UW- Crane Capstone: Sn62 Water Soluble Flux Paste System

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Background

Soldering is the process of joining two metal surfaces together by melting a filler metal, called **solder**. **Solder flux** is a chemical product that improves wetting and oxidation resistance during soldering, thus ensuring the reliability of the connections or joints. **Solder paste** is a ready-to-use mix of finely powdered metal solder in a flux medium.

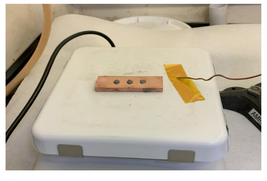
Crane Aerospace and Electronics uses solder pastes that require harsh cleaning solvents to be removed. These pastes are currently being phased out by environmental and health authorities, causing obsolescence concerns. To adapt, Crane launched this capstone project with the University of Washington whose goal was to **analyze commercially available, water-soluble solder pastes and evaluate their ability to meet industry, Crane, and UW criteria.** Specifically, evaluations was made of the pastes' abilities to adhere to and wet surfaces, minimize bridging, and be cleaned with only water.

Methods

Phase 1

Five tests were conducted to evaluate the solder paste and flux systems:

- Solder Ball: Evaluates the tendency of the solder pastes to form unwanted solder balls after reflowing to understand its spread and coalescence properties.
- Solderability: Evaluates the ability of the solder paste to adhere to and wet a surface.



Phase 2

- Cleanability: Determines how well the solder pastes' flux residue can be removed after reflowing with mechanical agitation in a DI water bath.
- Wetting: Evaluates how well the solder paste spreads and adheres to metal surfaced for joint reliability.
- Slump: Examines the spread of solder pastes over time to detect excessive spreading or bridging between solder pads.

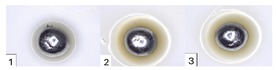
Selected Pastes for Testing

Manufacturer	Solder Paste Name	Classification
Kester	R562	ORH0
Kester	HM531	ORM0
AIM	WS488	ORM1
Indium	Indium6.3	ORH0
Indium	Indium6.6HF	ORH0

Results & Discussion

Phase 1

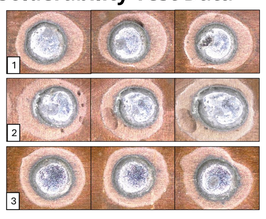
Solder Ball Test Data



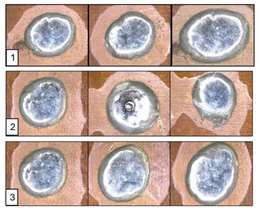
Pass for Solder Ball Test Indium 6.6HF

Pass and acceptable Solder Ball Test Kester R562

Solderability Test Data



Pass for Solderability Test Indium 6.6HF



Fail for Solderability Test Kester R562

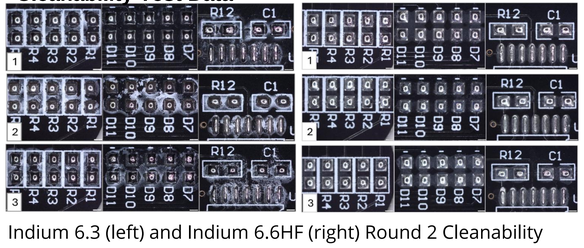
The tests above show Indium 6.6 HF passing in left image, while Kester R562 failed these tests, as shown on the right.

- Kester failed to maintain a circular shape after reflow and doubled in size
- Indium 6.6 maintained a circular shape and spread after reflow within acceptable limits

An increase in diameter of the applied solder paste after reflow is undesirable, as this can lead to solder bridging in electronic components. Given that the paste needs to pass both tests in phase 1, AIM WS488 was removed because it was not an Sn62, Kester R562 failed solderability, and HM531 failed solder ball. The solder pastes were down selected to only Indium 6.3 and Indium 6.6HF.

Phase 2 of Testing

Cleanability Test Data



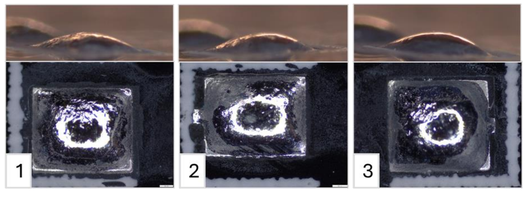
Indium 6.3 (left) and Indium 6.6HF (right) Round 2 Cleanability

Both Indium 6.3 and Indium 6.6HF were classified as Level 2, or acceptable, in the cleanability testing portion.

- Some flux residue was remained on the substrates after cleaning, even after using mechanical force with an organic solvent
- Indium 6.3 showed more residual white hue than Indium 6.6HF

Wetting Test Data

Solder Paste	Criteria	Trial 1	Trial 2	Trial 3
Indium 6.3	Level	Level 2	Level 1	Level 2
	Contact Angle	27.3°	28.5°	32.6°
	Spread Ratio (Final/Initial)	0.958	0.907	0.758
	Observations	Good wetting, several beads found around the solder area.	Good wetting, no beading	Good wetting, no beading
Indium 6.6HF	Level	Level 1	Level 1	Level 1
	Contact Angle	20.3°	18.5°	22.8°
	Spread Ratio	0.947	0.896	0.939
	Observations	Good wetting, no beading	Good wetting, no beading	Good wetting, no beading

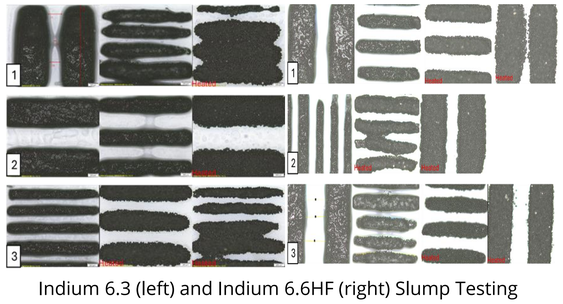


Indium 6.6 Wettability Testing

- Indium 6.6HF consistently had contact angles less than 30° and exhibited no dewetting, indicating it had excellent wettability.
- Indium 6.6HF exhibited larger contact angles than Indium 6.6HF and showed some signs of dewetting (beading).
- No significant difference in spread between the two pastes.

Using these measured results, it was found that Indium 6.6HF met Level 1 criteria for ALL trials; performing better than Indium 6.3.

Slump Test Data



Indium 6.3 (left) and Indium 6.6HF (right) Slump Testing

Indium 6.3:

- Non-heated samples did not experience bridging,
- Heated samples did exhibit some bridging

Indium 6.6HF:

- Both non-heated and heated samples exhibited minimal bridging

In Phase 2 it was evaluated that the cleanability, wetting and slump met standards, regarding leftover residue after cleaning, the contact angle and how much bridging occurred.

- Indium 6.3 and Indium 6.6 performed similarly for cleanability and slump tests
- However, Indium 6.6's contact angle in the wetting test performed better than Indium 6.3 meeting the under 30° contact angle on all measurements

Conclusion

Our final recommendation based of all the results from Phase 1 and 2 testing would be the Indium 6.6HF solder paste. Though some level of visual residue after cleaning was deemed acceptable, as elemental analysis on the residues was not performed, it is not known whether they contain any corrosive substances. Consequently, it would be best to proceed with caution regarding the presence of these white hues left behind by the flux. Thus, it is important that Indium6.6HF did not leave as significant residues after cleaning as the other paste, Indium 6.3, tested during Phase 2. Indium 6.6HF also met contact angle requirements during wetting, and both heated and non-heated samples had minimal bridging for spacings down to 0.7mm. It also performed better in terms of bridging compared to Indium 6.3.

Acknowledgements

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CRANE AEROSPACE & ELECTRONICS

MATERIALS SCIENCE & ENGINEERING

Sources

IPC-TM-650 2.4.35: Test Methods Manual
IPC J-STD-005: Requirements for Solder Pastes
MIL-STD-883E: Test Method Standard for Microcircuits
IPC-TM-650: Test Methods Manuals