal stencil allows for the build up solder paste on the aperture walls and hence smaller volumes of paste being deposited on the board. The one difference is the average height which was calculated to be 5.31 mils for the metal stencil and 4.62 mils for the plastic film stencil. This average height difference is likely linked to the "scooping" effect of the squeegee blades as pressure is applied during paste printing of the soft flexible film. The print volume averages were nearly identical for both of the populations but the consistency of the solder paste print volume was much better with the plastic film adhesive-backed stencil. The above reasons given for a greater consistency in the height of the prints as well as the film stencil being a single use version without the "plugging" of the metal stencil apertures with each subsequent print can be given as a reason for this print consistency. Any holding of the solder paste in the adhesive of the film stencil was marginal and hence the remnant release phenomenon of solder paste was minimal.

Acknowledgements:

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References:

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