Chemical Data vs. Electrical Data
Is one a better reliability predictor?

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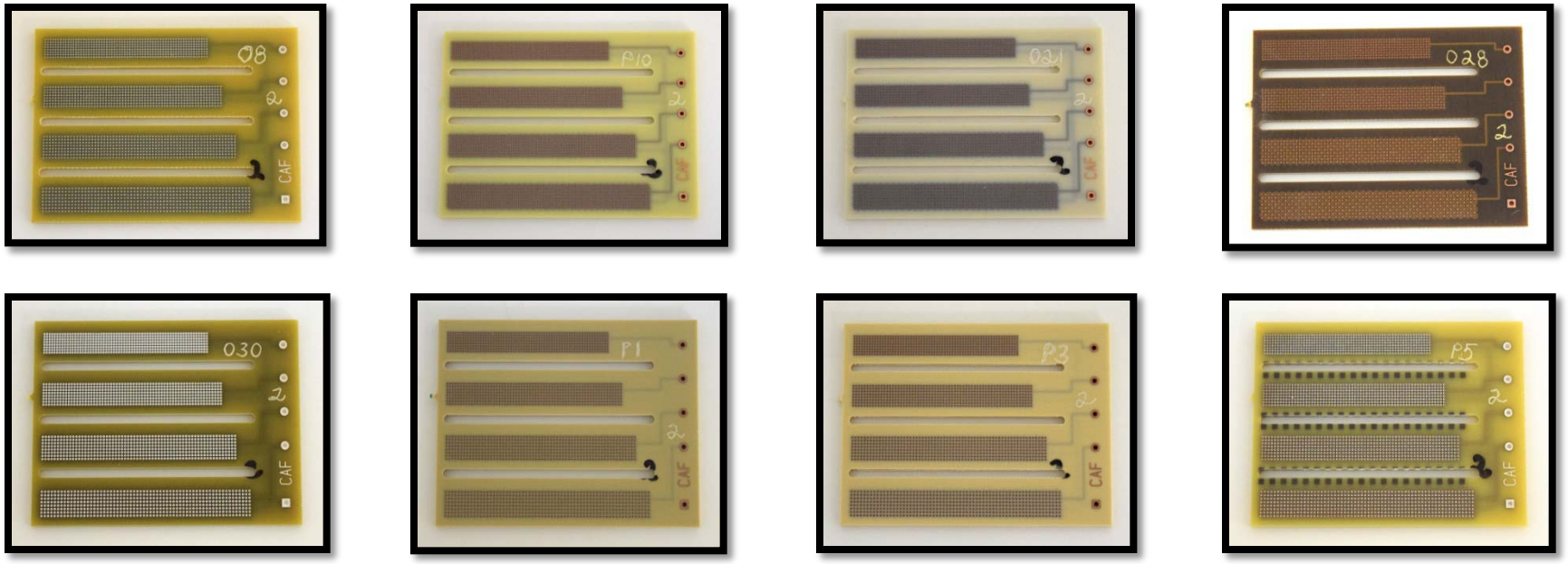
Abstract:

The goal of this study was to correlate IPC Chemical and Electrical CAF test results. The electrical testing utilized for the test coupons was found within the PCQR^2 Database document. The chemical testing of the coupons utilized Ion Chromatography (IC) testing in accordance with IPC-TM-650, method 2.3.28.

Test Subjects:



Experimental:

Coupons designed for Conductive Anodic Filament (CAF) testing were used for this study. Coupons were chemically screened before and after electrical testing.

Chemical Portion

1. Coupons were placed into ionically clean bags.
2. Fifteen milliliters of 75% 2-proponal and 25% deionized water was added to each bag with the coupon.
3. Coupons were extracted at 80^{o}C for 1 hour.
4. Coupons were removed after 1 hour extraction and allowed to cool to return to ambient conditions.
5. Extract solution analyzed using IC.

Electrical Portion

1. Boards preconditioned for 6 hours at 125^{o}C.
2. Coupons were reflowed 6 times at 260^{o}C.
3. Connector pins were soldered in place and then cleaned.
4. Test conditions were 75^{o}C / 85% RH for 500 hours.
5. Test bias was 48 Volts w/ measurements every minute.
6. Real time failure = 10^{7} Ω (Latch Level)

IC Data before CAF – Anions:

Data in micrograms per square inch

Sample Description	Fluoride F^-	Chloride Cl^-	Bromide Br^-	Nitrite NO_2^-	Nitrate NO_3^-	Phosphate PO_4^{3-}	Sulfate SO_4^{2-}	Organic Acids (SMT)	Organic Acids (PTH Clean)	Organic Acids (PTH No clean)	Acetate	Citrate	Formate	MSA
IEC Anion Limits	**1**	**3**	**5**	**3**	**3**	**3**	**3**	**25**	**0**	**150**	**3**	**2**	**1**	**0**
Mean P1 Group	0.00	1.20	3.40	0.00	0.37	0.00	0.60	0.00	0.00	0.00	0.00	0.00	**1.63**	0.00
Mean P3 Group	0.00	2.57	3.25	0.00	0.20	0.00	0.65	0.00	0.00	0.00	0.00	0.00	**2.13**	0.00
Mean P5 Group	0.00	1.15	0.00	0.00	0.29	0.00	0.13	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00
Mean P10 Group	0.00	1.50	0.79	0.00	0.21	0.00	0.43	0.00	0.00	0.00	0.00	0.00	**1.06**	0.00
Mean 08 Group	0.00	2.68	1.03	0.00	0.30	0.00	0.74	0.00	0.00	0.00	0.00	0.00	**0.49**	0.00
Mean 021 Group	0.00	1.62	0.52	0.00	0.10	0.00	0.47	0.00	0.00	0.00	0.00	0.00	**0.96**	0.00
Mean 028 Group	0.00	1.97	**5.45**	0.00	0.49	0.00	1.22	0.00	0.00	0.00	0.00	0.00	**2.75**	0.00
Mean 030 Group	0.00	1.46	**11.23**	0.00	0.31	0.00	0.48	0.00	0.00	0.00	0.00	0.00	**1.88**	0.00

Green = Below Limit; Yellow = At Limit; Red = Above Limit

Note: Full data set would not fit into slides, but is available upon request.

IC Data before CAF – Cations:

Data in micrograms per square inch

Sample Description	Lithium Li^+	Sodium Na^+	Ammonium NH_4^+	Potassium K^+	Magnesium Mg^{2+}	Calcium Ca^{2+}
IEC Cation Limits	**0**	**2**	**2**	**2**	**0**	**0**
Mean P1 Group	0.00	1.02	0.00	0.98	0.00	1.62
Mean P3 Group	0.00	1.47	0.00	1.62	0.00	1.40
Mean P5 Group	0.00	0.54	0.00	1.47	0.00	0.55
Mean P10 Group	0.00	0.73	0.00	0.82	0.00	0.99
Mean O8 Group	0.00	1.48	0.00	2.34	0.00	0.49
Mean O21 Group	0.00	1.12	0.00	0.33	0.00	0.99
Mean O28 Group	0.00	0.98	0.57	1.32	0.00	0.60
Mean O30 Group	0.00	0.63	1.08	0.83	0.00	1.46

Green = Below Limit; Yellow = At Limit; Red = Above Limit

Note: Full data set would not fit into slides, but is available upon request.

IC Data after CAF – Anions:

Data in micrograms per square inch

Sample Description	Fluoride F^-	Chloride Cl^-	Bromide Br^-	Nitrite NO_2^-	Nitrate NO_3^-	Phosphate PO_4^{3-}	Sulfate SO_4^{2-}	Organic Acids (SMT)	Organic Acids (PTH Clean)	Organic Acids (PTH No clean)	Acetate	Citrate	Formate	MSA
IEC Anion Limits	**1**	**3**	**5**	**3**	**3**	**3**	**3**	**25**	**0**	**150**	**3**	**2**	**1**	**0**
Mean P1 Group	0.00	0.74	0.00	0.00	0.14	0.00	0.40	0.00	**0.42**	0.00	0.00	0.00	0.27	0.00
Mean P3 Group	0.00	0.98	0.48	0.00	0.12	0.00	0.36	0.00	**1.24**	0.00	0.00	0.00	**1.35**	0.00
Mean P5 Group	0.00	0.62	0.32	0.00	0.20	0.00	0.50	0.00	**0.64**	0.00	0.00	0.00	0.42	0.00
Mean O8 Group	0.00	0.68	0.13	0.00	0.00	0.00	0.35	0.00	**0.93**	0.00	0.00	0.00	0.00	0.00
Mean O21 Group	0.00	0.67	0.82	0.00	0.00	0.00	0.65	0.00	**0.60**	0.00	0.00	0.00	0.00	0.00
Mean O28 Group	0.00	0.43	3.61	0.00	0.00	0.00	0.96	0.00	**1.17**	0.00	0.00	0.00	0.49	0.00
Mean O30 Group	0.00	0.65	0.58	0.00	0.00	0.00	0.42	0.00	**0.35**	0.00	0.00	0.00	0.00	0.00

Green = Below Limit; Yellow = At Limit; Red = Above Limit

Note: Full data set would not fit into slides, but is available upon request.

IC Data after CAF – Cations:

Data in micrograms per square inch

Sample Description	Lithium Li^+	Sodium Na^+	Ammonium NH_4^+	Potassium K^+	Magnesium Mg^{2+}	Calcium Ca^{2+}
IEC Cation Limits	**0**	**2**	**2**	**2**	**0**	**0**
Mean P1 Group	0.00	0.70	0.00	0.14	0.00	0.00
Mean P3 Group	0.00	0.42	0.00	0.16	0.00	0.06
Mean P5 Group	0.00	0.46	0.00	0.33	0.00	0.26
Mean 08 Group	0.00	0.89	0.15	0.45	0.17	0.00
Mean 021 Group	0.00	0.77	0.00	0.16	0.00	0.00
Mean 028 Group	0.00	0.56	0.33	0.61	0.00	0.00
Mean 030 Group	0.00	0.49	0.00	0.18	0.00	0.23

Green = Below Limit; Yellow = At Limit; Red = Above Limit

Note: Full data set would not fit into slides, but is available upon request.

Electrical Data – CAF Results:

Sample	CAF					Registration Radial Diatance (mils)
	Separation (mils)				Average	
	14	16	18	20		
Test suspended after 500 Hours						
P1	501	501	501	501	501	6
P3	501	501	501	501	501	6
P5	**60**	**150**	**91**	**480**	**195**	**8**
P10	**223**	501	501	501	**432**	6
O8	**65**	**64**	**47**	**22**	**50**	**8**
O21	501	501	501	501	501	6
O28	**5**	**4**	**8**	**33**	**13**	**8**
O30	**0**	**292**	501	501	**323**	**7**

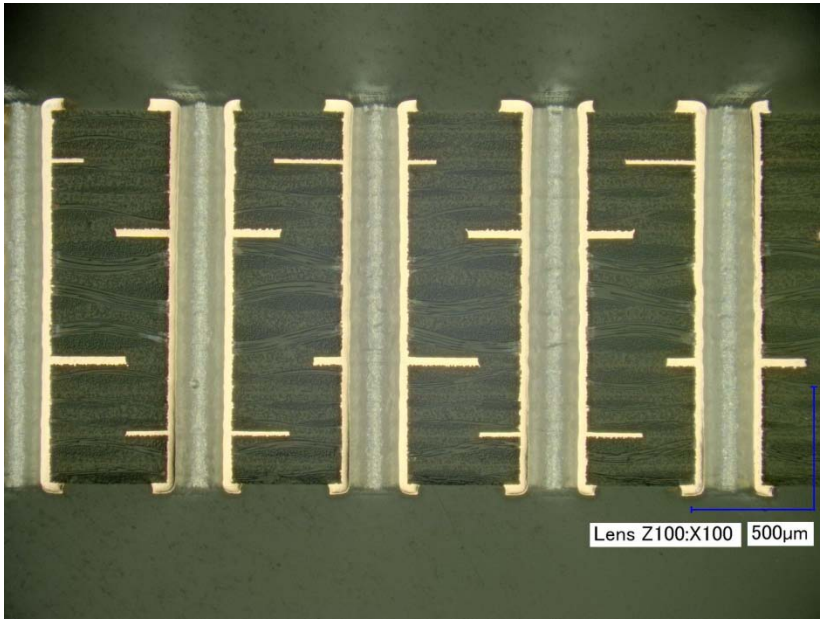
Red = Failed Test

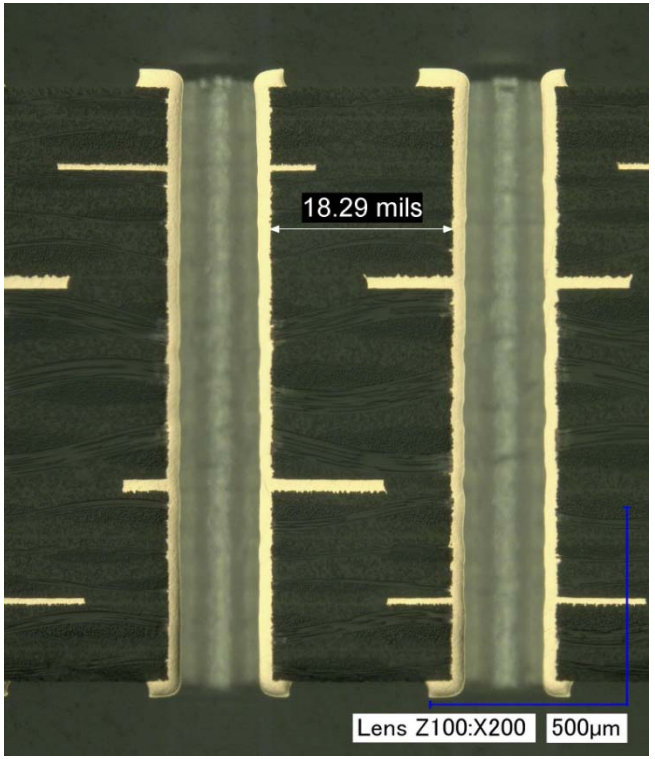
Green = Passed Test

Chemical + Electrical Data:

Sample	CAF					Registration Radial Diatance (mils)	Anion Results - After CAF Testing (micrograms per square inch)								Cation Results - After CAF (micrograms per square inch)					
	Separation (mils)				Avg.		Chloride Cl^-	Bromide Br^-	Nitrite NO_2^-	Nitrate NO_3^-	Phos. PO_4^{3-}	Sulfate SO_4^{2-}	Organic Acids (PTH Clean)	Formate	Lithium Li^+	Sodium Na^+	Ammonium NH_4^+	Pot. K^+	Mag. Mg^{2+}	Calcium Ca^{2+}
	14	16	18	20																
Limit (Hours)	**501**	**501**	**501**	**501**	**501**	**6**	**3**	**5**	**3**	**3**	**3**	**3**	**0**	**1**	**0**	**2**	**2**	**2**	**0**	**0**
P1	501	501	501	501	501	6	0.74	0.00	0.00	0.14	0.00	0.40	**0.42**	0.27	0.00	0.70	0.00	0.14	0.00	0.00
P3	501	501	501	501	501	6	0.98	0.48	0.00	0.12	0.00	0.36	**1.24**	**1.35**	0.00	0.42	0.00	0.16	0.00	0.06
P5	**60**	**150**	**91**	**480**	**195**	**8**	0.62	0.32	0.00	0.20	0.00	0.50	**0.64**	0.42	0.00	0.46	0.00	0.33	0.00	0.26
P10	**223**	501	501	501	**432**	6	**No samples available for chemical testing**													
O8	**65**	**64**	**47**	**22**	**50**	**8**	0.68	0.13	0.00	0.00	0.00	0.35	**0.93**	0.00	0.00	0.89	0.15	0.45	0.17	0.00
O21	501	501	501	501	501	6	0.67	0.82	0.00	0.00	0.00	0.65	**0.60**	0.00	0.00	0.77	0.00	0.16	0.00	0.00
O28	**5**	**4**	**8**	**33**	**13**	**8**	0.43	3.61	0.00	0.00	0.00	0.96	**1.17**	0.49	0.00	0.56	0.33	0.61	0.00	0.00
O30	**0**	**292**	501	501	**323**	**7**	0.65	0.58	0.00	0.00	0.00	0.42	**0.35**	0.00	0.00	0.49	0.00	0.18	0.00	0.23

Cross Section – Via Spacing:





Data Conclusions:

1. Currently no Pass / Fail cleanliness criteria exists for the IPC ion chromatography method. Criteria used for this study was based on customer suggested levels.

2. Current Pass / Fail criteria for CAF testing per PCQR^2 is $10^7\Omega$ latch level.

3. Per industry customer cleanliness criteria, the following groups failed chemical testing:
   * All, except P10 because there were no samples available after CAF testing

4. Per PCQR^2 criteria the following groups failed electrical testing:
   * P5, P10, 08, 028 and 030

5. Neither method is a better CAF reliability predictor.

Recommendations:

1. Remove soldered connectors from CAF coupons to eliminate extraneous residues from flux, cleaning steps and / or handling. Utilize press-fit connectors as a fix.

2. Improve cleanliness data by reducing the size of the coupon to get more focused extraction. This should improve precision and accuracy of the chemical test.

3. Develop a CAF Coupon Generator specific to PCB geometries on panel assembly verses current reduced pitch windowed approach.

4. Develop better pass / fail limits based on a larger data sampling and honing the testing methodologies (i.e. improve understanding of spatial relations and impacts to limits).

Questions?

Thank You!