A Unique Process that *Eliminates Solder Dross* and *Improves Quality* *P. KAY's MS2*

Jay Hardin
Product Manager
P. Kay Metal, Inc

IPC Mid West Conference
Chicago
Sept. 07

Co-Authors

Daniel (Baer) Feinberg
P. Kay Metal, Inc

Erik Severin, PhD
P. Kay Metal, Inc

Dross

- Oxidation of a molten metal
- Slag
- Dross = Solder = Dross
- Webster
  - A scum formed on the surface of molten metal
  - Waste material
  - Worthless stuff
- Interferes with the soldering process
- Increases Material Cost per Assembly

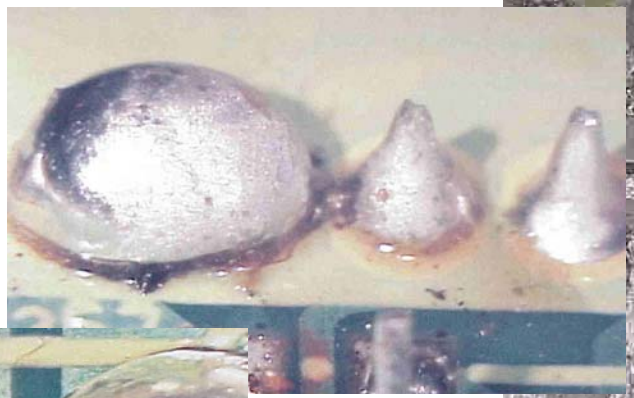
Dross, A Costly Issue

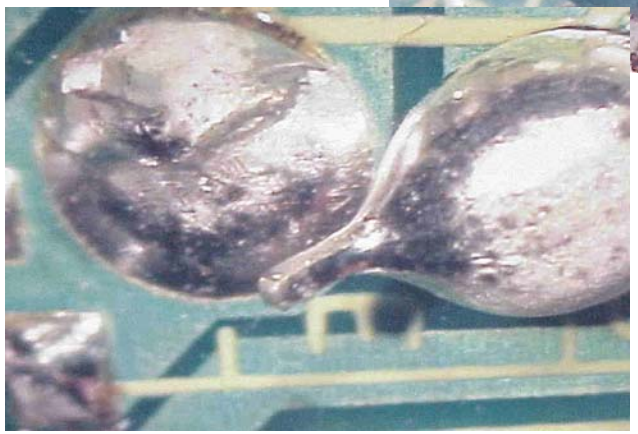
- Cost of Metal to Replace Dross
  - Much Higher with RoHS
- Reduced Efficiency
  - Down Time to Remove and Clean
  - Constant Wave Adjustment

Dross, Affects Quality

Reduced Quality

- Skips or Misses
- Shorts or Bridges
- Dross Inclusions





Dross, Hazardous Waste Handling

- Environmental Management System
- Majority of hazardous waste from an electronics' assembly facility is dross
- Highly regulated
- Manifests

Dross Reduction

- Mechanical
  - Nozzle or wave former design
  - Squeezing
  - Chopping
- Shielding
  - Nitrogen
- Chemical
  - Powders
  - Intermix oils
  - Surfactant

What it is

- Proprietary Surfactant
  - Surface active agent
  - Any substance that is surface active
  - Detergent or wetting agent that lowers the surface tension
- Floats on the surface of the molten metal

How it Works

When the active additive contacts a molten solder bath it performs two functions.

First, it forms an oxygen barrier over the surface of the molten metal.

Secondly, the active ingredients in the material complexes with metal oxides in the solder bath and render them soluble in the bulk material.

How it Works

The resulting organometallic complex that is formed between a metal oxide particle and the active ingredient remains suspended in the bulk material and is sequestered from the bulk metal.

This spent material builds up with time and use until it is removed in a periodic cleaning cycle.

The active ingredient does not react with metal in its native, chemically reduced, state.

How it Works

The surfactant is unique in its role as an oxide scavenger.

What it Does

Wave in normal operation, no material

Material added, normal operation, no dross

The surfactant:

- Does not mix with the metal
- Does not generate toxic smoke or odor
- Is not flammable or hazardous
- Has no known negative effect on the:
    - Solder joint
    - Substrate
    - Solder Mask
- There is no need to change flux, cleaners or solder type

What it does do is Totally Eliminate Dross

Reliability

Significant reliability testing has been undertaken at various 3rd party test and reliability facilities such as

Engent Labs

Foresite

STI

University of Toronto

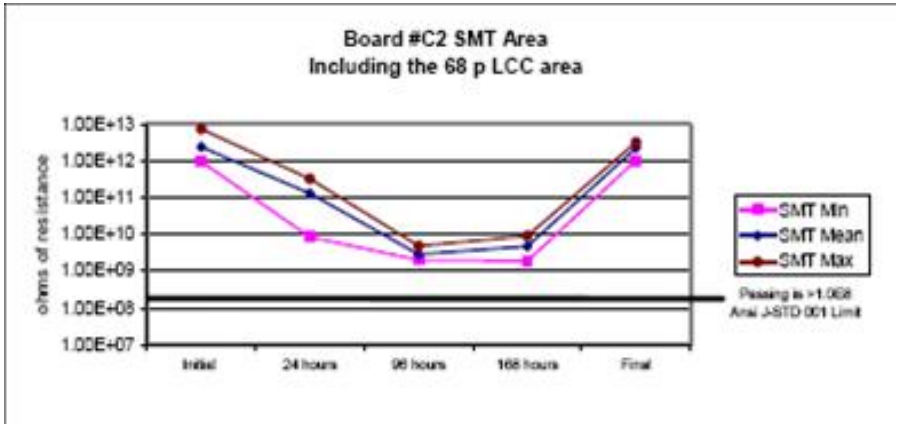
Numerous Customers

There have been no issues with reliability or contamination.

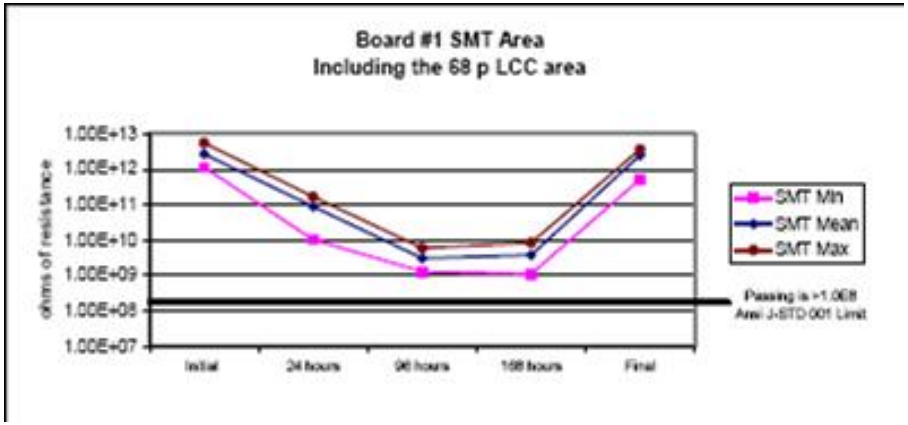
SIR electrical performance and ion chromatography testing have passed with levels well above the limits of 1E8 ohms of resistance per J-STD-001C.

SIR Results

Control Condition - Without Material



With Material



Per SIR criteria of J-STD-001C, all well above limits of 1e8 ohms resistance

The Economics of Dross

A Case Study

In a typical wave solder machine, dross generated after one hour of production is 2.7 lbs.

Up to 70% of solder added can be due to the need to replace metal tied up in dross.

Solder purchased per month: 4440 Lbs @ $13 / lb
Which equals $57,720 for (4) waves.

The facility generates 2288 lbs of dross per month or 52% of solder usage.

They sell the dross to a scrap broker for $9815.

Their cost for dross is therefore ($29,744 less $9815) or $19,929 per month.

The material is not free, therefore add in the cost of the material which in this case is approximately 50% of the savings and the company saves about $11,509 per month

Or $138,108 per year

$34,527 annual savings per machine

Cost Savings Summary

- Cost of Dross
  - $ 59,800 per machine per shift
- Reduction in solder purchases
  - 52%
- Savings realized
  - $34,500 per machine per shift

The Economics of Dross

Other Cost Factors:

- Down time to clean dross from the unit
- Down time to calibrate wave or fountain due to dross clogs
- Cost of dross related rework on the assembly
- Cost of storage and shipment of dross to the scrap broker

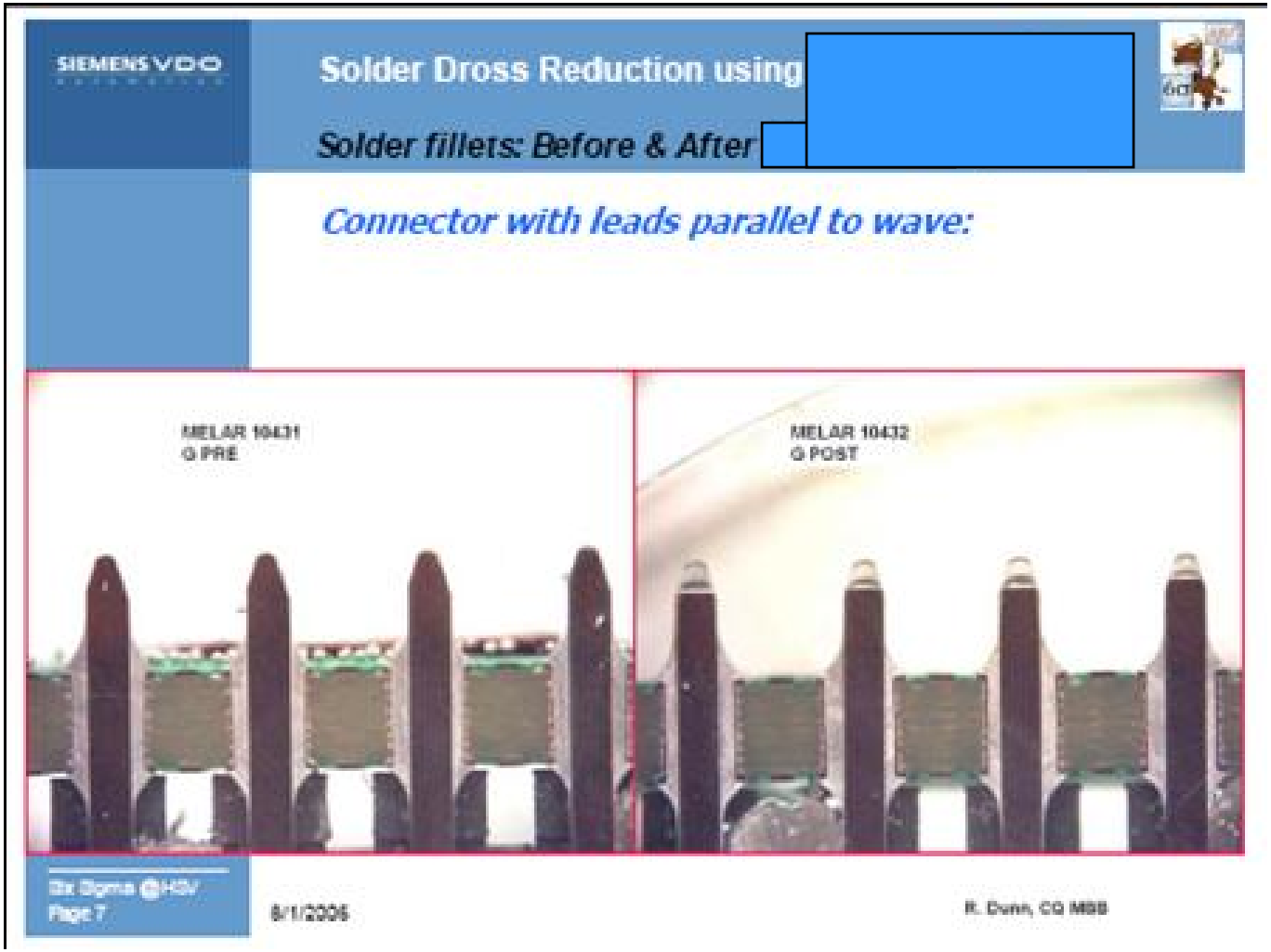
Reduced Maintenance

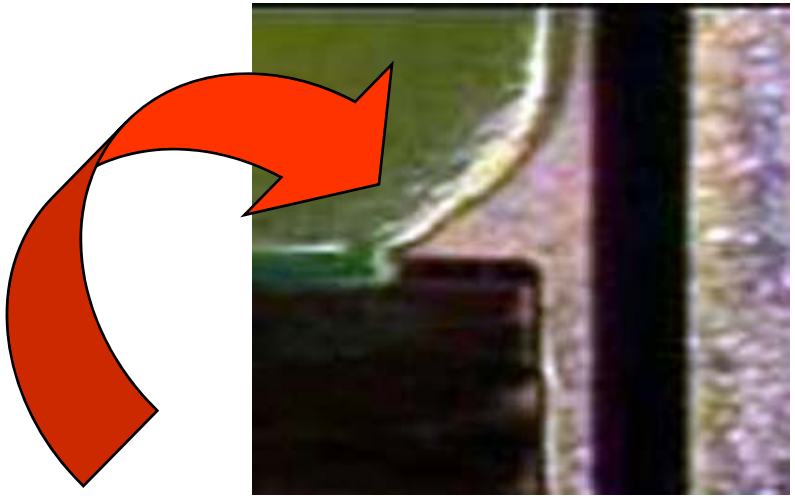
Less maintenance time or reduced period

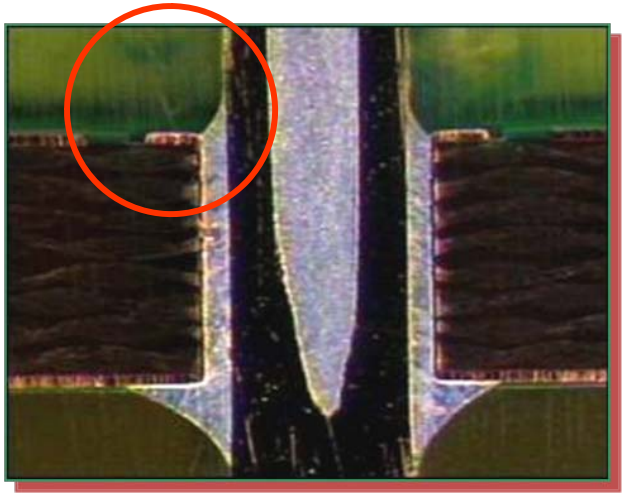
Increased frequency

With Additive				Standard Process		
Hour	Additive	Add Solder	Labor	Hour	Add Solder	Labor
8:30	150 ml		4 min	10:00	1.5 kg	
12:00	50 ml	0.5 kg	4 min	12:00	1.5 kg	
15:00	0		6 min	15:30	1 kg	
10hours	200 ml	0.5 kg	14 min	10 hours	4 kg	34 min
8:00	100 ml			10:00	1.5 kg	
12:00	100 ml	0.5 kg	5 min	12:00	1 kg	
16:00	50 ml	1 kg	5 min	15:30	2 kg	
10 hours	250 ml	1.5 kg	10 min	10 hours	4.5 kg	30 min
8:00	100 ml	1.5 kg	4 min	8:00	1.5 kg	
12:00	50 ml	1.5 kg	4 min	10:00	1.5 kg	
16:30	50 ml	0.5 kg	5 min	14:00	2.5	
7.5 hours	200 ml	3.5 kg	13 min	7.5 hours	5.5 kg	28 min

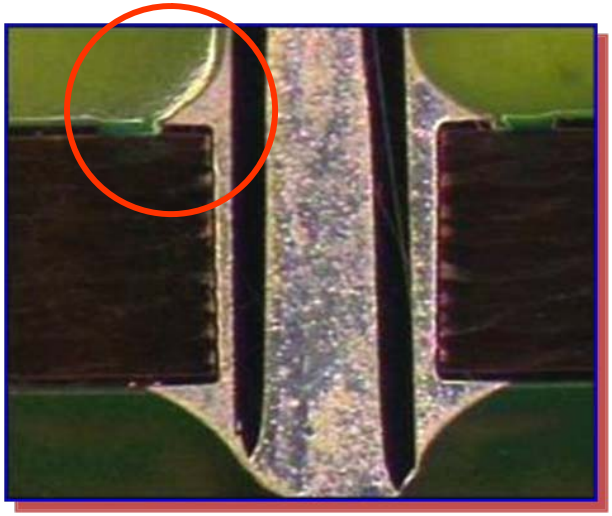
Before and After Material Added







Standard SN/PB Process

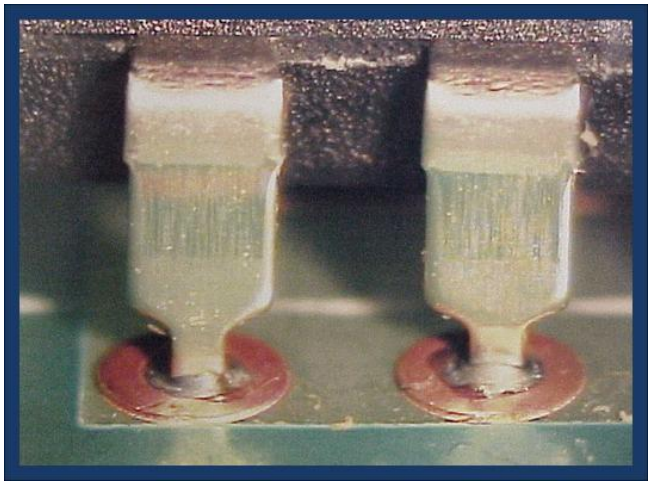


Standard SN/PB Process
With Material

“The conclusion that can be drawn is that the samples with have hole fill that is as good or better than without the surfactant”

Kola Akinade PhD, Scientific Atlanta

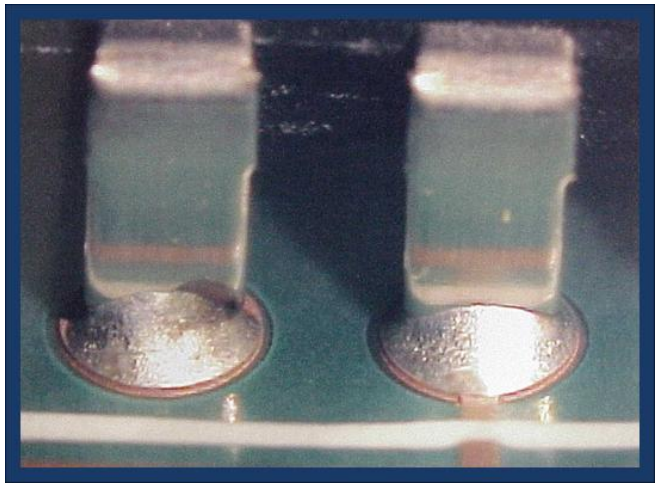
Solder Joint Comparison
SnAg (96/4) at 495 F with NC Flux



Fresh OSP Bare Board
Before Surfactant

The sample with and without the surfactant both show a good solder joint with good hole fill.

But the sample with shows better wetting still.

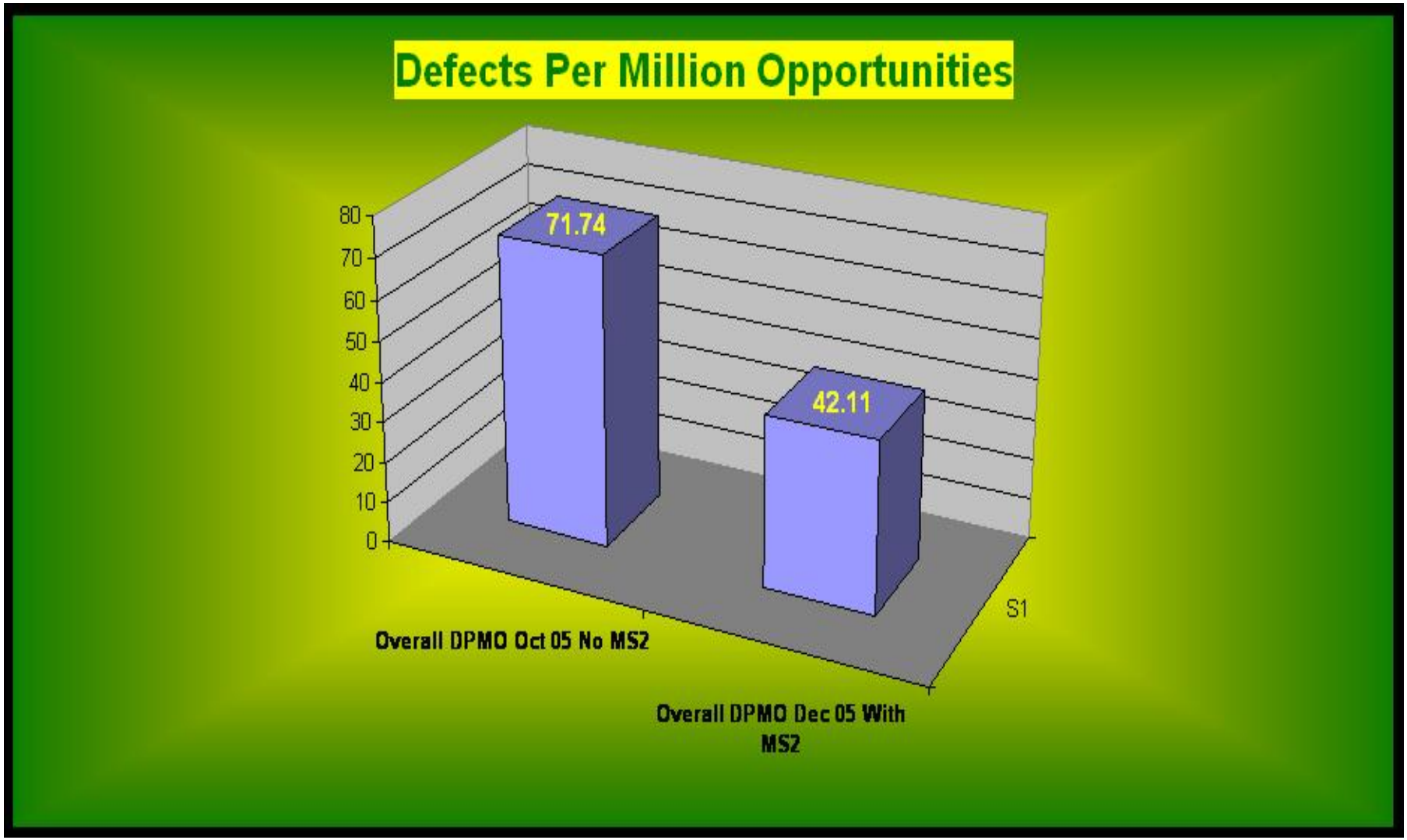


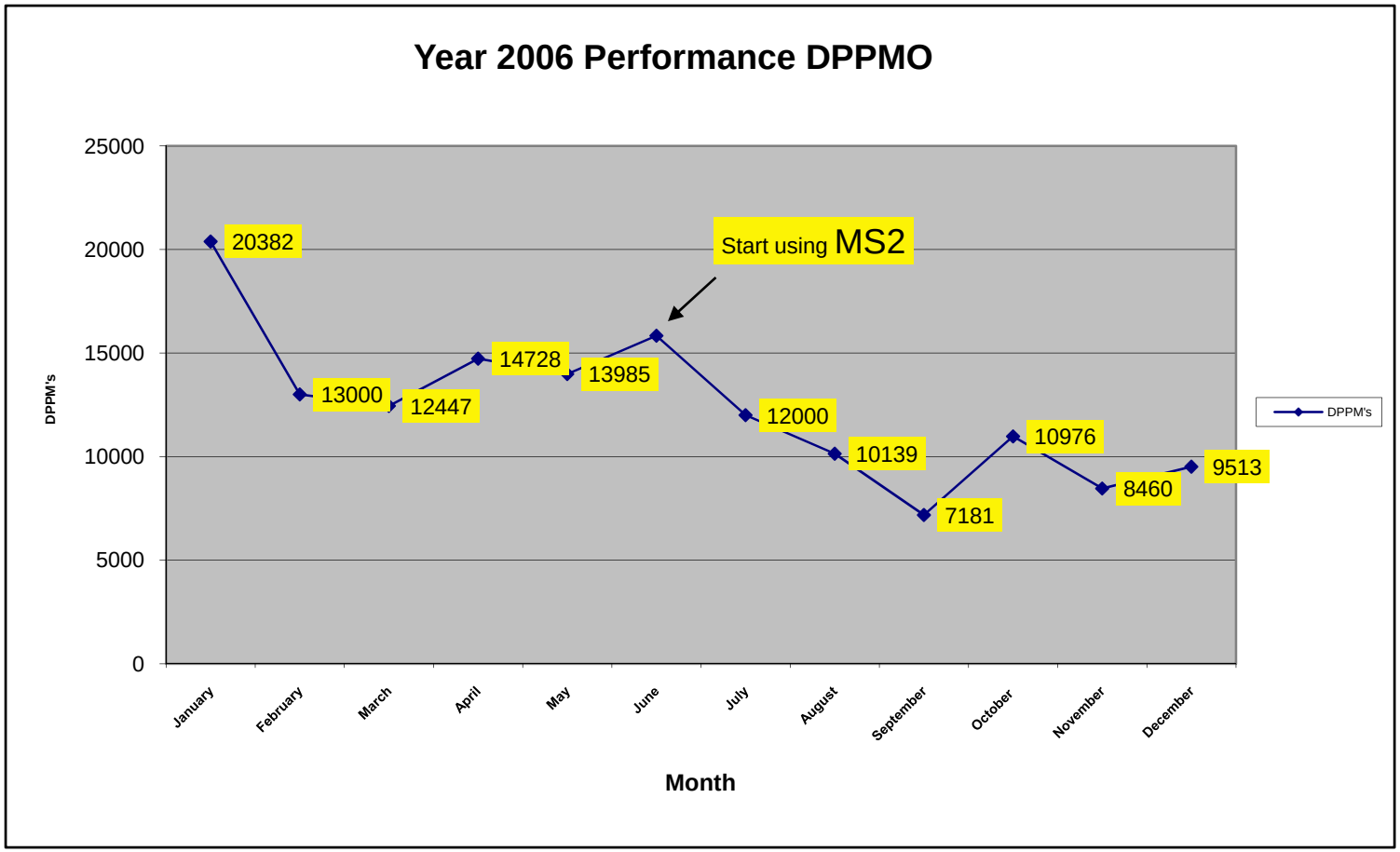
Fresh OSP Bare Board
After Surfactant Added

Statistically Valid Month vs. Month Comparison, Cisco Scientific Atlanta

Same Machine, Full Production

October Without Material vs. December With Material





Actual Data Sent From A Large Customer Using This Dross Elimination Material

Quality Improvements

Lead-free Test Vehicle

	DPMO		
	Shorts	Icicles	No wetting
Baseline	61,096	20,077	30,224
With Additive	6,620	2,590	15,544
% Improvement	89%	87%	49%

Source, A Major but Unnamed Customer

Reduced Hazardous Waste

90% Reduction

Conclusions

- Significant reduction in solder purchases, LOWER COST
- Improved manufacturing efficiency
- Improved process consistency resulting in a significant reduction in solder related defects
- Labor Savings
- Reduction in hazardous waste

Dross Elimination Surfactant

Thank You

jayhardin@pkaymetal.com

PK METAL