IPC SMTA Surface Mount Technology Association
High-Reliability Cleaning and Conformal Coating Conference

Evaluating Masking Residues

Doug Pauls
Principal Materials and Process Engineer
Rockwell Collins

Masking Residues

10.2 Conformal Coating – Masking When used, masking materials **shall (D1D2D3)** have no deleterious effect and **shall [D1D2D3]** be removable without leaving contaminant residue. Dimensions of masked areas **shall not [D1D2D3]** be decreased in length, width, or diameter by more than 0.75 mm [0.03 in] by application of conformal coating.

- So how does one gauge “deleterious effects” and “without leaving contaminant residue”?
- Could do chemical characterization tests, such as ion chromatography or Fourier Transform Infrared Spectroscopy (FTIR).
  - *Leaves you with the question of is any of the residue harmful?*
- Preferred method is to use Surface Insulation Resistance (SIR) testing
  - *Exposure to heat, humidity and electrical bias*
- Would like the test to be cost effective and simple to run

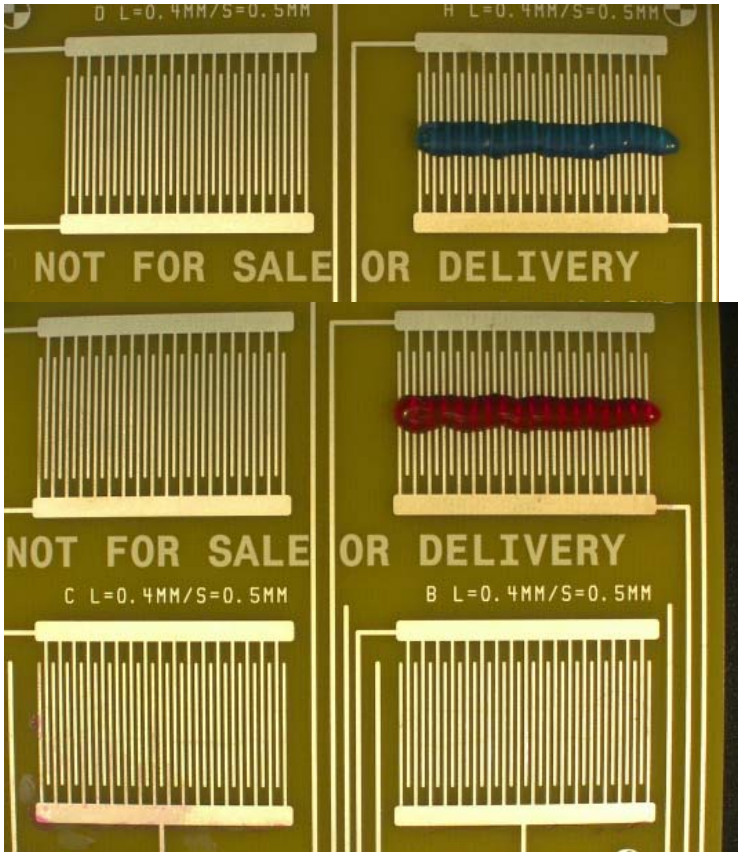
General Approach

- IPC-B-24 test board – relatively inexpensive, can get in a variety of metalizations
  - *Prefer to use a non-reactive metalization like ENIG*
  - *No corrosion or oxidation issues*
- Four identical comb patterns
- Setup for SIR testing
  - *Can do with both hard wiring or edge card connectors*
- Make sure the boards are clean before you do any processing

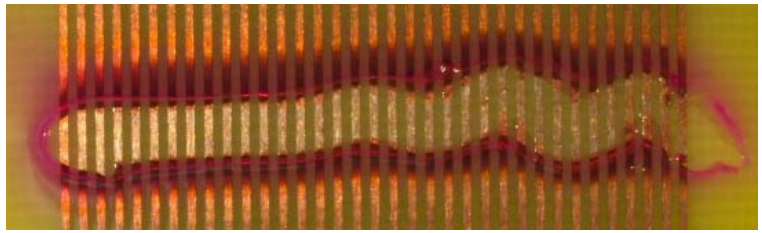
Experimental Approach

- Evaluating 3 masking materials
  - *UV curable peelable masking compound – thicker and blue*
  - *UV curable peelable masking compound – thinner and red*
  - *Hot melt masking compound*
- Evaluated after exposure to hydrofluoroether (HFE) carrier solvent – 2 solvents
- Evaluated for interactions with acrylic coating (B25A Board)
  - *UV cured, then coated*
  - *Coated, then UV cured*
- B-24 board
  - *Comb D – control – no exposure to masking materials*
  - *Comb C – masking compound – Exposure 1 (UV or heat) – removed after coating*
  - *Comb B – masking compound – Exposure 2 (longer UV or hotter heat) – removed after coating*
  - *Comb A – masking compound – Exposure 2 – coated – masking compound left in place*

Examples

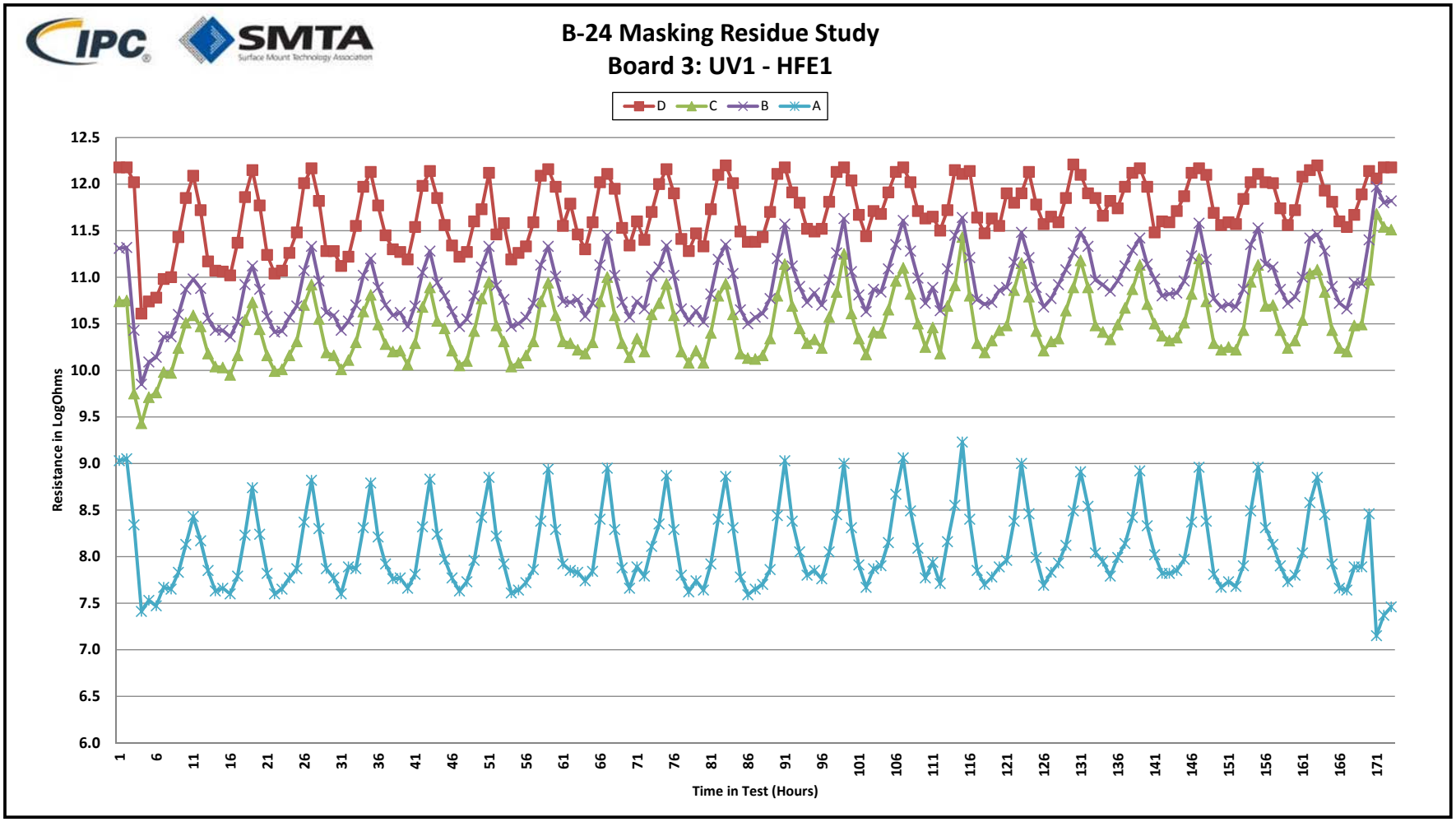

NOT FOR SALE
OR DELIVERY
NOT FOR SALE
C L=0.4MM/S=0.5MM
OR DELIVERY
B L=0.4MM/S=0.5MM

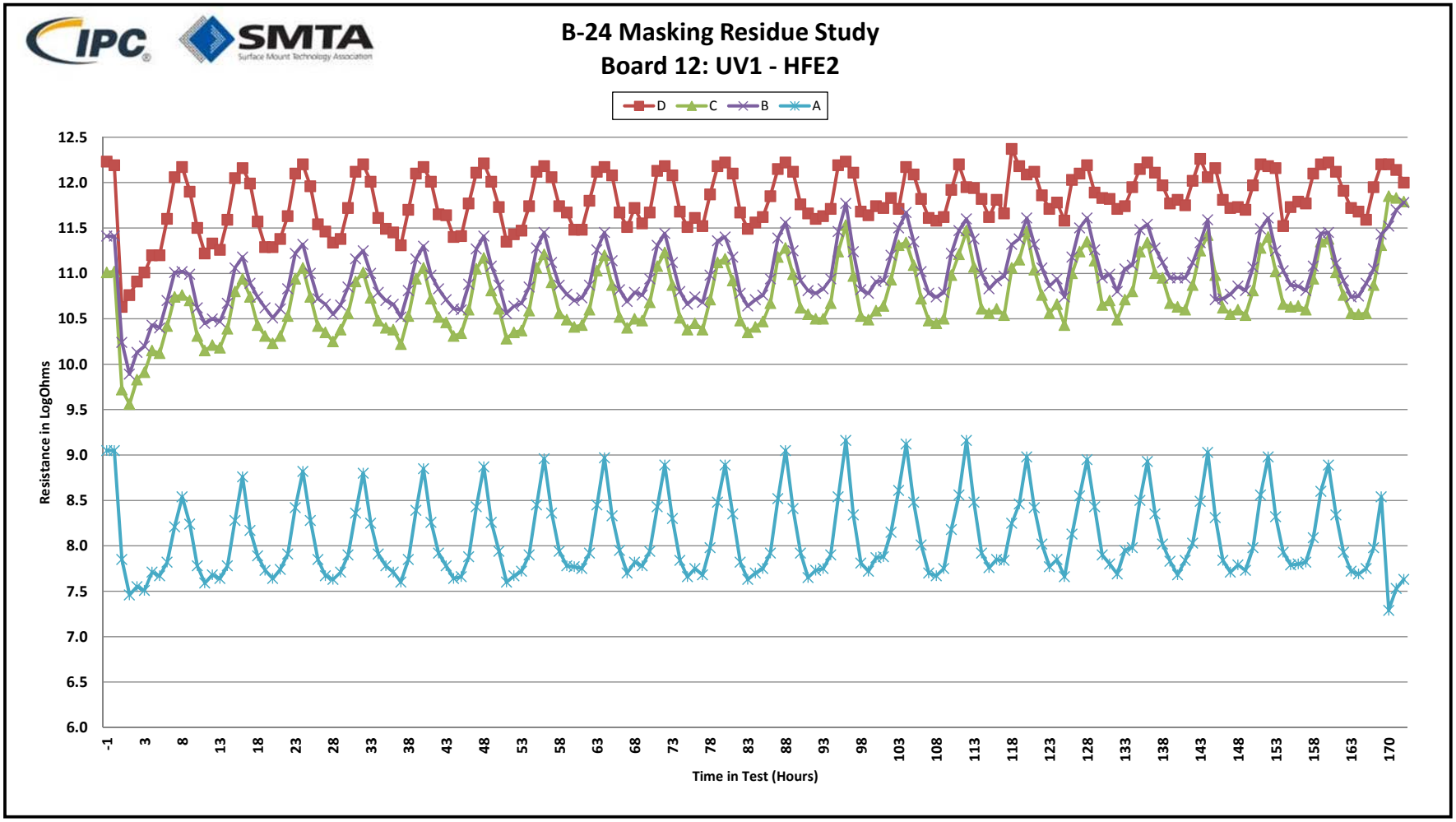

NOT FOR SALE
C L=0.4MM/S=0.5MM
OR DELIVERY
B L=0.4MM/S=0.5MM

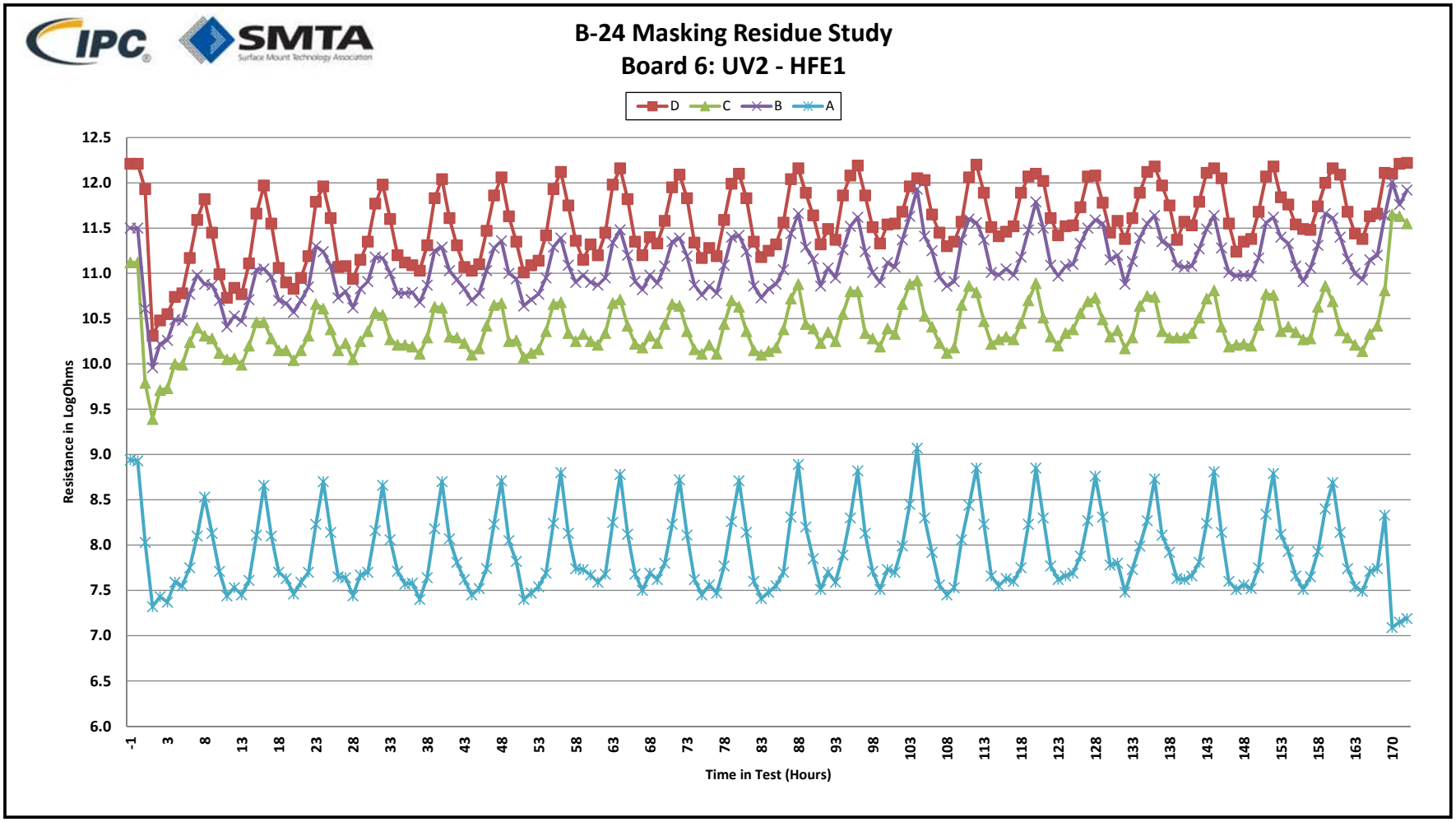


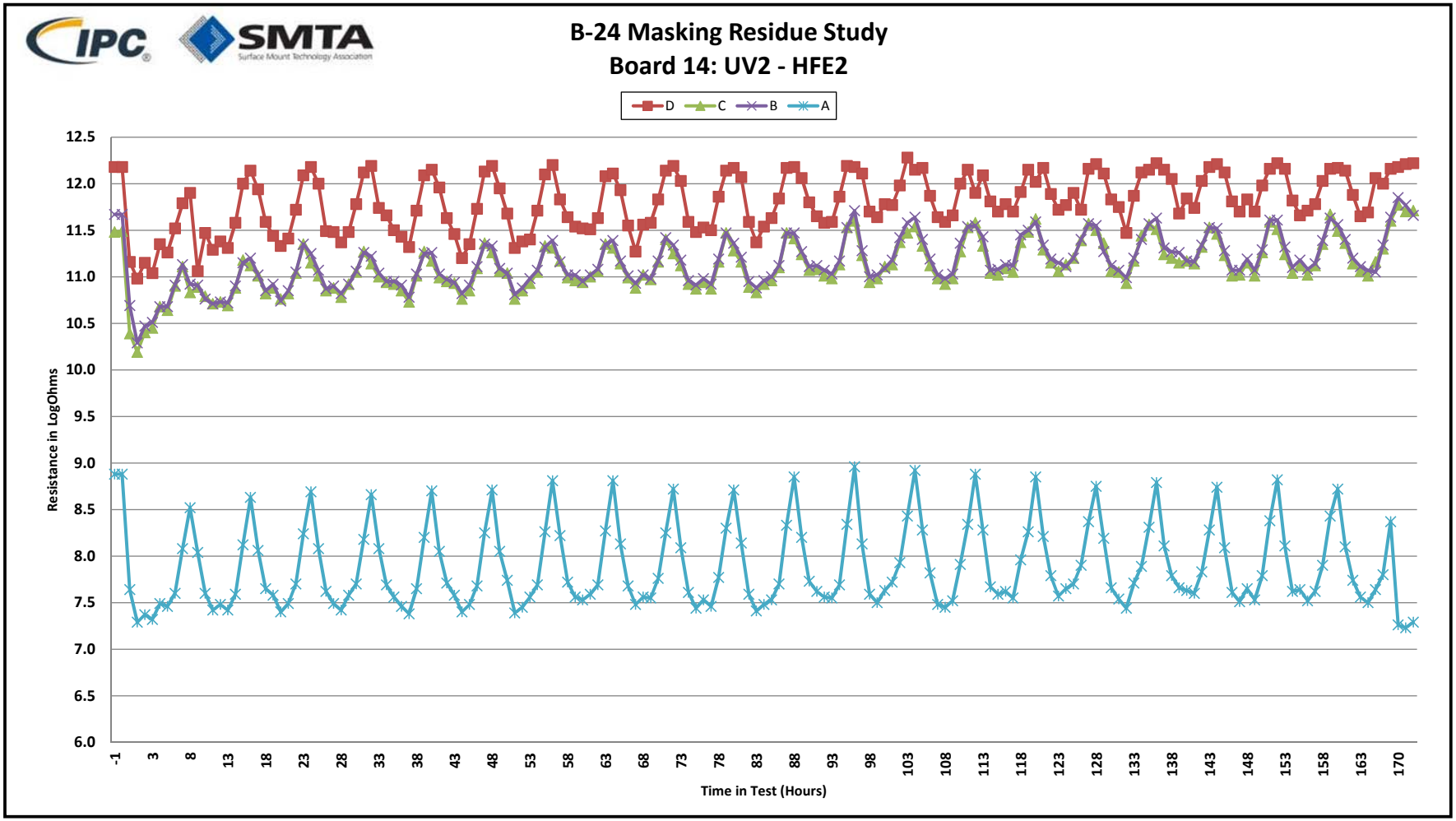
Processing

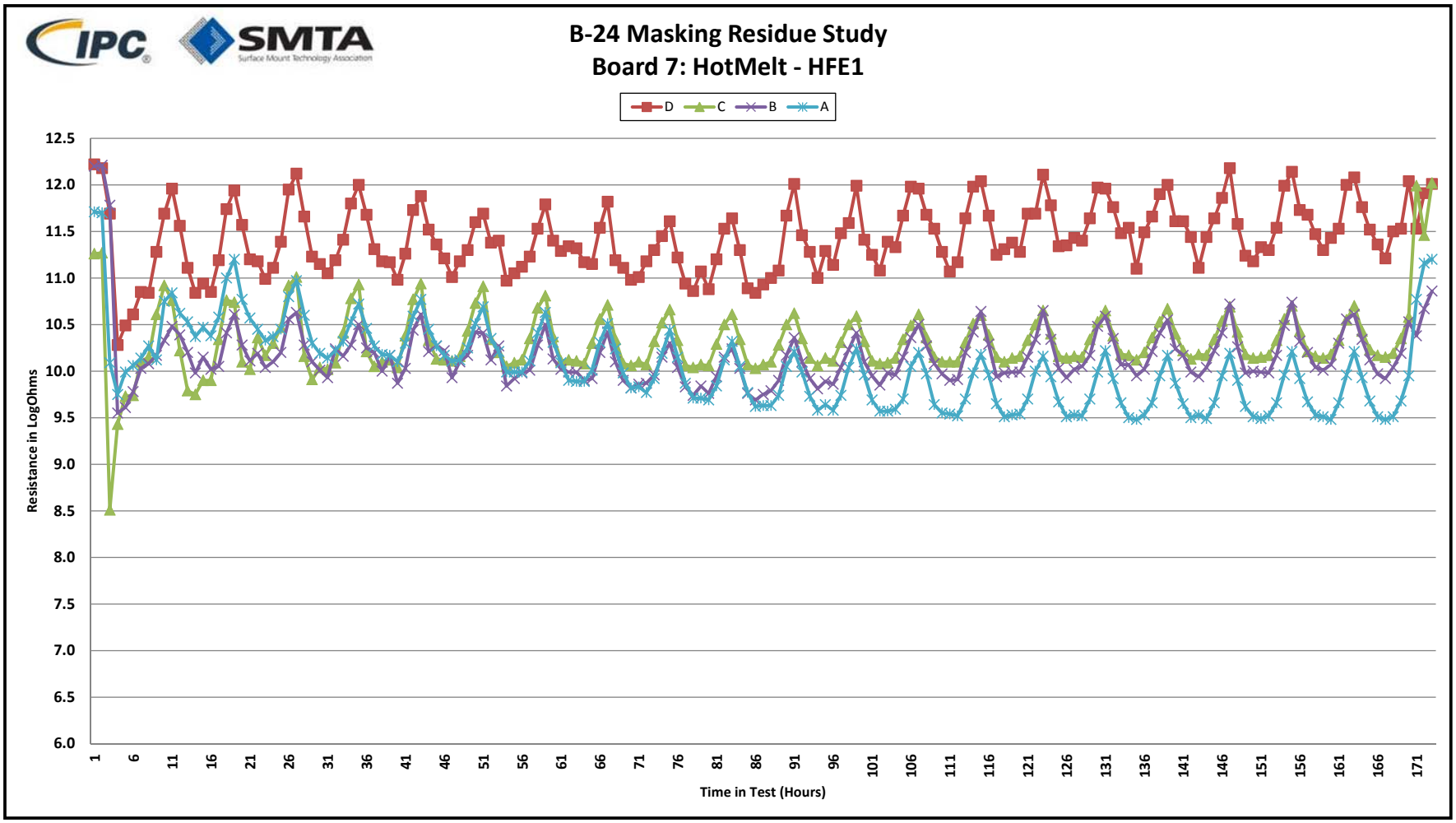
- Precleaned the test boards and dried for 60 min @100C
- Materials dispensed per manufacturers recommended process
  - *UV masking materials – mercury bulb and light pipe – spot curing*
    - Short duration was about 30 seconds, long duration was 60 seconds
    - One set – acrylic coated, UV irradiated when tack free, then removed before cure
  - *Hot melt materials – dispensed with a specialized hot glue gun*
    - Temp 1 – manufacturer's recommend temperature
    - Temp 2 – about 15C hotter than recommended (yields a runnier material)
- HFE exposure was done via dip processing as would be done in production (60 sec)
- Acrylic exposure was done using spray coating, drying in air, curing with IR lamp.
- SIR testing per IPC-TM-650 method 2.6.3.1, measuring hourly
  - *For aerospace, temperature and humidity are cyclic*
- In some cases, also did DWV per IPC-TM-650, method 2.5.7.1

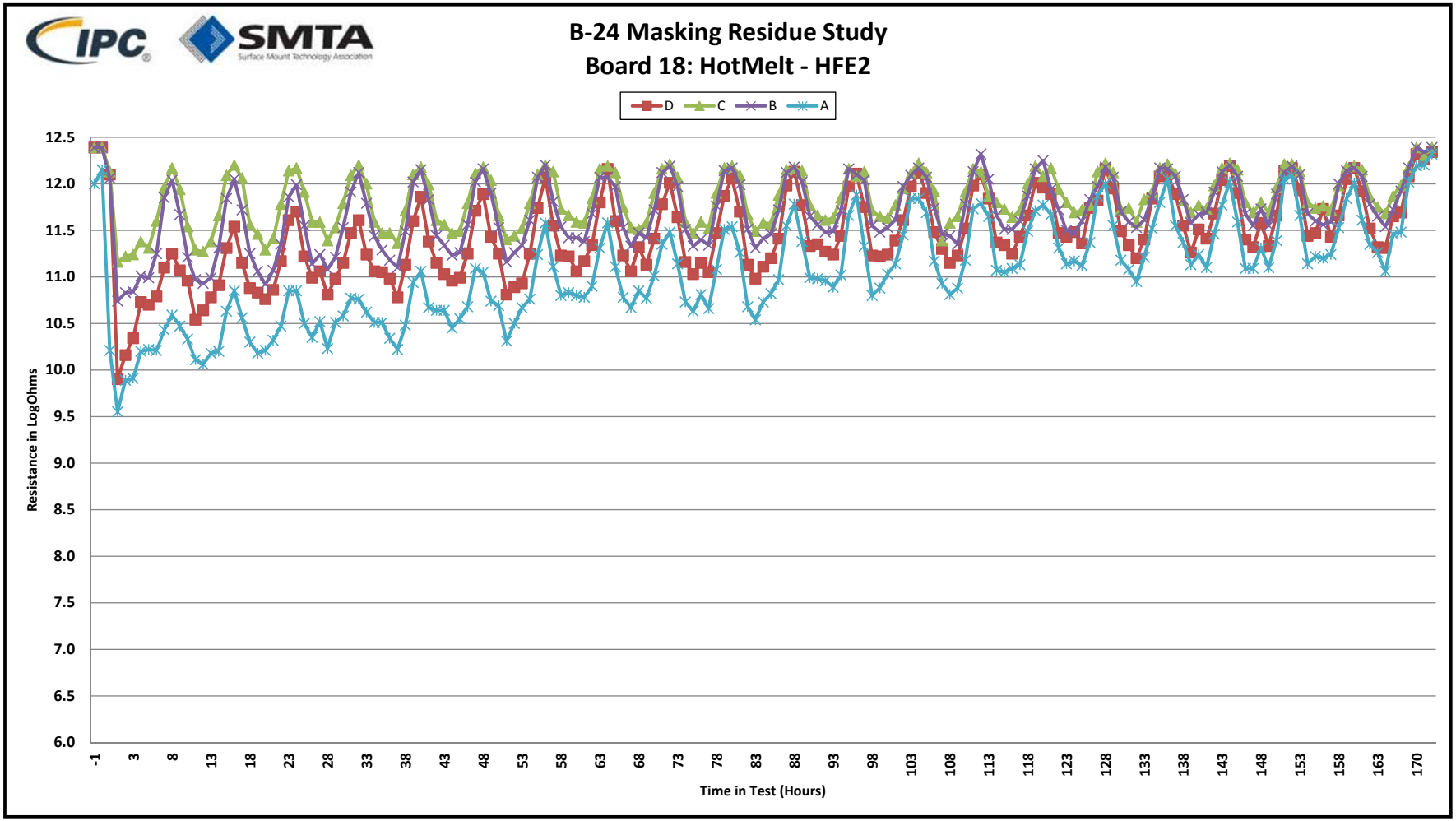

B-24 Masking Residue Study
Board 3: UV1 - HFE1
D
C
B
A
Resistance in LogOhms
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1
6
11
16
21
26
31
36
41
46
51
56
61
66
71
76
81
86
91
96
101
106
111
116
121
126
131
136
141
146
151
156
161
166
171
Time in Test (Hours)

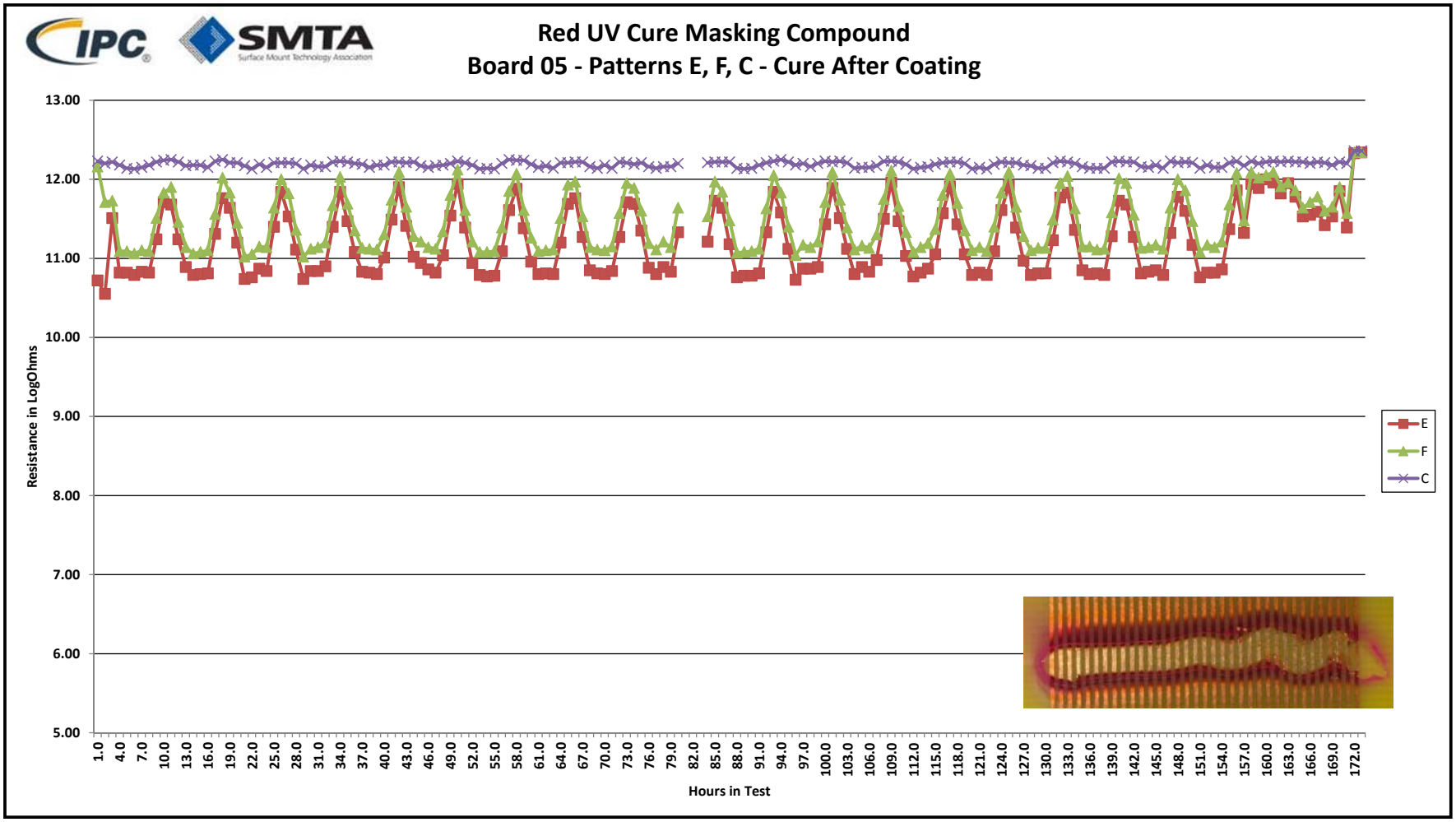

B-24 Masking Residue Study
Board 12: UV1 - HFE2
D
C
B
A
Resistance in LogOhms
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
-1
3
8
13
18
23
28
33
38
43
48
53
58
63
68
73
78
83
88
93
98
103
108
113
118
123
128
133
138
143
148
153
158
163
170
Time in Test (Hours)


B-24 Masking Residue Study
Board 6: UV2 - HFE1
D
C
B
A
Resistance in LogOhms
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
-1
3
8
13
18
23
28
33
38
43
48
53
58
63
68
73
78
83
88
93
98
103
108
113
118
123
128
133
138
143
148
153
158
163
170
Time in Test (Hours)


B-24 Masking Residue Study
Board 14: UV2 - HFE2
D
C
B
A
Resistance in LogOhms
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
-1
3
8
13
18
23
28
33
38
43
48
53
58
63
68
73
78
83
88
93
98
103
108
113
118
123
128
133
138
143
148
153
158
163
170
Time in Test (Hours)


B-24 Masking Residue Study
Board 7: HotMelt - HFE1
D
C
B
A
Resistance in LogOhms
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1
6
11
16
21
26
31
36
41
46
51
56
61
66
71
76
81
86
91
96
101
106
111
116
121
126
131
136
141
146
151
156
161
166
171
Time in Test (Hours)

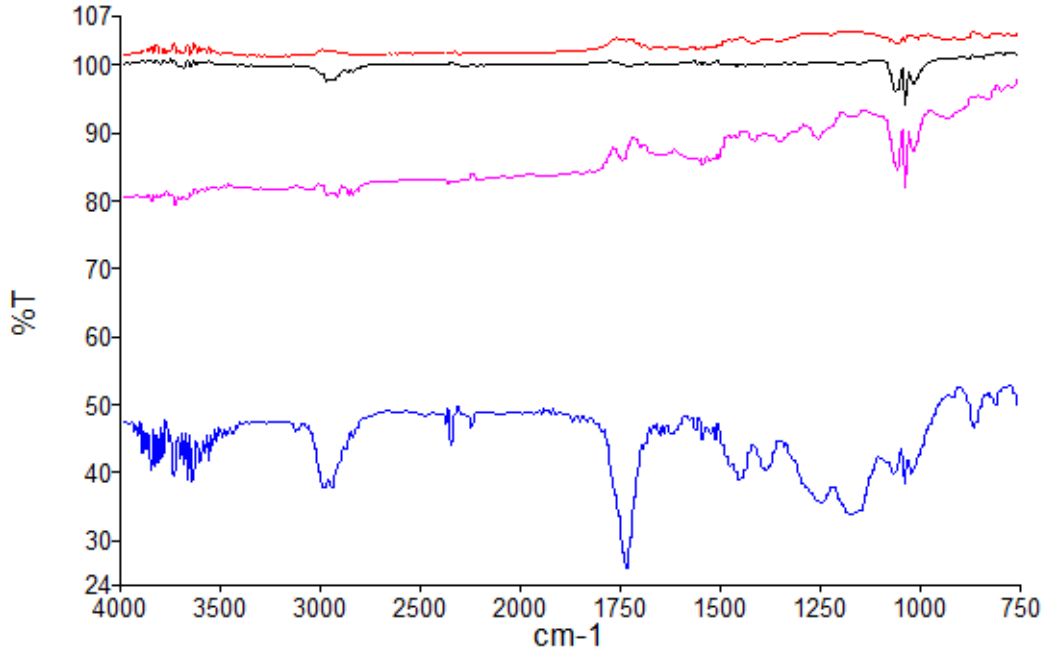

B-24 Masking Residue Study
Board 18: HotMelt - HFE2
D
C
B
A
Resistance in LogOhms
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
-1
3
8
13
18
23
28
33
38
43
48
53
58
63
68
73
78
83
88
93
98
103
108
113
118
123
128
133
138
143
148
153
158
163
170
Time in Test (Hours)


Red UV Cure Masking Compound
Board 05 - Patterns E, F, C - Cure After Coating
Resistance in LogOhms
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
1.0
4.0
7.0
10.0
13.0
16.0
19.0
22.0
25.0
28.0
31.0
34.0
37.0
40.0
43.0
46.0
49.0
52.0
55.0
58.0
61.0
64.0
67.0
70.0
73.0
76.0
79.0
82.0
85.0
88.0
91.0
94.0
97.0
100.0
103.0
106.0
109.0
112.0
115.0
118.0
121.0
124.0
127.0
130.0
133.0
136.0
139.0
142.0
145.0
148.0
151.0
154.0
157.0
160.0
163.0
166.0
169.0
172.0
Hours in Test
E
F
C

Chemical Characterization

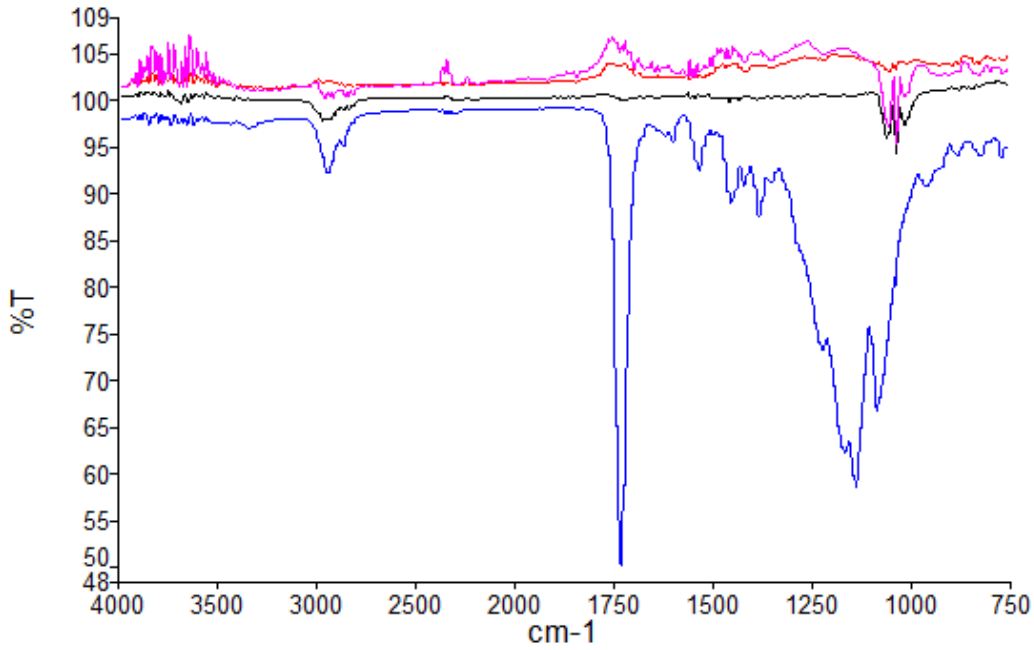
- 2 in x 2 in low temperature co-fired ceramic squares
- Precleaned
- Masking materials applied and cured (long or hot cures)
- Masking materials characterized by Fourier Transform Infrared Spectroscopy (FTIR)
- Areas where masking materials were removed were characterized by FTIR

FTIR – UV1



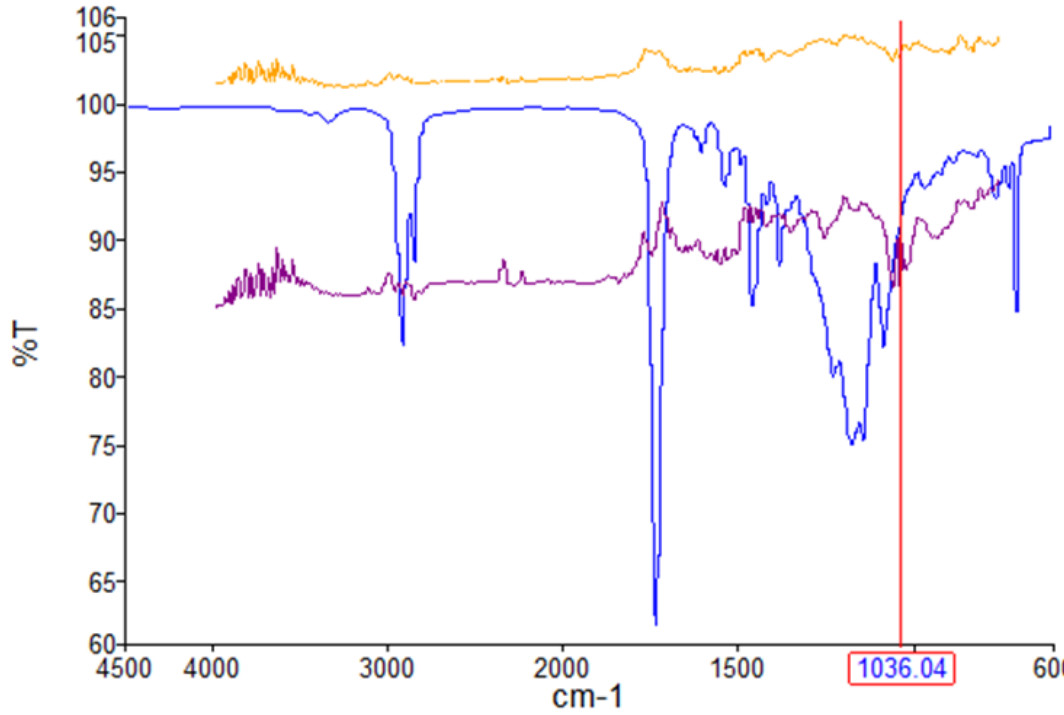
Name	Description
Background2	Spectrum at 25209,8373,-9130 Micrometers Aperture: 100,100
Bare Board1	Spectrum at 25209,8373,8823 Micrometers Aperture: 100,100
Blue Material	Spectrum at -6518,1011,7120 Micrometers Aperture: 100,100
Blue Peeled Off Area	Spectrum at 5516,-18743,7275 Micrometers Aperture: 100,100

FTIR – UV2



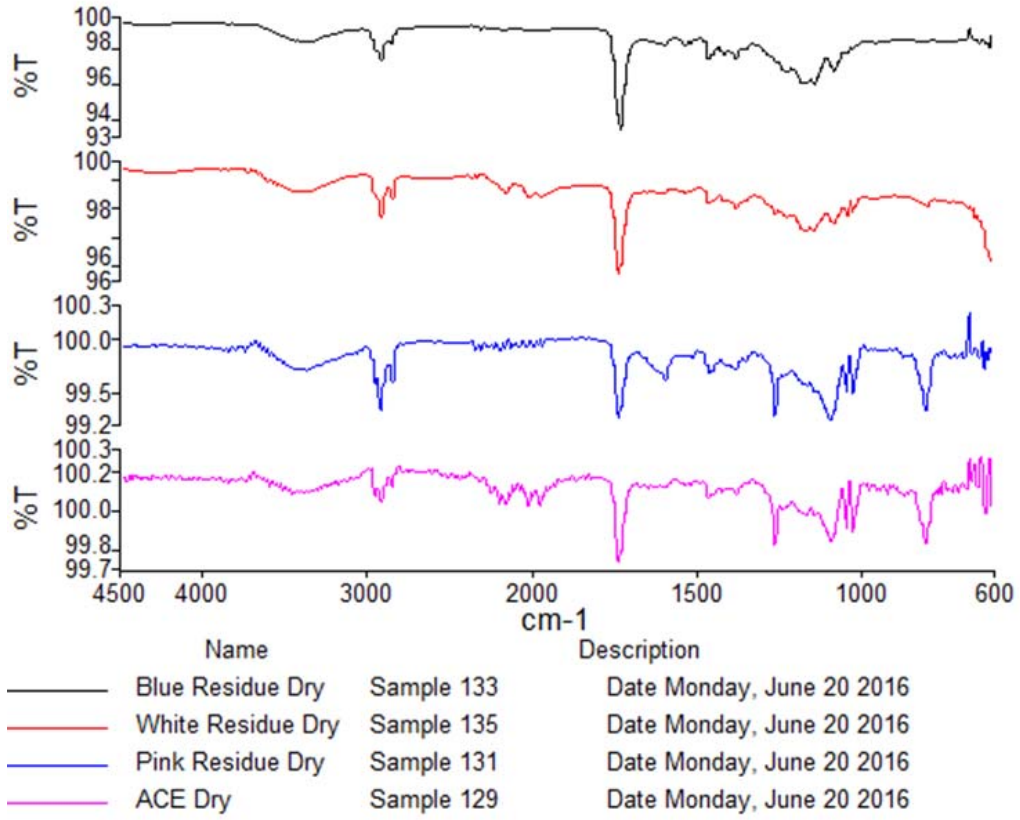
Name	Description
Background	Spectrum at 25209,8373,-9130 Micrometers Aperture: 100,100
Bare Board	Spectrum at 25209,8373,8823 Micrometers Aperture: 100,100
Pink Material	Spectrum at 292,8373,7462 Micrometers Aperture: 100,100
Pink Peeled Off Area	Spectrum at 14062,1838,7324 Micrometers Aperture: 100,100

FTIR – Hot Melt



Name	Cursor	Description
White Material Frontier	91.027 %T	Sample 122 Thursday, June 09 2016
Bare Board1	104.12 %T	Spectrum at 25209,8373,8823 Micrometers Aperture
White Peeled Off Area	88.57 %T	Spectrum at -1658,10151,7377 Micrometers Apertur

FTIR with Acetonitrile Extract



Conclusions

- All of the masking materials performed their intended function
- None of the masking materials studied left behind deleterious materials as evidenced by SIR
- The UV cure materials may be hydrophilic and need to be removed from the board
  - *Even so, lowest readings were in the 30 megohm range*
- The UV cure materials showed better SIR with longer UV irradiation
- The red dye from UV2 that bled into the conformal coating did not cause degradation
- The hot melt masking material showed better SIR performance compared to the UV masking materials with less risk should it remain on the board

Questions


The teacher poses a question and scans the audience...
Must... Not... Make... Eye... Contact...