

Water Soluble Solder Paste Wet Behind the Ears or Wave of the Future?

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Why Develop a New Lead-Free Water Soluble Solder Paste?

- Water soluble solder paste technology has fallen behind no clean technology
- High reliability applications require removal of flux
- Water soluble flux residues are much easier to remove than no cleans



Is a New Solder Paste Wet Behind the Ears?



Performance Testing
Incubates the Product

Process of Formulating a New Solder Paste

1. Set performance objectives.
2. Develop multiple formulations.
3. Produce small batches of formulations.
4. Conduct testing to measure the performance.
5. Compare the results to well-known products.
6. Repeat steps 2 - 5 until the objectives are met.

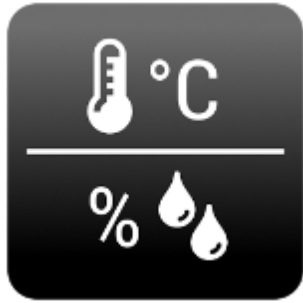


Ingredients Used in Solder Paste Fluxes

Ingredient Type	Function
Solvents	Dissolve other ingredients to make a uniform mixture
Rosins / resins	Add “body” and some activity
Activators	Oxide removal and promotes soldering
Surfactants	Aids in wetting and cleaning of flux residues
Rheology modifiers	Enables solder paste to be printed
Others (Trade Secrets)	“Gray Magic”



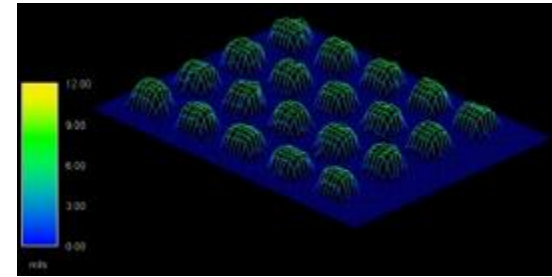
Performance Attributes of a New Lead-Free Water Soluble Solder Paste



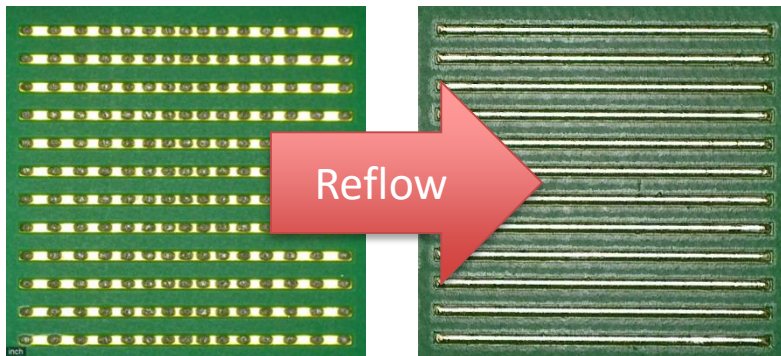
Environmentally stable in a range of operating conditions



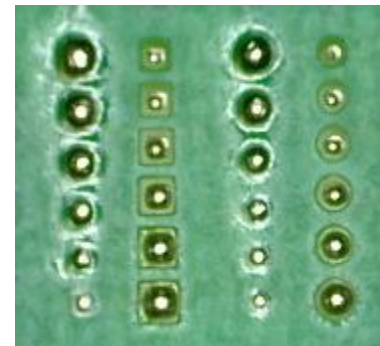
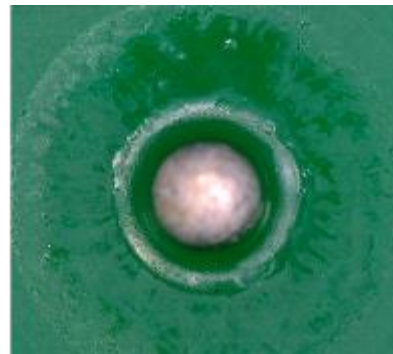
Flux residues that are easy to wash



Long stencil life
Excellent print characteristics



Nominal wetting



Very low solder balling and graping

Test Methods to Challenge Solder Paste

Environmental Stability

- Mass change with air exposure in high and low humidity
- Tack force change with air exposure and humidity
- 6-hour mix with air exposure

Print Tests

- Stencil life 8-hour print test with response to pause
- Print speed variation: 20, 50, 100 mm/sec

Reflow Tests

- Wetting / spread on ENIG and OSP
- Solder balling and graping

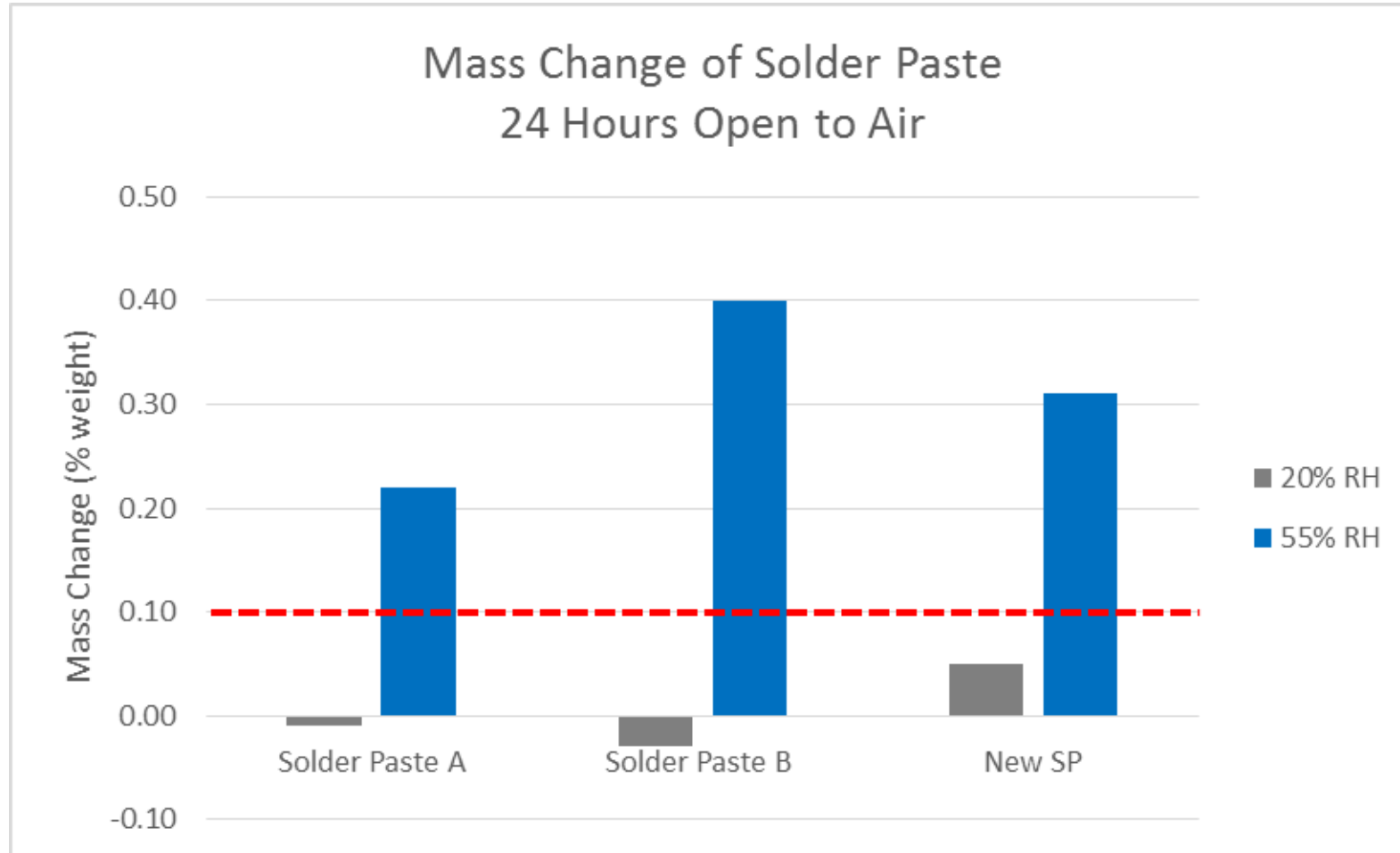
Washability

- Circuit board appearance after wash
- Water solubility of flux residues

Three Solder Pastes
(SAC305 Type 3):

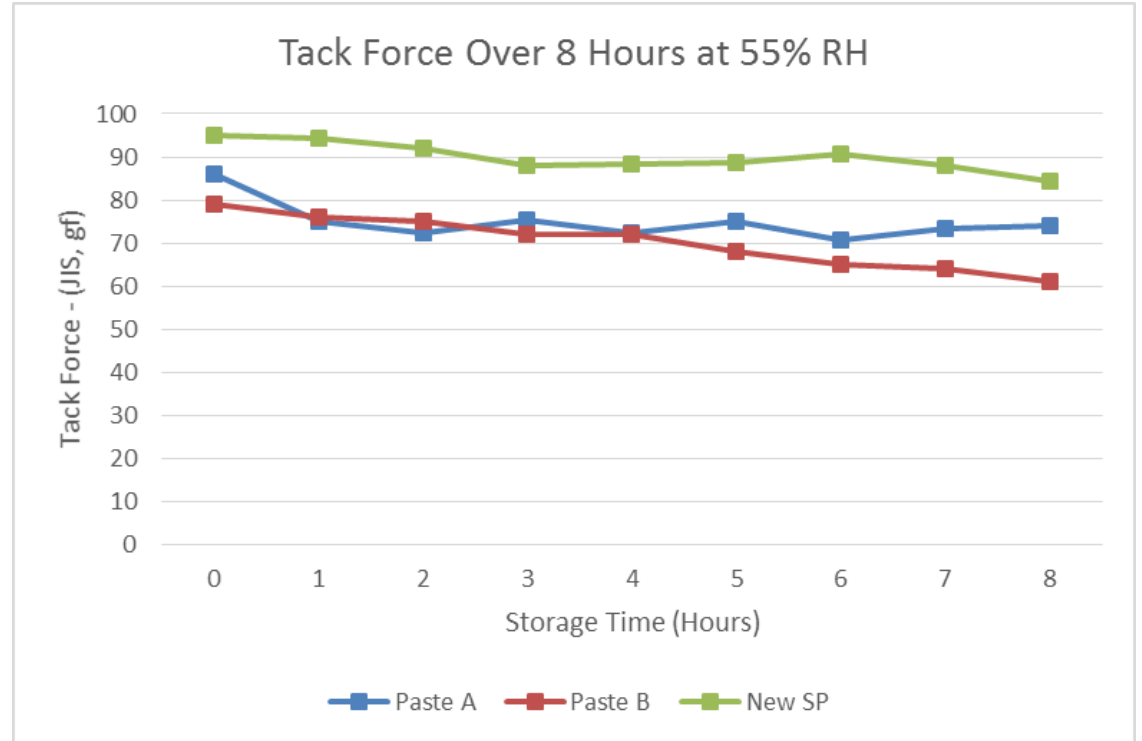
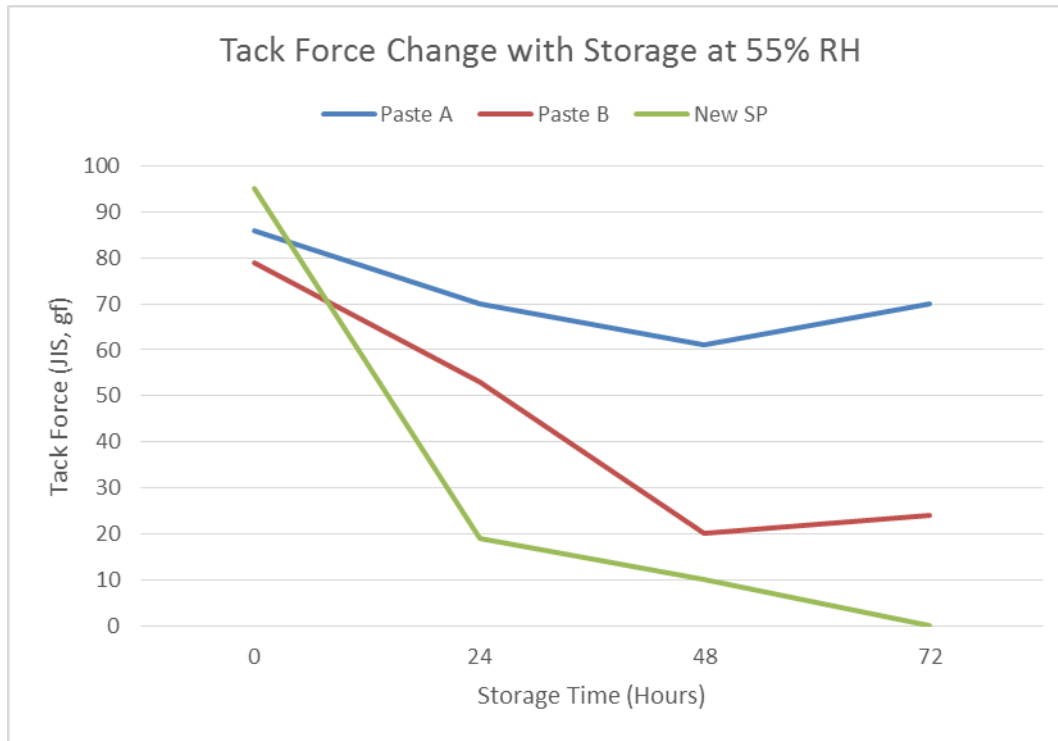
Solder Paste A
Solder Paste B
New Solder Paste

Environmental Stability – Mass Change



Mass change < 0.10% indicates good stability

Environmental Stability – Tack Force



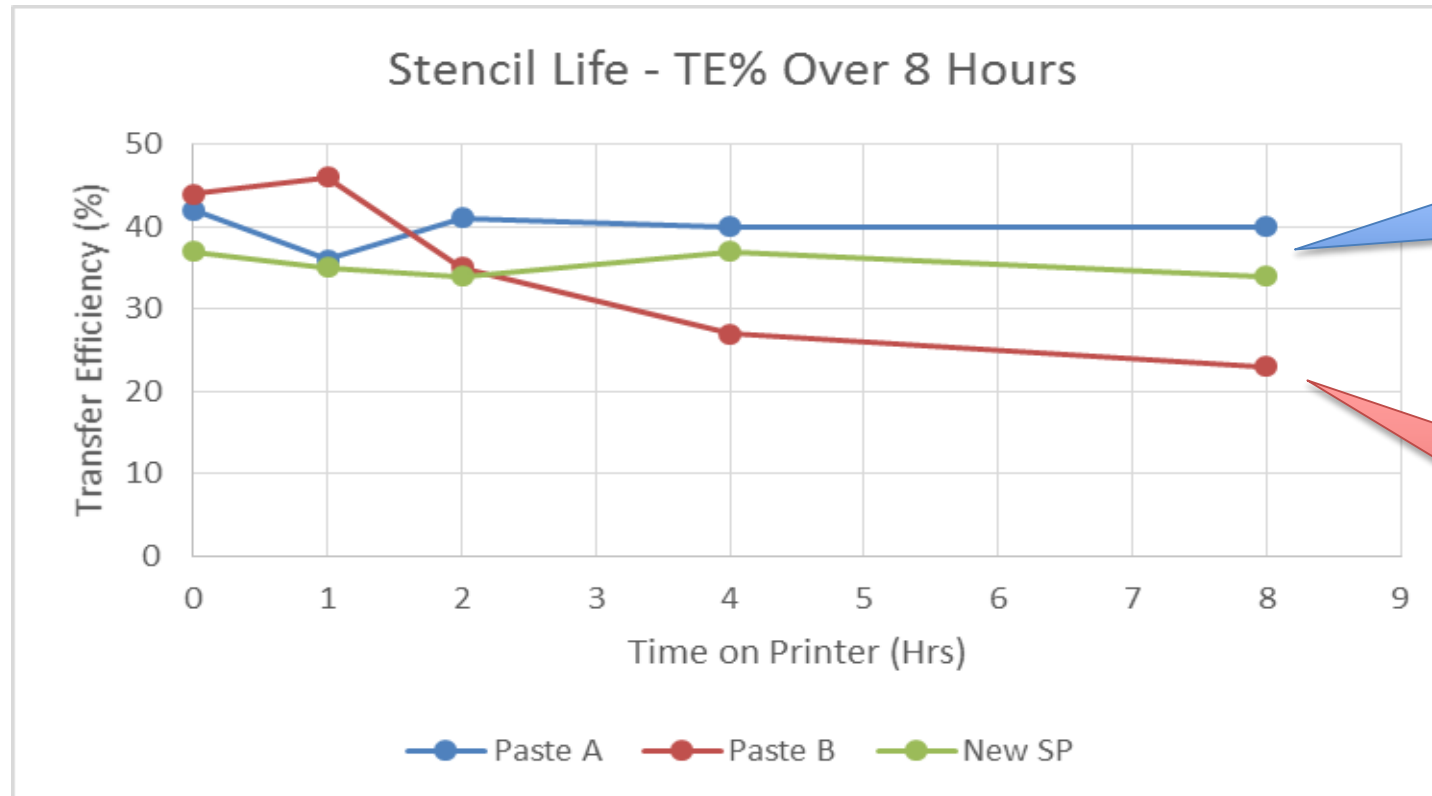
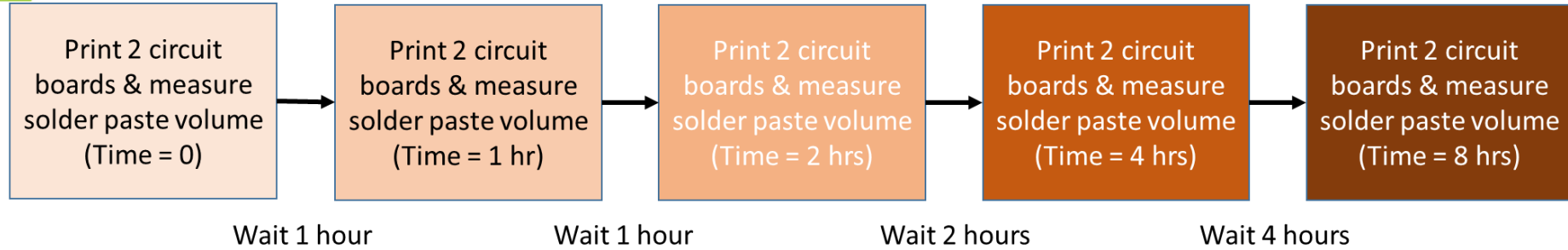
Ideal solder pastes show little change in tack force.

Environmental Stability – 6 Hour Mix

Solder Paste	Viscosity Initial (Brookfield, Kcps)	Viscosity Final (Brookfield, Kcps)	Viscosity Change (%)
Solder Paste A	630	680	7.9% increase
New Solder Paste	760	690	9.2% decrease

Viscosity decrease of less than 10% indicates good stability.

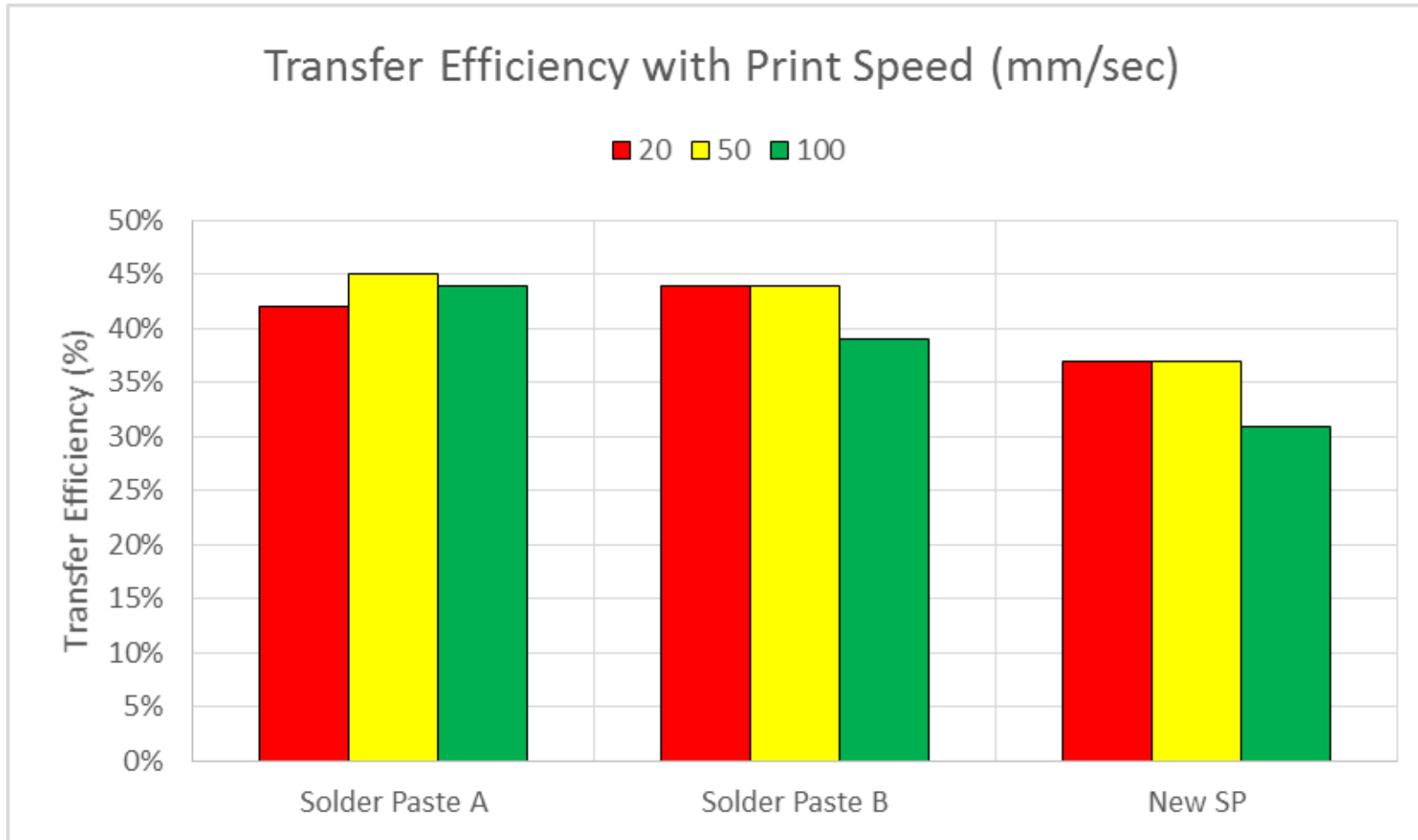
Stencil Life and Response to Pause



Excellent
Stencil Life
(A & New)

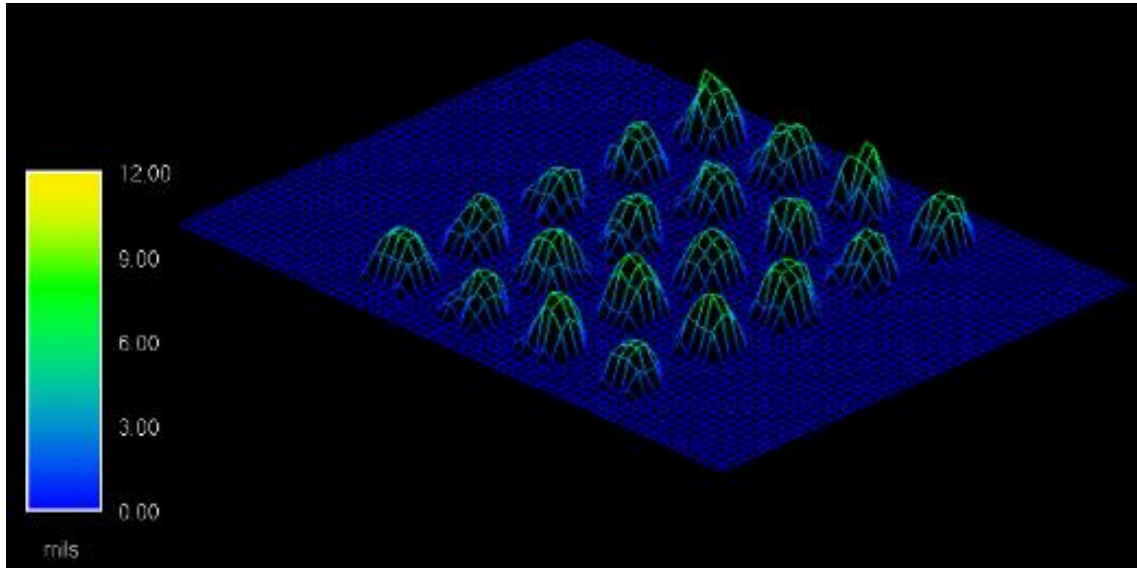
Shorter
Stencil Life
(B)

Print Characteristics – Speed Variation

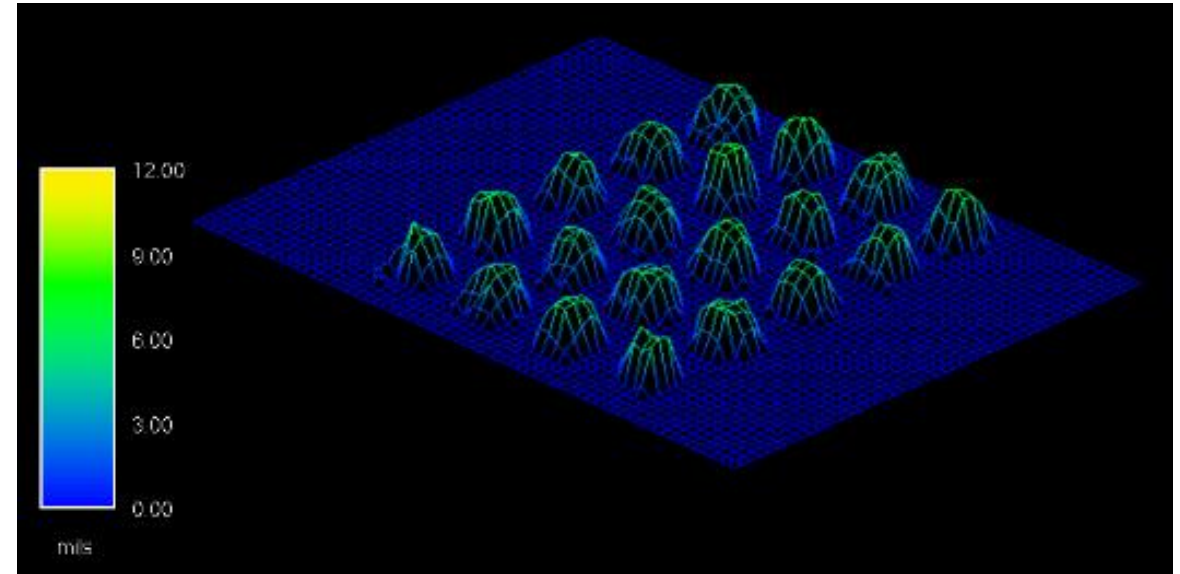


Ideal solder pastes give similar TE% at all print speeds.

Print Characteristics - Brick Definition (50 mm/sec print speed)



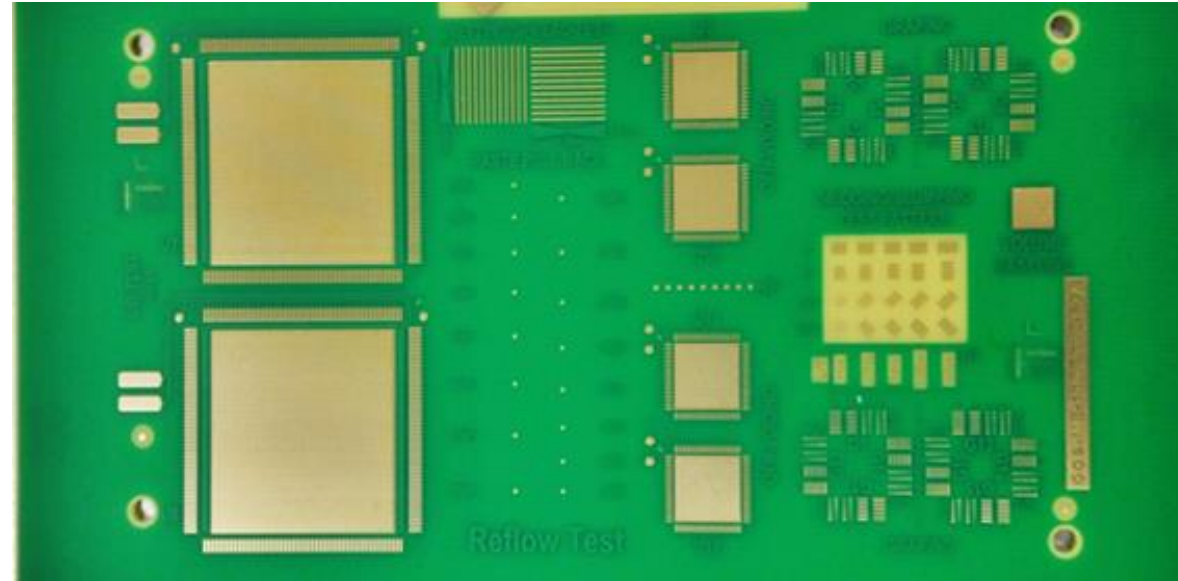
Solder Paste B



New Solder Paste

Test Board and Linear Reflow Profile

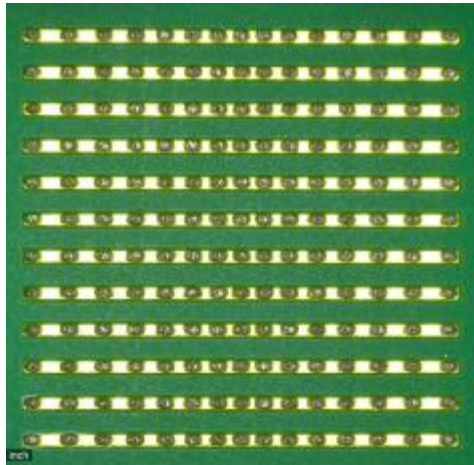
Reflow Test
Board



Profile Length (45 °C to Peak Temperature)	4.0 to 4.5 minutes
Ramp Rate	1.0 to 1.5 °C/second
Time Above Liquidus (217 °C)	50 to 70 seconds (60 seconds nominal)
Peak Temperature	240 to 250 °C (245 °C nominal)

Wetting Test Pattern

Printed Solder Paste on
Wetting Pattern



15 bricks on each line
Pitch 0.1 to 0.4 mm

Reflow

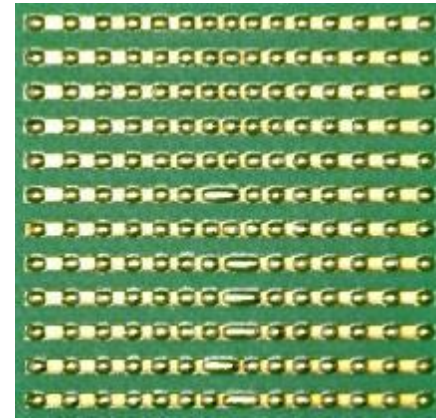
Poor Wetting
on ENIG (76%)



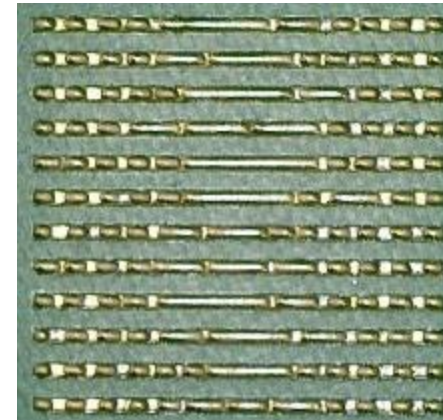
Ideal Wetting
on ENIG (100%)



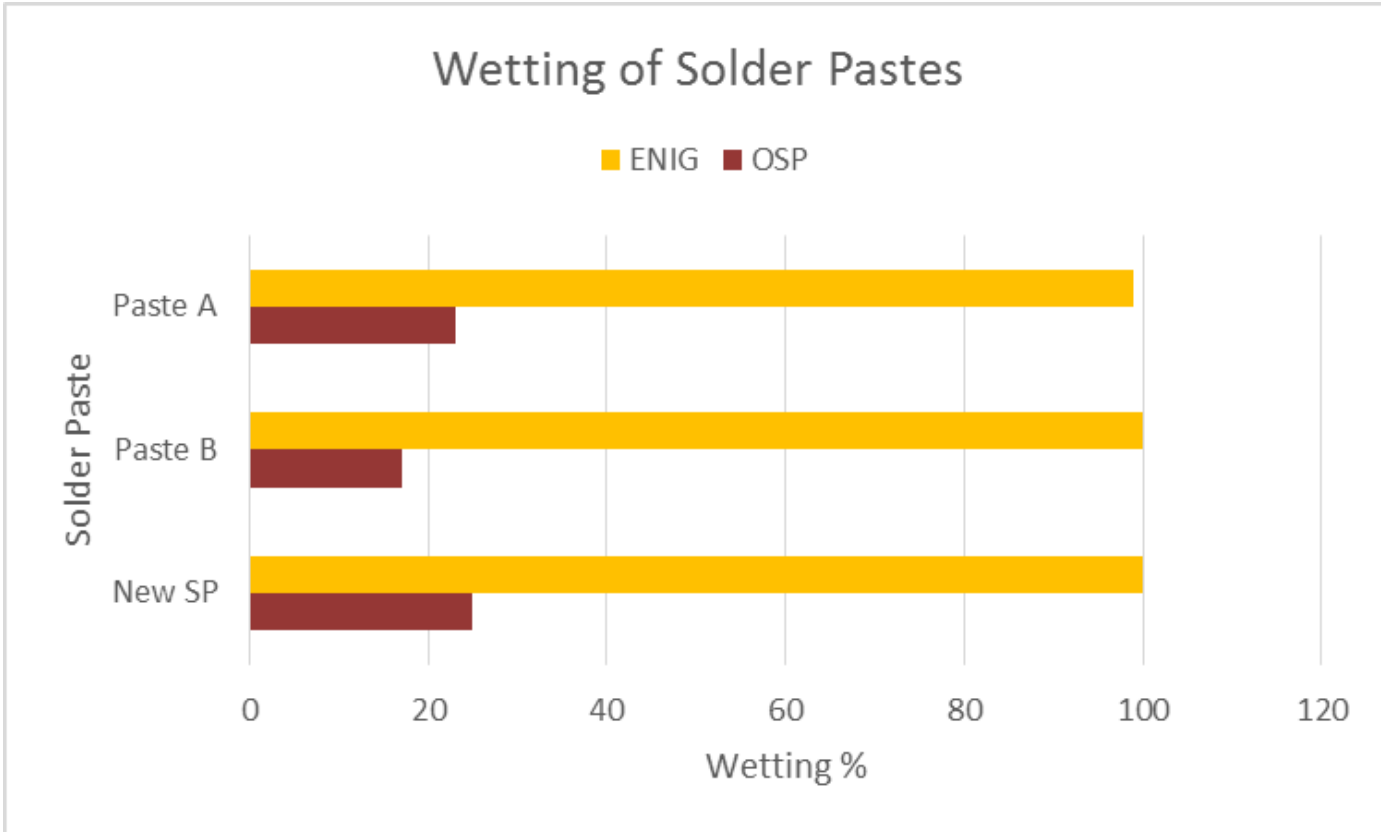
Poor Wetting
on OSP (7%)



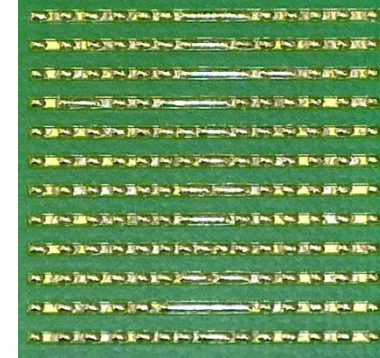
Good Wetting
on OSP (36%)



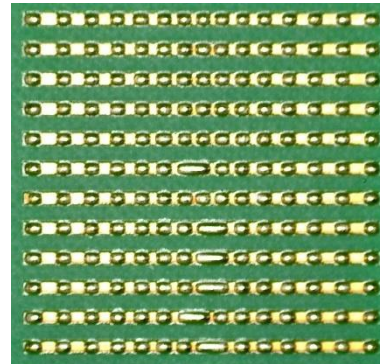
Wetting on ENIG and OSP



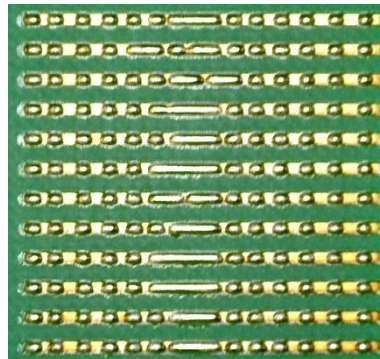
Wetting on OSP



Paste A
23%



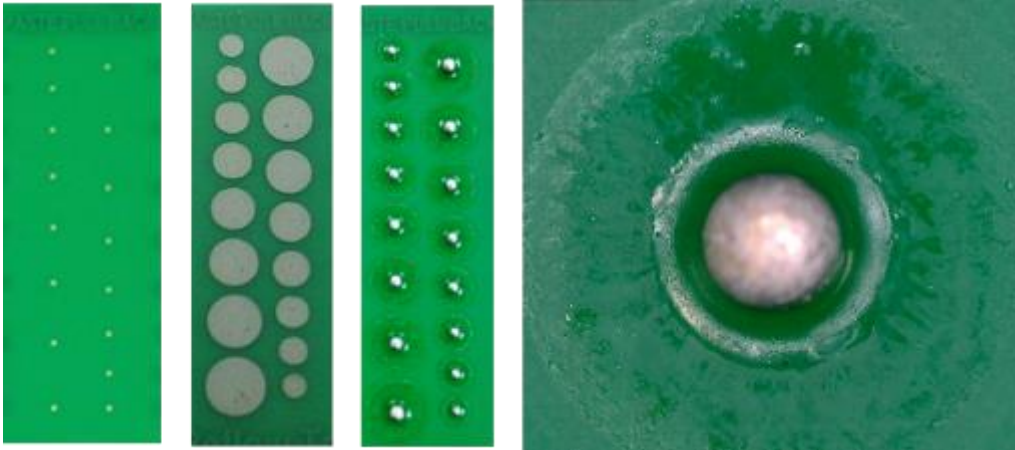
Paste B
17%



New Paste
25%

Solder Balling and Graping Patterns

Solder Balling

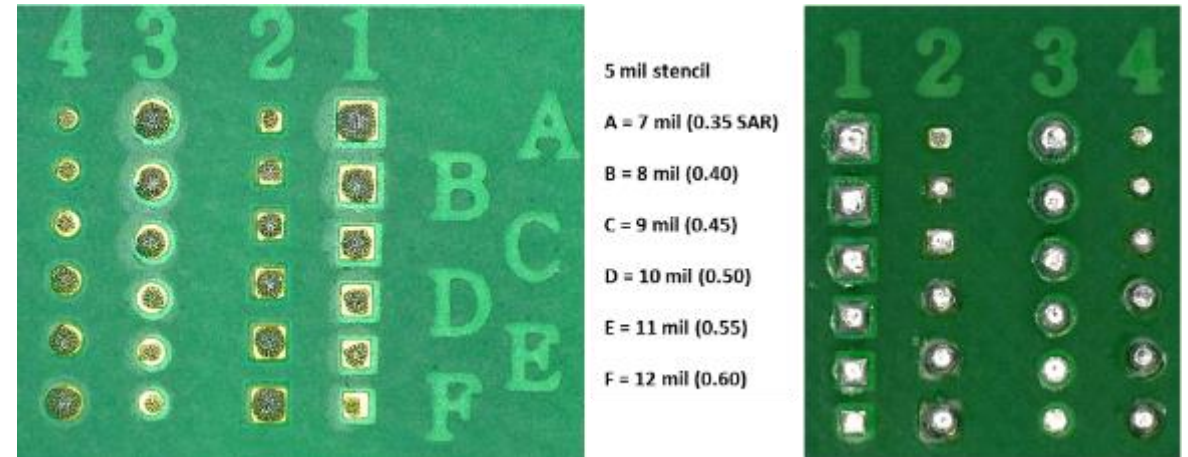


Overprint 500%
to 1250%

Reflow

Inspect flux pools
for solder balls

Graping



Print 0.35 to
0.60 area ratios

Reflow

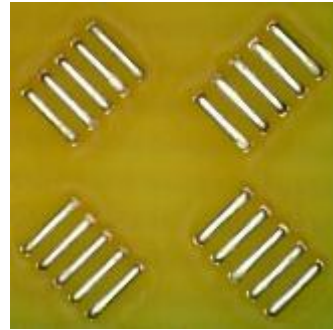
Inspect solder
and count graping

Solder Balling and Graping

Test	Solder Paste A	Solder Paste B	New SP	Best Possible Result / Goal
Graping (%)	42%	9%	17%	0%
Solder Balling (<10 balls)	900% overprint	1250% overprint	1250% overprint	1250%
Solder Balling (<5 balls)	750% overprint	1100% overprint	1250% overprint	1250%

Water Washability

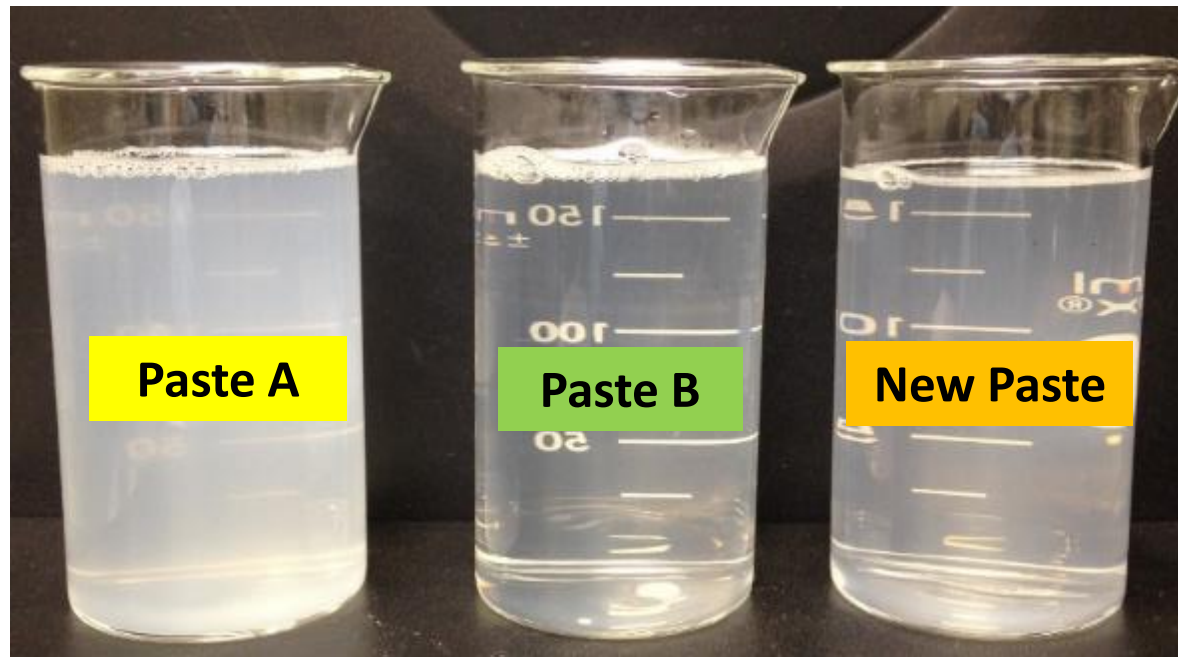
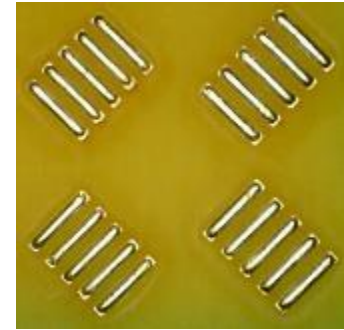
Paste A



Paste B



New Paste



Paste B and the
New Paste are
Water Soluble

Summary of Results

Test Method / Property	Solder Paste A	Solder Paste B	New Solder Paste
Environmental stability: Low relative humidity	0	0	0
Environmental stability: High relative humidity	+	-	0
Tack force change over 72-hours	+	0	-
Tack force change over 8-hours	0	-	+
Reactivity testing: 6-hour mix	0	Not determined	+
Stencil life: 8-hour print test	+	-	0
Print speed variation: 20, 50, 100 mm/sec	+	-	0
Wetting on ENIG	+	+	+
Wetting on OSP	0	-	+
Solder balling	-	0	+
Graping	-	+	0
Water washability: circuit board cleanliness	0	-	0
Water washability: solubility in water	-	0	0
Sum of Rankings (+ and -)	5 (+) 3 (-)	2 (+) 6 (-)	5 (+) 1 (-)
NET RANK	2 (+)	4 (-)	4 (+)

Conclusions

- The development process created a new high performance lead-free water soluble solder paste.
- The new solder paste exceeds the overall performance of two solder pastes used in the market for many years.
- The test methods used to evaluate solder paste performance are rigorous and evaluate key characteristics that are desirable in solder pastes.
- The new solder paste may be “wet behind the ears” but promises to become the “wave of the future”.



Acknowledgments

- ✓ The author would like to thank the R&D Team at FCT Assembly for their work running tests and gathering data for this paper.

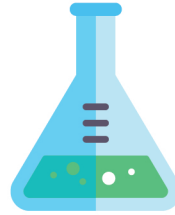


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