ADDITIVE SERIES PROCESS FOR FLEXIBLE SOLDER RESIST - OUR NEW STANDARD

Webinar
09.11.2021
Markus Kennert
Jürgen Wolf
AGENDA

1. Flexible solder resist in the conventional process
2. Flexible solder resist in additive technology
   - Process flow and procedures
   - Technology comparison
   - Presentation of the equipment and flexible inkjet solder resist
3. Summary
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FLEXIBLE SOLDER RESIST
What does „flexible solder resist“ mean?

Common industry terms:
- Flexible lacquer, flexible solder mask or flexible solder resist

Flexible solder resist serves different purposes on a printed circuit board for electronic circuits:
- Protection of copper structures in bendable areas of
  - flex-rigid with external flex
  - semiflex (thinned FR4 for simple flex-to-install applications without polyimide)
- Flex-to-Install – multiple bending capability
- Small bending radii
- Defined transition rigid to flexible solder resist
- Replacement of expensive polyimide coverlay, which is partially applied
FLEXIBLE SOLDER RESIST
The "conventional" process flow

Screen printing of flexible resists:

1. create screen
2. pre-cleaning
3. screen printing
4. thermal curing
5. screen washout
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Flexible solder resist in additive technology:

- Pre-cleaning
- Inkjet printing
- UV-curing
- Thermal curing
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY
How to print? Schematic Illustration

Basic procedure:

- 1\textsuperscript{st} printing step: Covering of the edges

- 2\textsuperscript{nd} printing step: Filling of the flex area
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY
How to print?

3D-printing with multiple printheads in parallel

UV-LEDs
Printheads (behind cover)
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY
How to print? Real time process

Printing of flexible solder resist using additive technology in production
Flexible solder resist in additive technology:

- pre-cleaning
- Inkjet printing
- UV-curing
- thermal curing

For comparison, once again, the application by screen printing:

- create screen
- pre-cleaning
- screen printing
- thermal curing
- screen washout
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY
Implementation in the Niedernhall flex-rigid plant

Presentation of the equipment and flexible inkjet solder resist

MicroCraft CPQ7861
MicroCraft MPJ101-FG20
UV & thermal curable inkjet solder resist
presentation of the equipment and flexible inkjet solder resist

welcome,

Takayuki Hidehira
Executive Vice President – MicroCraft

and

Hans Fritz
General Manager – SAT Electronic GmbH
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY
Presentation of the machine and the inkjet printable resist

MicroCraft CPQ7861

- Extremely fast printheads: discharge frequency of up to 45 kHz and 1024 nozzles per head
- 4 parallel printheads for high throughput
- Automatic high-pressure “Air Purge System”, prevents clogging of the nozzles
- Selectable resolutions up to 2160 dpi
- Serialization and Barcode is possible
- Table with edge clamps and vacuum suction
- Loader and Unloader available (CPA)
Presentation flexible solder resist

MicroCraft MPJ101-FG20

- Designed for the use in CraftPix series printers
- Designed to work with printers with piezo-electric printheads
- Specially developed for direct-to PCB
- Requires chemical or physical pretreatment
- Applications include:
  - Flexible PCBs (Polyimid)
  - Flex-rigid PCBs
  - Metal or plastic substrates
- Certified UL 94 V-0
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY
Presentation of the machine and the inkjet printable resist

MicroCraft MPJ101-FG20 – Extract from the TDS

<table>
<thead>
<tr>
<th>Item</th>
<th>Test method</th>
<th>Test standard</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencil Hardness</td>
<td>On Copper</td>
<td>IPC-SM-840C 3.5.1</td>
<td>3H Pass (Above 3H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IPC TM650 2.4.27.2 (ASTM D3363)</td>
<td></td>
</tr>
<tr>
<td>(Lead-free) Solder</td>
<td>Solder float test, Rosin Flux</td>
<td>IPC-SM-840C 3.7.2 (288°C / 10 sec, 1cycle)</td>
<td>Passed</td>
</tr>
<tr>
<td>Heat Resistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhesion</td>
<td>Cross Cut 10x10 &amp; Tape peeling test On Cu foli/FR-4</td>
<td>IPC-SM-840C 3.5.2</td>
<td>Passed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IPC TM 650 2.4.16 (ASTM D3359) (J-STD-003)</td>
<td></td>
</tr>
<tr>
<td>Solvent Resistance</td>
<td>PGM-Ac and IPA, 20°C / 30min</td>
<td>IPC-SM-840C 3.6.1</td>
<td>Passed</td>
</tr>
<tr>
<td>Electroless Ni/Au</td>
<td>Ni: 3 - 5µm, Au: 0.03µm</td>
<td>Internal Test Method</td>
<td>Passed</td>
</tr>
</tbody>
</table>
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY

Presentation of the machine and the inkjet printable resist

MicroCraft MPJ101-FG20 – Extract from the TDS

<table>
<thead>
<tr>
<th>Item</th>
<th>IPC-SM-840E Test Method</th>
<th>Standard</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric Strength</td>
<td>Determined in accordance with TM2.5.6.1 of IPC-TM-650.</td>
<td>No change of ink in DC 500V (25μm)</td>
<td>Passed</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>Minimum resistance before and after soldering.</td>
<td>More than 5×10⁹ ohm</td>
<td>Passed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 5×10⁹ ohm</td>
<td></td>
</tr>
<tr>
<td>Moisture &amp;</td>
<td>25-65°C 85%RH cycling for 7 days Bias voltage 50 V D.C.</td>
<td>More than 5×10⁹ ohm</td>
<td>Passed</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td></td>
<td>More than 5×10⁹ ohm</td>
<td></td>
</tr>
<tr>
<td>Electrochemical</td>
<td>Class H/FT-85a2°C 90±3%RH 168hrs. Bias voltage 10 V D.C.±5%.</td>
<td>More than 2×10⁶ ohm</td>
<td>Passed</td>
</tr>
<tr>
<td>Migration</td>
<td></td>
<td>No change of appearance</td>
<td></td>
</tr>
<tr>
<td>Thermal Shock</td>
<td>-65°C 15min to +125°C 15min, Transition should not exceed 2 minutes. 1000 cycles.</td>
<td>No blistering, crazing, and delamination</td>
<td>Passed</td>
</tr>
<tr>
<td>Flammability</td>
<td>UL-94</td>
<td>V-0</td>
<td>Passed</td>
</tr>
<tr>
<td>Bending Test</td>
<td>30μm on Polyimide Film 180° Folding (500g Weight)</td>
<td>Above 3Cycle</td>
<td>Passed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No Crack, Delamination</td>
<td></td>
</tr>
<tr>
<td>Halogen-free</td>
<td>JPCA-E501-2003</td>
<td></td>
<td>On going</td>
</tr>
</tbody>
</table>
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY

Presentation of the machine and the inkjet printable resist

MicroCraft MPJ101-FG20

- Excellent continuous temperature resistance at 125°C:
  - after 500h still 25 cycles 180° bending around 1mm mandrel
  - previous screen printing resist already cracks after 250h

check for cracks
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY

Quick poll

Poll

At present, we have a distance from the copper to the flex-rigid transition of 1000µm in the standard for build-ups with flexible solder resist.

Which value would you like to see for a new process to support miniaturisation?
FLEXIBLE SOLDER RESIST
Comparison of the technologies – Details

Design Rules (e.g. 1F – xRi)

Now

Technical standard  Advanced requirements
G Flexible lacquer: Spacing, exposed Cu to flex-rigid transition coupling (top) ≥ 1000 µm  ≥ 800 µm

New

Technical standard  Advanced requirements
G1 Flexible lacquer: Spacing, exposed Cu to flex-rigid transition coupling (top) ≥ 800 µm  ≥ 400 µm

Now ≥ 400 µm
New ≥ 800 µm

-50%
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY
The detailed view

Higher Accuracy

- Reduction of the distances
  - flex resist to copper and thus
  - less overlapping flex resist to rigid resist
  possible

- Better usage of the rigid area, especially with narrow layouts

- Further reduction possible in future
FLEXIBLE SOLDER RESIST IN ADDITIVE TECHNOLOGY

The detailed view

Microsections

Coverage of copper structures on flex

Overlap flexible to rigid solder resist
## FLEXIBLE SOLDER RESIST

### Process comparison

<table>
<thead>
<tr>
<th></th>
<th>conventional</th>
<th>digital additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of process steps</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Equipment costs</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Resist costs</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Screen preparation costs</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Screen washout costs</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Resist waste</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>↓</td>
<td>↑</td>
</tr>
</tbody>
</table>

Equipment and resist costs lead to a cost-neutral process.

Digital additive process is more sustainable.
Poll

What further developments would you like to see from WE on the subject of flexible solder resists?
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Flexible solder resist applied via Inkjet

- represents a digital and additive technology
- meets all common flexible solder resist specifications
- offers minimal thickness variation
- can be combined with legend printing
- promotes greater design freedom by reducing spacing requirements by half compared to conventional screen-printing resists
- provides higher reliability with higher bending cycles
Flexible solder resist in additive technology

What kind of application do you have?

How can WE support you?

Talk to our “FLEXperts”

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