VIDEO ANALYSIS OF SOLDER PASTE RELEASE FROM STENCILS

Chrys Shea
Shea Engineering Services
Burlington, NJ USA

Mike Bixenman, D.B.A. and Wayne Raney
Kyzen Corporation
Nashville, TN

Ray Whittier
Vicor Corporation – VI Chip Division
Andover, MA USA

ABSTRACT

Solder paste release from the stencil is a critical factor in print quality, and ultimately, overall electronic product quality and reliability. To better understand release mechanics, an experiment was devised using a video microscope to capture the separation of the stencil from the PCB. The experiment incorporates different aperture area ratios, solder pastes, stencil nanocoatings and underwipe solvents to visualize their effects on paste release.

This study builds on previous research that developed the test setup and recording methods, and incorporates some modifications to the original experimental configuration to improve image quality. The outputs of the experiments are videos that demonstrate the effects of solder paste formulation, solvent under wiping and nanocoating on paste release at different area ratios. The paper will discuss the observations from the videos, and the presentation will play the videos.

Key words: stencil printing, solder paste printing, stencil under wiping, solvent under wiping, nanocoating, solder paste release video

INTRODUCTION

Many factors influence solder paste release from the stencil. They include, but are not limited to, stencil aperture area ratio, solder paste formulation, solder powder particle size, stencil cleanliness and flux-repelling nanocoatings. Other factors include print parameters, separation speed, PCB design, tooling setup and environmental factors. This study focuses on the first listing of factors, but not the second.

Much work has been performed to characterize solder paste release using automated solder paste inspection (SPI) that generates numerical data regarding deposit volumes, areas or heights to help indicate the end results of the print process. However, visual information on the mechanics of paste release is limited. The purpose of this study is to produce visual data to gain a better understanding of the factors in solder paste release mechanics.

BACKGROUND

Arguably, the most influential factor in solder paste release is the aperture area ratio. The area ratio (AR) is calculated as the area of the contact side opening divided the area of the aperture walls. Because solder paste is tacky in nature, it sticks to both the PCB pad and stencil wall during the separation process. The adhesive forces between the solder paste and pad must overcome the adhesive forces between the solder paste and aperture wall. The adhesive forces are proportional to their respective contact areas and therefore, the ratio of the areas indicates the amount of solder paste that will be released from the apertures, also known as transfer efficiency (TE). More simply stated, the lower the AR, the lower the TE; the higher the AR, the higher the TE.

Area Ratio, AR

$$AR = \frac{\text{Area of circuit side opening}}{\text{Area of aperture walls}}$$

Transfer Efficiency, TE

$$\%\ TE = \left(\frac{\text{Volume of paste deposited}}{\text{Volume of stencil aperture}}\right) \times 100$$

Figures 1a&b. Formulas for Area Ratio and Transfer Efficiency.

As electronics become more miniaturized, their interconnections become smaller, driving ARs lower. The lower ARs present substantial challenges to high-yield solder paste printing.

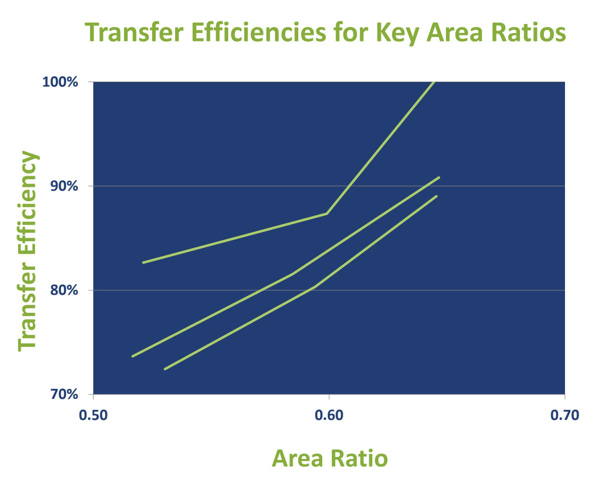


Figure 2. Example of AR-TE comparison chart. 80% TE is a commonly used benchmark for acceptable paste release.

Aperture wall quality further exacerbates low AR print challenges. Smooth walls are most desirable, however, they are not easy to achieve. The most dimensionally accurate stencils are produced by laser cutters, and both the stencil material and cutting parameters heavily influence wall quality. Figure 3 illustrates a poor Laser Cut versus a good Laser Cut.

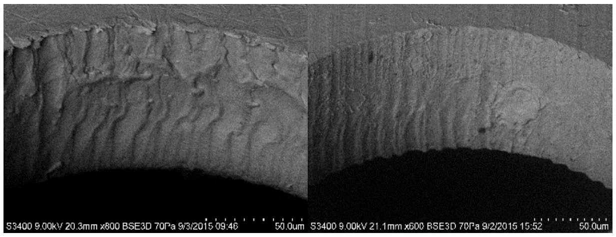


Figure 3. Laser Cut Quality Impacts Paste Release

Figure 4 illustrates a comparison of nanocoated aperture walls versus non-coated apertures. The nanocoating fills in the laser cuts, creates a smooth wall for the paste to release and creates a hydrophobic surface. Each of these features are designed to promote improved transfer efficiency when printing apertures with ARs less than 0.60.

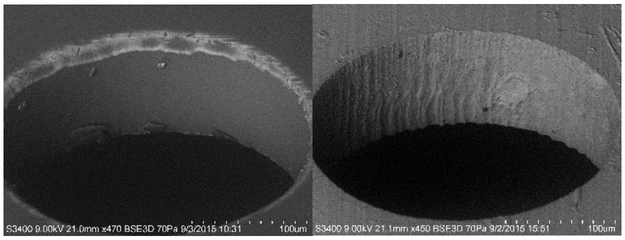


Figure 4. Nanocoated versus Non-Coated Aperture Walls

Nano-coating helps overcome wall quality issues. Polymer coatings help smooth the peaks and valleys created by the laser cutting process and lower the adhesion properties of the aperture walls to help promote release. Thinner, non-polymeric (also called SAMP) nanocoatings don't smooth the peaks and valleys in the same way as polymeric coatings, but do lower the adhesion properties in a similar fashion by reducing the surface energy of the stencil. Nanocoatings on the PCB contact surface of the stencil helps repel flux to prevent wicking and ameliorate gasketing issues.

EXPERIMENTAL METHODS

To visualize solder paste release mechanics, tests were devised to capture videos during the separation of the PCB from the stencil. Two angles were videoed: one from the top down and one from the side.

The top-down videos were recorded using a smart phone with a microscope attachment. The side-view videos were recorded using a BGA inspection camera mounted in specialized fixture.

Figure 5. Top and Side View Captures

Both video setups incorporated multiple ARs in each field of view (FOV). The top-down videos image a 0.5mm BGA 36 with ARs ranging from 0.45 to 0.70 in 0.05 increments. Both circular and square apertures ranged in size from 180-280µms (7-11mils) on a 100µm (4mil foil), as shown in Figure 6.

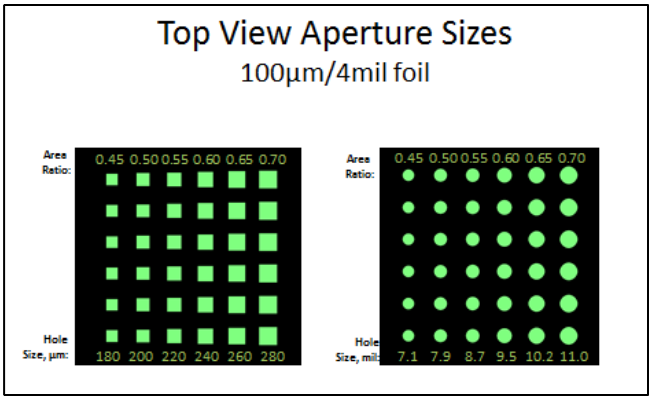


Figure 6. Area Ratios and hole sizes for top down imaging

The side-view videos image a single row of a similar 0.5mm BGA36 print. A single row is used to eliminate background noise observed in previous tests[1]. Two sets of ARs were incorporated into the side-view FOVs, as seen in Figure 7. One set had ARs of 0.60, 0.65 & 0.70 to represent generally accepted stencil design practices for Type 3 & 4 solder pastes. The other set had ARs of 0.45, 0.55 & 0.65 to demonstrate the challenges associated with miniaturization.

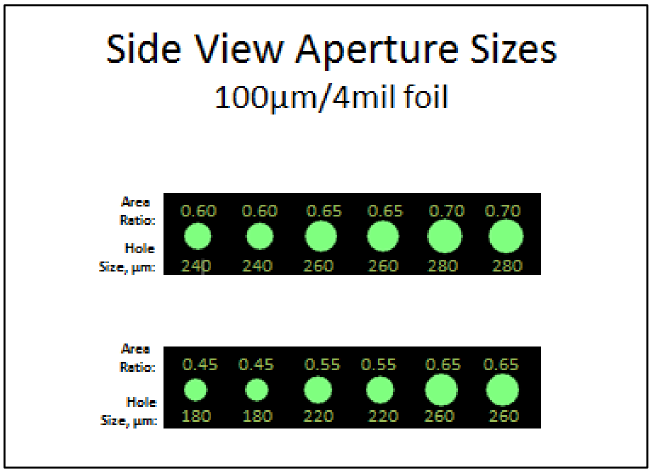


Figure 7. Area Ratios and aperture sizes for side view imaging

STENCIL MANUFACTURE

The first stencil used (#1) was a laser cut, 100µ (4mil), Fine Grain foil provided by a high-quality, US-based stencil supplier. It was not nanocoated. The second and third stencils used (#2 & #3) were also laser cut, provided by a high-quality European supplier. The two European stencil designs were identical; one had polymer nanocoating and one did not. These stencils did not incorporate the top-down BGA patterns that Stencil #1 had; only side view videos are available to assess the effect of nanocoatings and solvent underwiping on release characteristics.

DOE DESIGN

Solder Pastes

1. No-Clean A
   a. Type 4.5
   b. New formulation introduced in 2014
2. No-Clean B
   a. Type 4
   b. New Formulation introduced in 2015
3. No-Clean C
   a. Type 4
   b. New Formulation introduced in 2015

Note: None of these solder pastes are the same solder pastes tested last year. Solder paste can be classified by the size of the small spheres (powder) that make up the metal content of the solder paste (Table 1). These particle sizes are sorted into "mesh size" categories.

Table 1. JEDEC designation of solder powder types

Type Designation	Mesh Size (lines per inch)	Particle Size, um (at least 80% in range)*
1		150-75
2	-200/+325	75–45
3	-325/+500	45–25
4	-400/+635	38–20
5	-500	25–10
6	-635	15–5
7		11–2
8		8–2

*Type 4.5 powder sizes are not listed because they are not an official JEDEC Type classification and vary from manufacturer to manufacturer

EXPERIMENTAL DESIGN

Wipe Sequence

- Wet-Dry-Dry; all using vacuum
- Solvent type: KYZEN Cybersolv 8882 specifically engineered to clean raw solder paste

Print Sequence

- Start with squeegee in back
- Print 2 boards
- Video top-down release of BGA on bd #2
- Print 2 boards
- Video side-view release of BGA on bd#4 (no wipe)
- Print one board
- Wipe – 5th print
- Video top-down view of wipe
- Print one board
- Video side-view of BGA on board #6 (after wipe)

Print Parameters

- Squeegee speed: 63mm/sec (2.5 in/sec)
- Squeegee pressure: 0.2 kg/cm (1.1 lb/in)
- Separation speed: 0.05mm/s (0.02in/sec)

Run Order

- 0.60 – 0.70 ARs and square BGA apertures
- 0.450 – 0.65 ARs and circular apertures
- Two replicates of each run in first phase of experiment; one replicate in second, third and fourth phases

Phase 1: Side-view and top-down videos of solder paste release using a non-nanocoated stencil – 2 replicates, as seen in Table 2.

Table 2. Stencil #1 – Not Coated Run Order

Solder Paste	Side View ARs	Top View Aperture Shape	Wipe	Prints	Clean	Video #
A	0.60-0.70	Square	No	4	Dirty	1
A	0.60-0.70	Square	Yes	6th	Clean	2
A	0.60-0.70	Square	No	4	Dirty	3
A	0.60-0.70	Square	Yes	6th	Clean	4
A	0.45-0.65	Circular	No	4	Dirty	5
A	0.45-	Circular	Yes	6th	Clean	6

	0.65					
A	0.45-0.65	Circular	No	4	Dirty	7
A	0.45-0.65	Circular	Yes	6th	Clean	8
B	0.60-0.70	Square	No	4	Dirty	9
B	0.60-0.70	Square	Yes	6th	Clean	10
B	0.60-0.70	Square	No	4	Dirty	11
B	0.60-0.70	Square	Yes	6th	Clean	12
B	0.45-0.65	Circular	No	4	Dirty	13
B	0.45-0.65	Circular	Yes	6th	Clean	14
B	0.45-0.65	Circular	No	4	Dirty	15
B	0.45-0.65	Circular	Yes	6th	Clean	16
C	0.60-0.70	Square	No	4	Dirty	17
C	0.60-0.70	Square	Yes	6th	Clean	18
C	0.60-0.70	Square	No	4	Dirty	19
C	0.60-0.70	Square	Yes	6th	Clean	20
C	0.45-0.65	Circular	No	4	Dirty	21
C	0.45-0.65	Circular	Yes	6th	Clean	22
C	0.45-0.65	Circular	No	4	Dirty	23
C	0.45-0.65	Circular	Yes	6th	Clean	24

Phase 2: Side-view videos comparing nanocoated and non-nanocoated stencil – 1 replicate, as seen in Table 3.

Table 3. Stencil #2 – Nanocoated Run Order

Solder Paste	Side View ARs	Top View Aperture Shape	Wipe	Prints	Clean	Video #
A	0.60-0.70	Square	No	4	Dirty	25
A	0.60-0.70	Square	Yes	6th	Clean	26
A	0.45-0.65	Circular	No	4	Dirty	27
A	0.45-0.65	Circular	Yes	6th	Clean	28
B	0.60-0.70	Square	No	4	Dirty	29
B	0.60-0.70	Square	Yes	6th	Clean	30
B	0.45-0.65	Circular	No	4	Dirty	31
B	0.45-0.65	Circular	Yes	6th	Clean	32
C	0.60-0.70	Square	No	4	Dirty	33
C	0.60-0.70	Square	Yes	6th	Clean	34
C	0.45-0.65	Circular	No	4	Dirty	35
C	0.45-0.65	Circular	Yes	6th	Clean	36

Stencil #3: Side-view videos using a non-nanocoated stencil – 1 replicate, as seen in Table 4.

Table 4. Stencil # 3 - Not Nanocoated – Run Order

Solder Paste	Side View ARs	Top View Aperture Shape	Wipe	Prints	Clean	Video #
A	0.60-0.70	Square	No	4	Dirty	43
A	0.60-0.70	Square	Yes	6th	Clean	44
A	0.45-0.65	Circular	No	4	Dirty	41
A	0.45-0.65	Circular	Yes	6th	Clean	42
B	0.60-0.70	Square	No	4	Dirty	47
B	0.60-0.70	Square	Yes	6th	Clean	48
B	0.45-0.65	Circular	No	4	Dirty	45
B	0.45-0.65	Circular	Yes	6th	Clean	46
C	0.60-0.70	Square	No	4	Dirty	39
C	0.60-0.70	Square	Yes	6th	Clean	40
C	0.45-0.65	Circular	No	4	Dirty	37
C	0.45-0.65	Circular	Yes	6th	Clean	38

Phase 3: Top-view release videos using non-nanocoated stencil #1 comparing wet wipe with dry wipe. The Wet wipe sequence was wet-dry, both wiper passes with vacuum on and the Dry wipe sequence was dry-dry, both wiper passes with the vacuum on. Snips from the videos before and after each pass are shown in Tables 8 and 9.

RESULTS

Phase 1 – Snips from the videos illustrate the effect of AR on TE, and the elastic nature of solder paste upon separation of the PCB and stencil. Post-separation snip are shown in Table 5. The differences among area ratios, solder pastes and clean vs. dirty stencils is often obvious.

Snips from the top down release videos are shown in Figures 9 and 10. They show the printed aperture pre-release in the first frame, the paste stretching out of the aperture in the second frame, the paste snapping back into the aperture in the third frame, and the final release (or retention) in the fourth frame. While some of the smaller apertures appear fully occluded, they did, in fact transfer paste onto the PCBs as seen in Figure 8 and in the side-view videos and snips.

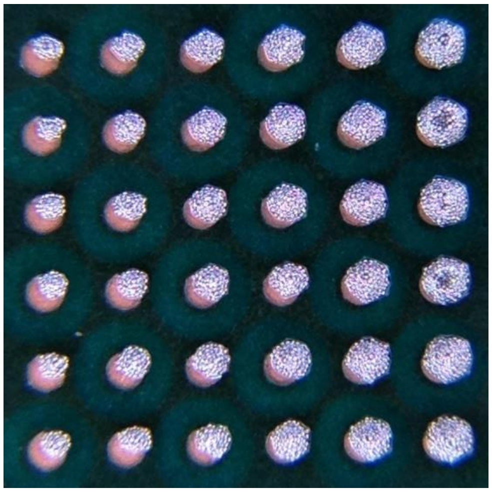
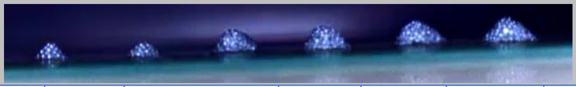
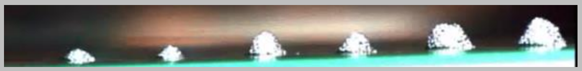
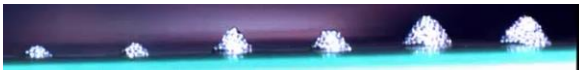
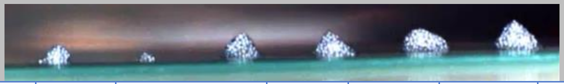
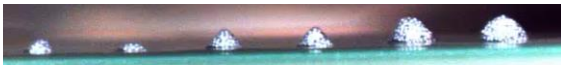
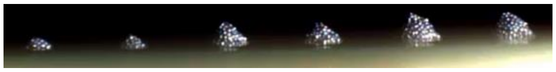


Figure 8. Typical paste release from top-down tests.

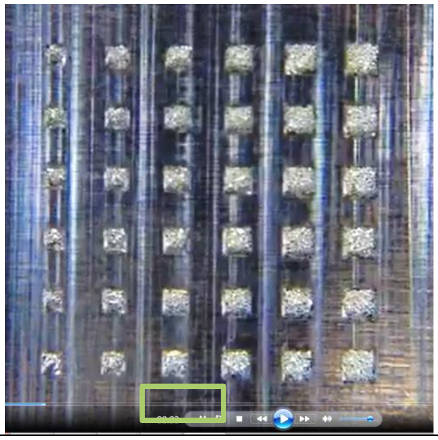
Table 5. Paste Transfer from Stencil #1 – Not Coated

Solder Paste	ARs	Hole Sizes	Wipe	Prints	Clean?	Video #
A	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	1
						
A	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	2
						
A	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	3
						
A	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	4
						
A	0.45-0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	5
						
A	0.45-0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	6
						
A	0.45-0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	7
						
A	0.45-0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	8
						
B	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	9
						
B	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	10
						
B	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	11
						
B	0.60-0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	12
						

Solder Paste	ARs	Hole Sizes	Wipe	Prints	Clean?	Video #
B	0.45-0.65	180-220-260μm 7.1-8.7-10.2mil	No	4	**Dirty**	13
						
B	0.45-0.65	180-220-260μm 7.1-8.7-10.2mil	Yes	6th	**Clean**	14
						
B	0.45-0.65	180-220-260μm 7.1-8.7-10.2mil	No	4	**Dirty**	15
						
B	0.45-0.65	180-220-260μm 7.1-8.7-10.2mil	Yes	6th	**Clean**	16
						
C	0.60-0.70	240-260-28 μm 9.5-10.2-11.0mil	No	4	**Dirty**	17
						
C	0.60-0.70	240-260-280μm 9.5-10.2-11.0mil	Yes	6th	**Clean**	18
						
C	0.60-0.70	240-260-280μm 9.5-10.2-11.0mil	No	4	**Dirty**	19
						
C	0.60-0.70	240-260-280μm 9.5-10.2-11.0mil	Yes	6th	**Clean**	20
						
C	0.45-0.65	180-220-260 μm 7.1-8.7-10.2mil	No	4	**Dirty**	21
						
C	0.45-0.65	180-220-260μm 7.1-8.7-10.2mil	Yes	6th	**Clean**	22
						
C	0.45-0.65	180-220-260μm 7.1-8.7-10.2mil	No	4	**Dirty**	23
						
C	0.45-0.65	180-220-260μm 7.1-8.7-10.2mil	Yes	6th	**Clean**	24
						

SQUARE APERTURES

ARs:	0.45	0.50	0.55	0.60	0.65	0.70
Sizes (μm):	180	200	220	240	260	280
Sizes (mil):	7.1	7.9	8.7	9.5	10.2	11.0



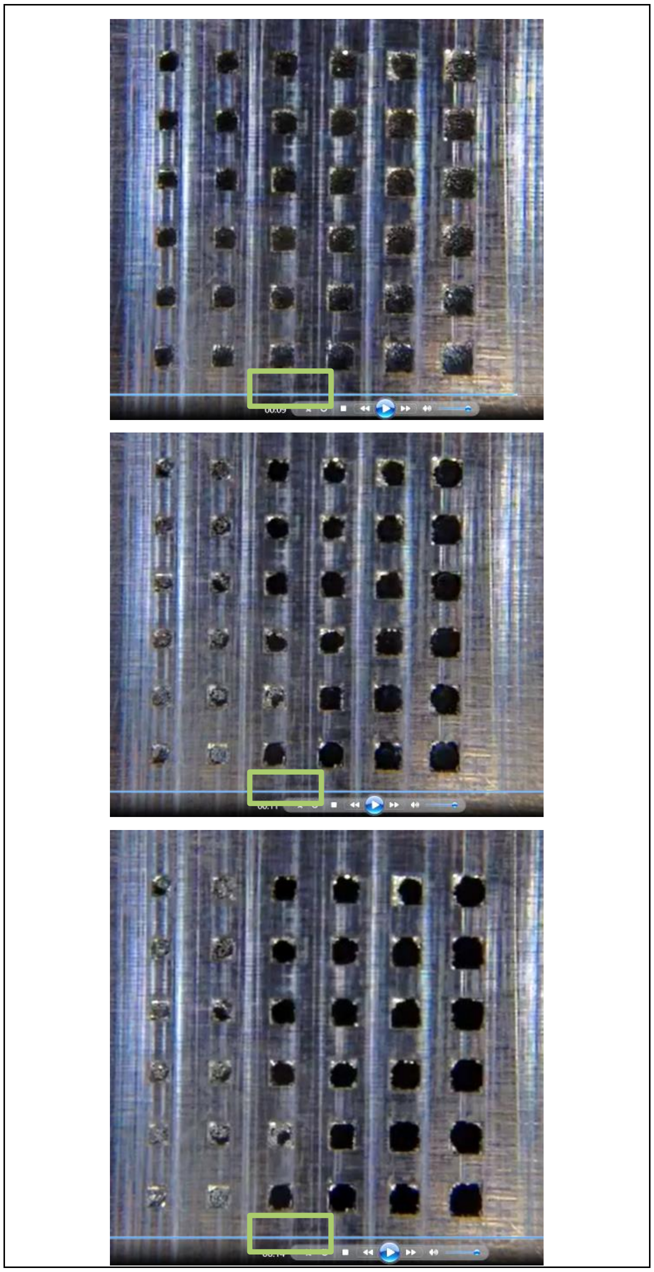


Figure 9. Frames from top-down release video of square apertures.

CIRCULAR APERTURES

ARs:	**0.45**	**0.50**	**0.55**	**0.60**	**0.65**	**0.70**
Sizes (µm):	180	200	220	240	260	280
Sizes (mil):	7.1	7.9	8.7	9.5	10.2	11.0

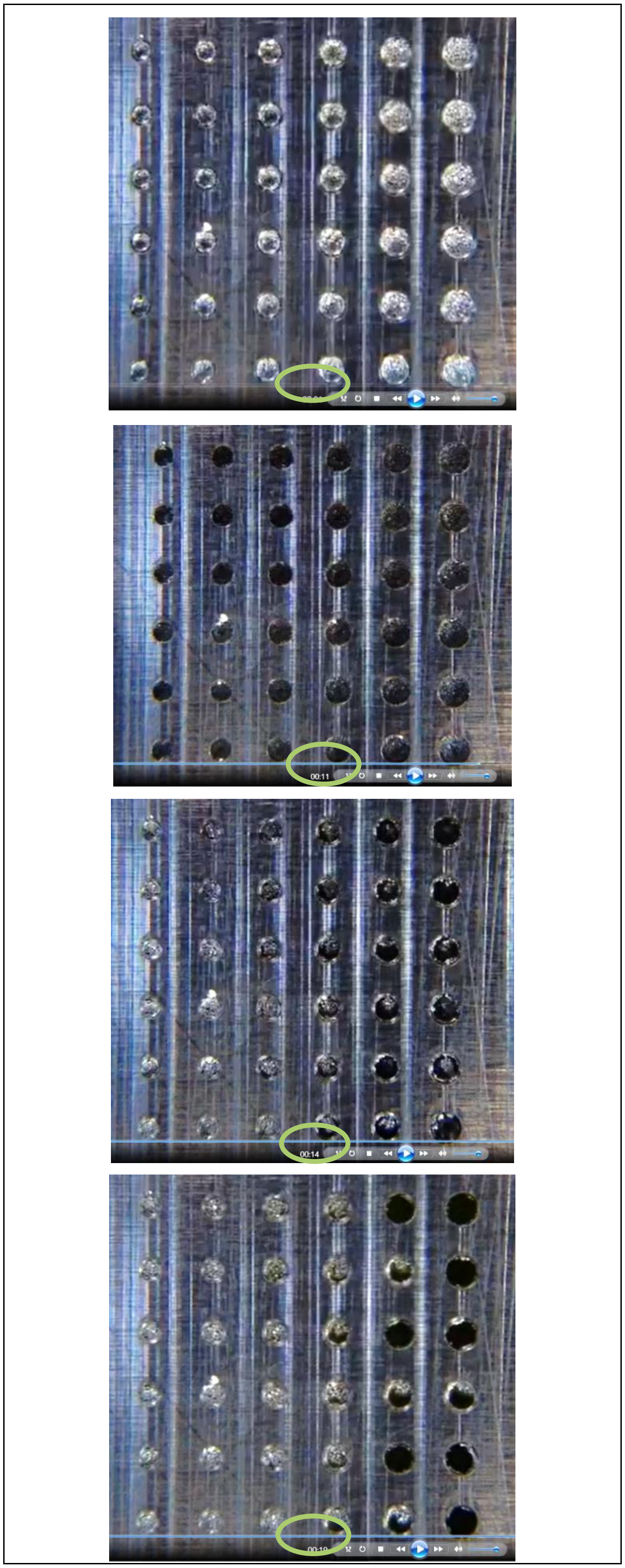


Figure 10. Frames from top-down release video of circular apertures.

Phase 2: Side-view videos of solder paste transfer using a nanocoated stencil. The nanocoated stencil was laser cut and had a Polymer coating as shown in Figure 2. The differences in TE between nanocoated and non-nanocoated apertures is abundantly clear.

Table 6. Stencil #2 – Nanocoated

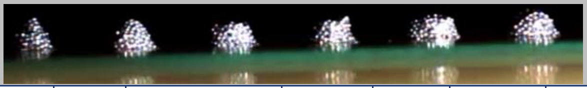
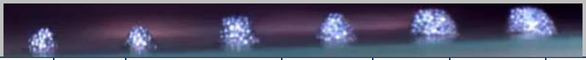
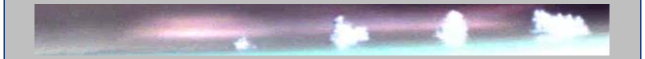
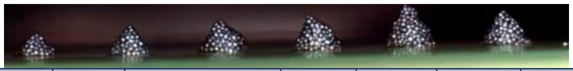
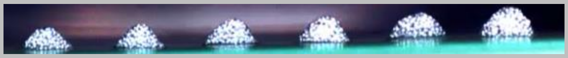
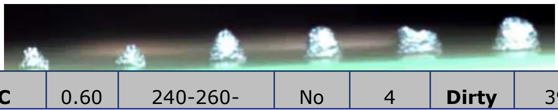
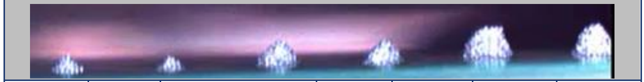
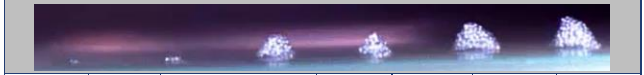
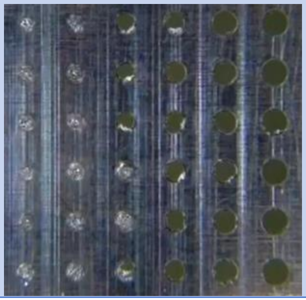
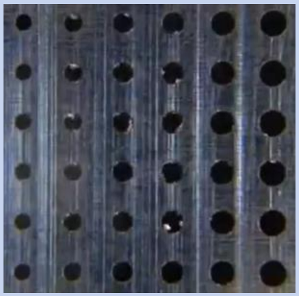
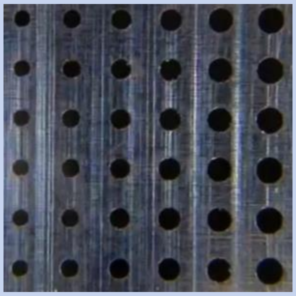
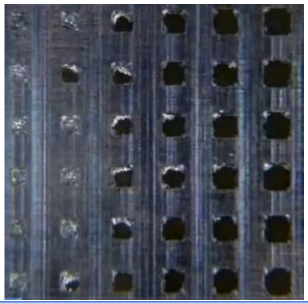
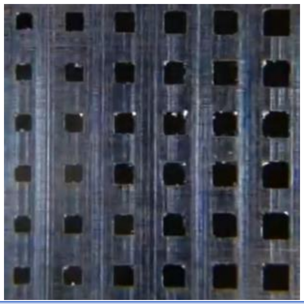
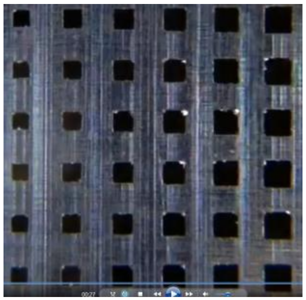
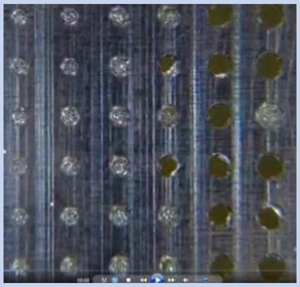
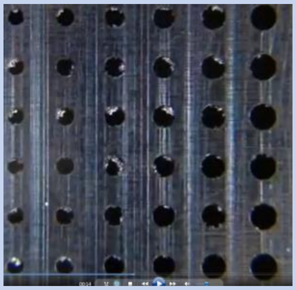
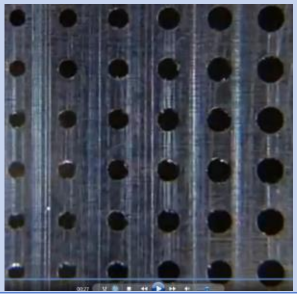
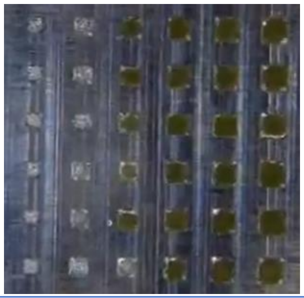
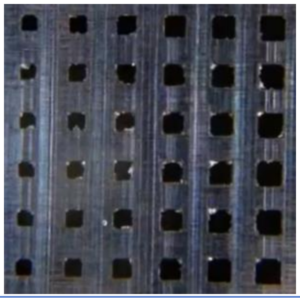
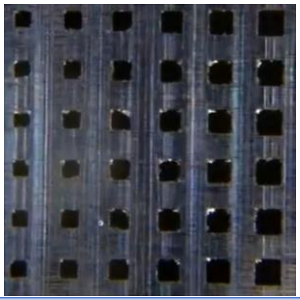
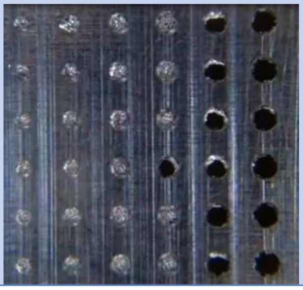
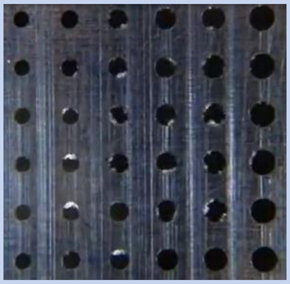
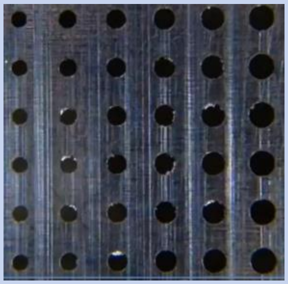
Solder Paste	ARs	Hole Sizes	Wipe	Prints	Clean ?	Video #
A	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	25
						
A	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	26
						
A	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	27
						
A	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	28
						
B	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	29
						
B	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	30
						
B	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	31
						
B	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	32
						
C	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	33
						
C	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	34
						
C	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	35
						
C	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	36
						

Table 7. Stencil #3 – Not Nanocoated

Solder Paste	ARs	Hole Sizes	Wipe	Prints	Clean ?	Video #
A	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	43
						
A	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	44
						
A	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	41
						
A	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	42
						
B	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	47
						
B	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	48
						
B	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	45
						
B	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	46
						
C	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	No	4	**Dirty**	39
						
C	0.60 - 0.70	240-260-280µm 9.5-10.2-11.0mil	Yes	6th	**Clean**	40
						
C	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	No	4	**Dirty**	37
						
C	0.45 - 0.65	180-220-260µm 7.1-8.7-10.2mil	Yes	6th	**Clean**	38
						

Phase 3: Top-view video snips of wiper #1.
effectiveness using a non-nanocoated stencil

Table 8. BGA images after print, after first and second dry-vac wiper passes

Solder Paste	Board Release	After Dry Pass #1	After Dry Pass #2
A **Round Apertures**			
A **Square Apertures**			
B **Round Apertures**			
B **Square Apertures**			
C **Round Apertures**			

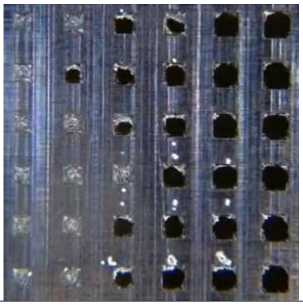
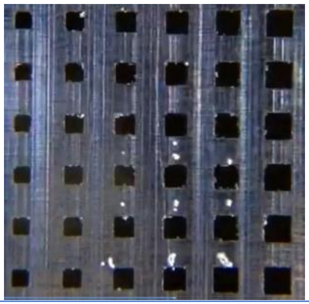
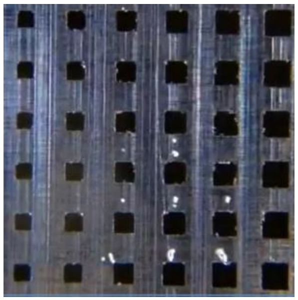
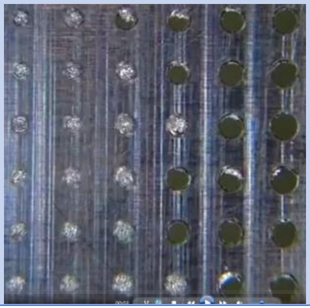
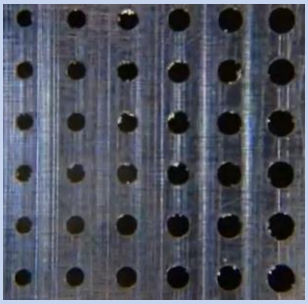
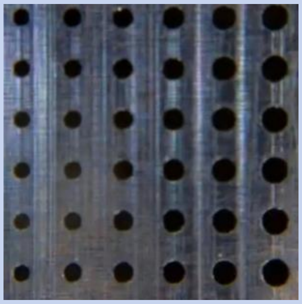
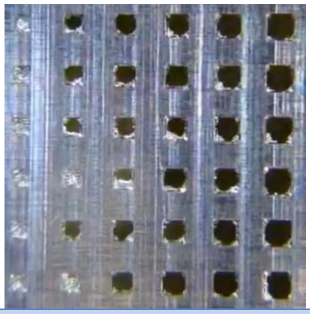
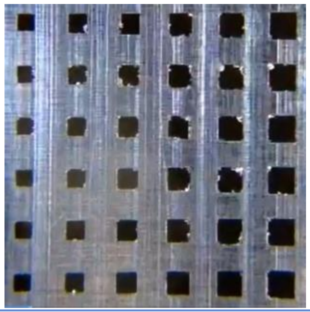
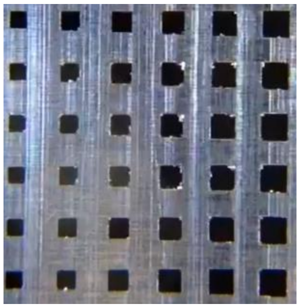
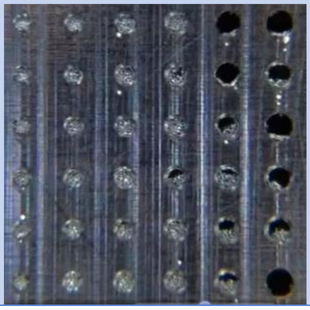
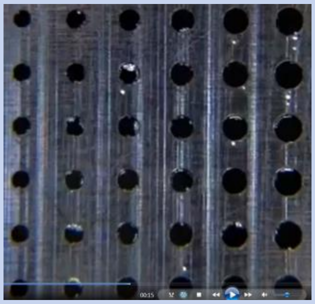
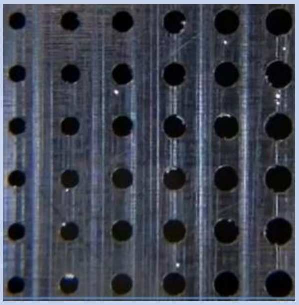
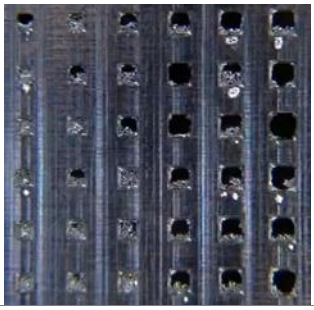
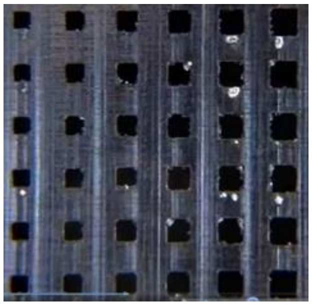
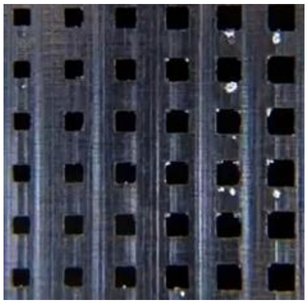
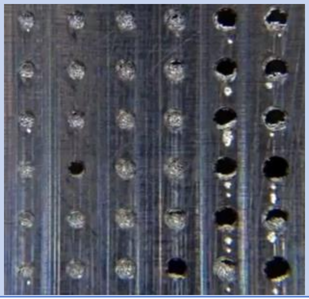
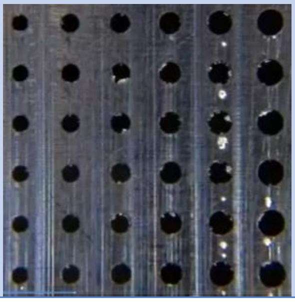
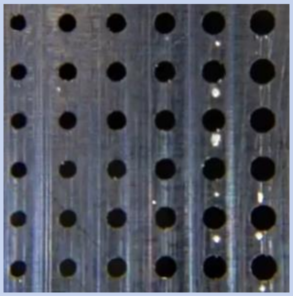
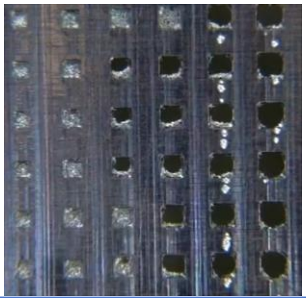
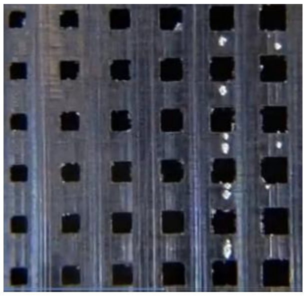
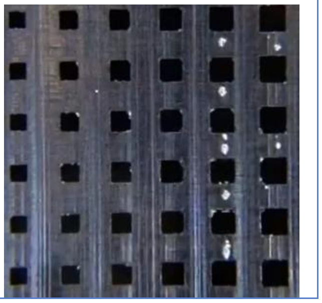
C **Square Apertures**			

Table 9. BGA images after print, after first wet-vac and second dry-vac wiper passes

Solder Paste	Board Release	After Wet Pass #1	After Dry Pass #2
A **Round Apertures**			
A **Square Apertures**			
B **Round Apertures**			
B **Square Apertures**			

C **Round Apertures**			
C **Square Apertures**			

INFERENCES FROM THE DATA FINDINGS

The side view lighting is critical to see the solder paste snap-off resolution. As the experiment progressed, the research team got better at lighting. As such, the videos were much better for Phase 2 tests.

Phase 1 Side-view videos show considerable differences in release properties between solder paste formulations, stencil cleanliness conditions. Solder paste A videos showed poorer release performance than pastes B or C. It should be noted that a slow separation speed (0.05mm/sec) was used to aid in capturing the video, and some pastes release much better at higher separation speeds. Of pastes B and C, both consistently showed better release from a clean stencil than a dirty one.

Phase 1 testing on a laser cut, non-nanocoated stencil found the following effects on transfer efficiency:

Smaller apertures impacted transfer efficiency. Apertures of 0.45 and 0.50 did not totally release from the stencil. The number of cycles without a cleaning cycle impacts transfer efficiency.

Solder Paste B transfer efficiency appeared slightly better than Solder Paste C.

Both Solder Pastes B & C had better transfer efficiency than did Solder Paste A. Solder paste A typically performs better than it did in this test.

The Understencil Wipe before a print appeared to improve transfer efficiency.

Square apertures appeared to release better than circular ones. The videos snip shown comparing the release of the different aperture shapes were of Paste B. This behavior was typical of most releases in that the square apertures cleared better than the circular ones. The 0.55 AR is where most circular apertures showed residual paste across the span of the aperture, while squares were still partially open at the 0.55 and 0.50 ARs.

Phase 2 testing to compare similar laser cut stencils with and without nanocoating found the following effects on transfer efficiency:

Transfer Efficiency was superior using the nanocoated stencil as compared to the non-nanocoated stencil.

The transfer efficiency for four prints before an understencil wipe did not appear much different than the transfer efficiency following a clean wipe on the nanocoated stencil. This reinforced the concept that the nanocoating keeps the stencil contact surface cleaner by repelling the flux.

All three solder pastes tested performed better when using the nanocoated stencil. Some were very impressive at the 0.45 AR.

1. The smaller the aperture, the greater the effect of the nanocoating on TE. While all aperture sizes appeared to benefit from nanocoating, the smaller ones showed the greatest improvement in TE and in repeatability.

Phase 3 testing to compare the aperture cleaning effectiveness of wet vs. dry wipe on a non-nanocoated stencil was largely inconclusive.

Whereas the wet wiped apertures may appear slightly cleaner, the difference between the two cases and the small sample sizes are not enough to conclusively state that wet wiping is more effective at clearing small, non-nanocoated apertures. However, previous tests[2] have conclusively shown that wet wiping is much more effective and removing flux residues from the PCB contact surface of the stencil, which is in important factor in clean separation and the redeposition of flux or solder powder on unwanted area of the PCB.

In both cases, the majority of the visible solder paste (spheres) are removed from the aperture on the first wiper pass.

Smaller apertures, which appeared to retain more solder paste than the larger ones, cleared just as easily as the larger ones.

CONCLUSIONS

Miniaturization of electronic components and their interconnects have considerable implications on the assembly process, overall output quality, and long-term product reliability.

Small feature sizes that drive ARs below 0.65 demonstrate a considerable decline in TE and an often substantial increase in variability, even with some of the newest, highest performing solder pastes currently on the market.

The basic stencil printing process as it has slowly evolved over the past three decades can no longer support small feature sizes without (sometimes) disruptive changes to the materials and process.

Stencil nanocoating is an enabling technology that not only increases solder paste transfer rates, it also reduces variability in transfer rates.

Under stencil wiping also improves print quality, especially on non-nanocoated stencils

Nanocoated stencils did not demonstrate as much dependency on under wiping as non-nanocoated stencils in this series of tests.

The use of solvents in under stencil wiping can aid in removing solder paste from apertures and from the PCB contact side of the stencil.

End-use reliability of electronic devices is heavily dependent on the integrity of each individual solder joint.

The more miniaturized and variable the joint formation, the lower the overall reliability of the product.

Measures to not only deposit the most paste possible from any given AR, but also to produce the most consistently-sized deposits, should be employed, particularly at ARs of 0.55 or lower, or on devices with low standoff interconnects like LGAs, BTCs, or 0201 or smaller chips.

The video and still images from these tests provide strong visual images that illustrate the relationship between AR and TE and its associated variability. Technical professionals often address this relationship using numerical data generated by SPI and calculate or manipulate the data in somewhat abstract terms. Viewing the video and still images adds a new, visible dimension to the challenges faced on the assembly line, and the nuances left uncaptured by standard SPI.

[1] Understencil Video Effects to Study Solder Paste Transfer and Wiping Effects

Authors: Mike Bixenman, D.B.A., Wayne Raney, Chrys Shea, and Ray Whittier
Company: Kyzen Corporation, Shea Engineering Services, and Vicor Corporation
Date Published: 9/28/2014 Conference: SMTA International

[2] Originally published at the International Conference on Soldering and Reliability, Toronto, Ontario, Canada, May 13, 2014 1 QUANTIFYING THE IMPROVEMENTS IN THE SOLDER PASTE PRINTING PROCESS FROM STENCIL NANOCOATINGS AND ENGINEERED UNDER WIPE SOLVENTS Chrys Shea, Shea Engineering Services Mike Bixenman and Debbie Carboni, Kyzen Brook Sandy-Smith and Greg Wade, Indium Ray Whittier, Vicor Corporation Joe Perault, Parmi Eric Hanson, Aculon