Formulation of a New Liquid Flux for High Temperature Soldering

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FCT Companies
Outline/Agenda

- Introduction
- Experimental Methods
- Results of Experiments
- Conclusions
- Acknowledgements
- Q & A
Introduction

Wave soldering is alive and well!
Wave Soldering

- Provides quick soldering of multiple holes
- Large thermal capacity lends itself to challenging assemblies
- Ideal for high volume production
The Role of Flux

- Aids in solder wetting
- Removes oxides
- Can provide thermal protection for the circuit board

No Flux  Flux
Why Formulate a New Flux?

- Fluxes were formulated for tin-lead temps
- Need fluxes for high temps and long contact times
- Selective soldering uses much higher temps than wave
Attributes of Water Soluble Flux

- Works with high temperatures:
  - Wave 290 °C
  - Selective 315 °C
- Optimal hole fill & minimal bridging
- Halide & halogen free
- Neutral pH
- Easy to wash and no residues
- Used in wave & selective and with all solder types
Wave vs. Selective Soldering
Wave vs. Selective Soldering

Flux application → Pre-heat → Wave solder → Pre-heat (optional) → Flux application → Selective solder
Fluxing Systems

Foaming:
- Solvent evaporates
- Flux concentrates over time
- Applied liberally to the board

Spray and Jet:
- Minimal solvent loss
- Localized application
- Small nozzles can clog
Flux System Requirements

Foaming:
- Hold stable foam head, but not too much foam
- Able to be analyzed for solvent addition
- Non-corrosive to other contacted areas

Spray and Jet:
- Non-clogging
- Easy to turn into micro-droplets
- Non-corrosive in overspray areas
Experimental Method

1. Create test fluxes
2. Test in the lab
3. Scale up for beta-site testing
4. Use feedback to refine the formulation
5. Verify performance in the lab and beta-sites
6. Finalize the new flux
Standard Test Board

- 0.062” (1.57 mm) thick
- Double sided
- 0.5 ounce copper weights
- Hole sizes - finished:
  - 0.055” (1.40 mm)
  - 0.039” (0.99 mm)
  - 0.032” (0.81 mm)
Thermally Demanding Test Board

- 0.092” (2.34 mm) thick
- 4 layer board
- 2.0 ounce copper weights

Hole sizes - finished:
- 0.060” (1.52 mm)
- 0.043” (1.09 mm)
- 0.027” (0.68 mm)
- 0.016” (0.41 mm)
- 0.013” (0.33 mm)
- 0.007” (0.18 mm)
<table>
<thead>
<tr>
<th>NC = NO CONNECT</th>
<th>1C = 1 LAY</th>
<th>CONNECT</th>
<th>2C = 2 LAY CONNECT</th>
<th>2C</th>
<th>1C</th>
<th>NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>020 HOLES</td>
<td>061 HOLES</td>
<td>0156 HOLES</td>
<td>0453 HOLES</td>
<td>010 HOLES</td>
<td>0295 HOLES</td>
<td></td>
</tr>
</tbody>
</table>

Thermally Demanding Test Board
Flux Ingredients

- Solvents – isopropanol and others
- Activators – organic acids
- pH adjustors – bases
- Wetting agents – surfactants
- Other additives
# Flux Properties

<table>
<thead>
<tr>
<th>Flux</th>
<th>Density (g/cc)</th>
<th>Halogens</th>
<th>Non-volatile content (% wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>0.87</td>
<td>yes</td>
<td>20</td>
</tr>
<tr>
<td>SP 20%</td>
<td>N/A</td>
<td>yes</td>
<td>20</td>
</tr>
<tr>
<td>W</td>
<td>0.92</td>
<td>yes</td>
<td>40</td>
</tr>
<tr>
<td>X</td>
<td>0.93</td>
<td>yes</td>
<td>40</td>
</tr>
<tr>
<td>Y</td>
<td>0.90</td>
<td>yes</td>
<td>37</td>
</tr>
<tr>
<td>Z</td>
<td>0.92</td>
<td>yes</td>
<td>38</td>
</tr>
<tr>
<td>A</td>
<td>0.91</td>
<td>no</td>
<td>26</td>
</tr>
<tr>
<td>B</td>
<td>0.91</td>
<td>no</td>
<td>27</td>
</tr>
<tr>
<td>C</td>
<td>0.90</td>
<td>no</td>
<td>27</td>
</tr>
<tr>
<td>D</td>
<td>0.88</td>
<td>no</td>
<td>28</td>
</tr>
<tr>
<td>E</td>
<td>0.85</td>
<td>no</td>
<td>24</td>
</tr>
<tr>
<td>F</td>
<td>0.85</td>
<td>no</td>
<td>26</td>
</tr>
<tr>
<td>G</td>
<td>0.85</td>
<td>no</td>
<td>26</td>
</tr>
<tr>
<td>I</td>
<td>0.86</td>
<td>no</td>
<td>25</td>
</tr>
</tbody>
</table>
Standard Test Board

Less than 100% filled

Ideal 100% filled
Standard Test Board

Percentage of Holes Filled at 260 °C
Standard Test Board

Percentage of Holes Filled at 280 °C

- Current
- Sp 20%
- W
- X
- Z
- A
- C
- D
- F
- G
- I

- 0.055" diameter
- 0.039" diameter
- 0.032" diameter
Standard Test Board

Percentage of Holes Filled at 300 °C

- Current
- SP 20%
- Z
- A
- C
- D
- F
- G
- I

- 0.055" diameter
- 0.039" diameter
- 0.032" diameter
Standard Test Board

Average Flux Performance

- Current
- SP 20%
- Z
- A
- C
- D
- F
- G
- I

Legend:
- 260C
- 280C
- 300C
Water Washability

Flux A

Flux E
## Water Washability

<table>
<thead>
<tr>
<th>Flux</th>
<th>Water Wash Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>Washed clean. No residues</td>
</tr>
<tr>
<td>SP 20%</td>
<td>Washed clean. No residues</td>
</tr>
<tr>
<td>W</td>
<td>White haze over surface</td>
</tr>
<tr>
<td>X</td>
<td>White haze over surface</td>
</tr>
<tr>
<td>Y</td>
<td>White haze over surface</td>
</tr>
<tr>
<td>Z</td>
<td>Faint residue on surface, but improved over W, X, and Y</td>
</tr>
<tr>
<td>A</td>
<td>Gratuituous white waxy residue, especially around solder joints</td>
</tr>
<tr>
<td>B</td>
<td>Waxy residue</td>
</tr>
<tr>
<td>C</td>
<td>Waxy residue</td>
</tr>
<tr>
<td>D</td>
<td>Waxy residue</td>
</tr>
<tr>
<td>E</td>
<td>Washed clean. No residues</td>
</tr>
<tr>
<td>F</td>
<td>Washed clean. No residues</td>
</tr>
<tr>
<td>G</td>
<td>Washed clean. No residues</td>
</tr>
<tr>
<td>I</td>
<td>Washed clean. No residues</td>
</tr>
</tbody>
</table>
Thermally Demanding Test Board

Less than 100% filled

Ideal 100% filled
Thermally Demanding Test Board

Percentage of Holes Filled
Flux Current - 260 °C

- 60 mil holes
- 43 mil holes
- 27 mil holes
- 16 mil holes
- 13 mil holes
- 7 mil holes

2C 1C NC
Thermally Demanding Test Board
Thermally Demanding Test Board

- Percentage of Holes Filled
- Flux Current - 280 °C
- Flux SP20 - 280 °C
- Flux Z - 280 °C
- Flux I - 280 °C
Thermally Demanding Test Board
Thermally Demanding Test Board

Percentage of Holes Filled
Flux Current - All Temperatures

Flux Current

- 0C: 260 C
- 1C: 280 C
- 2C: 300 C

16 mil holes
13 mil holes
Thermally Demanding Test Board

Percentage of Holes Filled
Flux I - All Temperatures

- 0°C
- 1°C
- 2°C

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

260°C 280°C 300°C

16 mil holes
13 mil holes
Beta Site Testing

Wave soldering
- SAC305, SN100C and 63Sn / 37Pb alloys
- Excellent soldering results
- Good Washability

Selective soldering
- SAC305, SN100C and 63Sn / 37Pb alloys
- Excellent soldering results
- Working well with drop jet systems
Conclusions

This process created a new flux:

- Works with high temps & long contact times
- Also works with low temps / leaded solder
- Halogen and halide free
- Easy to wash / leaves no residues
- Beta site testing shows good results with wave, selective and multiple alloys
Acknowledgements

We thank Jay Vyas at SigmaTron International for his continued support and beta site testing.

Much appreciation to Sven Bock of FCT Companies for his help with design and production of our test boards.
Thank You!

Any Questions?

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