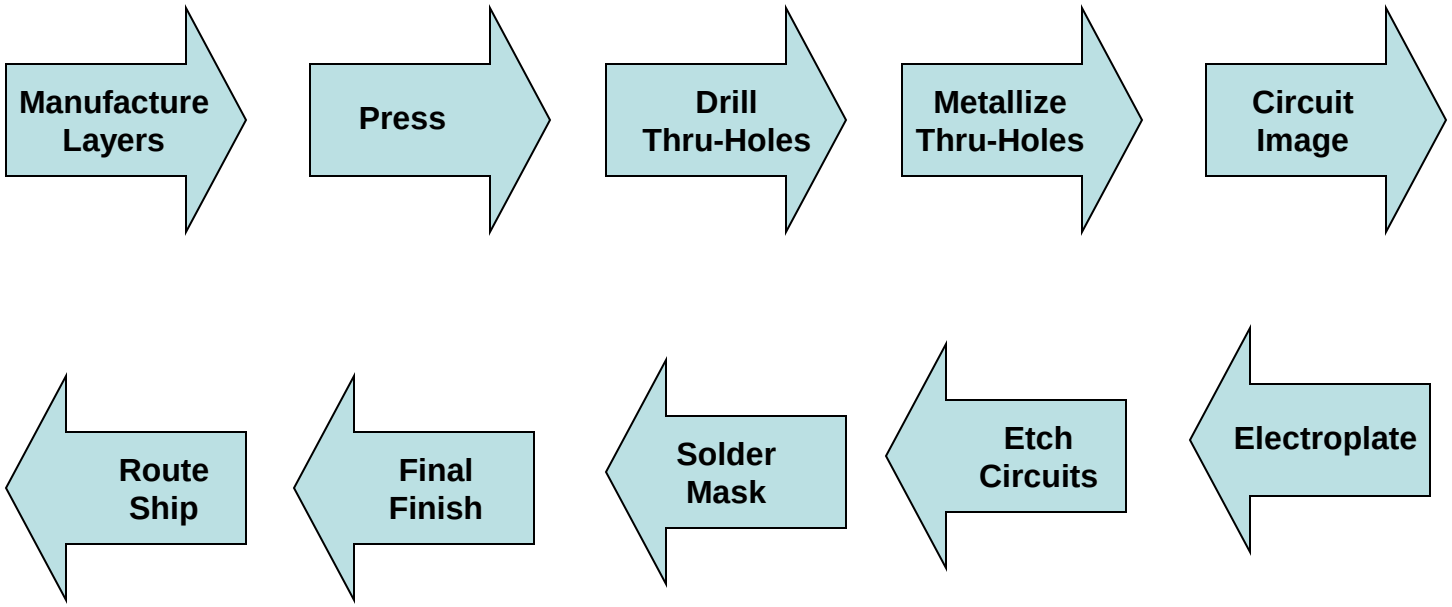
Carbon-based direct plate for today's complex Printed Wiring Board requirements

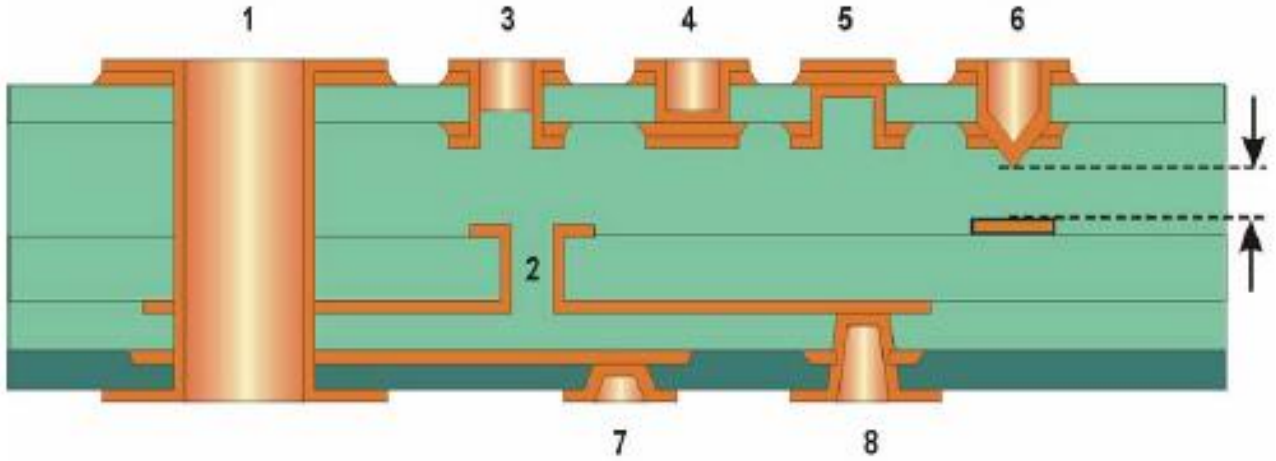
MacDermid
Electronics Solutions

Electronics are part of today's life

Printed Wiring Board Manufacturing Process



Metallization of Thru-Holes



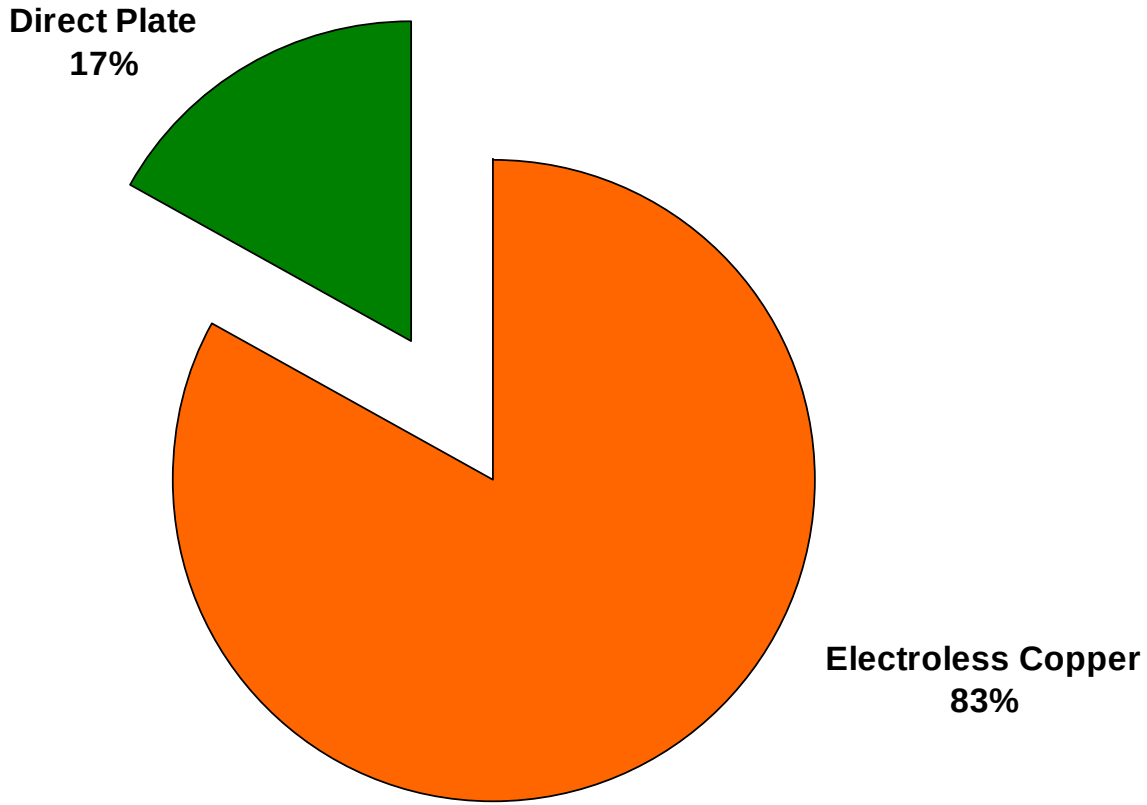
1) Standard through hole via
2) Standard buried via
3) Semi-blind (semi-buried) via
4) Blind via (laser drilled)
5) Reverse blind via
6) Controlled depth drill
7) Photo-defined via
8) Trepaned via (laser)

Figure C1-16: Hole Characteristics

Thru-Hole Metallization Methods

- Electroless Copper
  - Formaldehyde Free
- Direct Plate
  - Carbon
  - Graphite
  - Conductive Polymer
  - Organic Palladium

Direct Plate Penetration in North America



Why Eliminate Electroless Copper

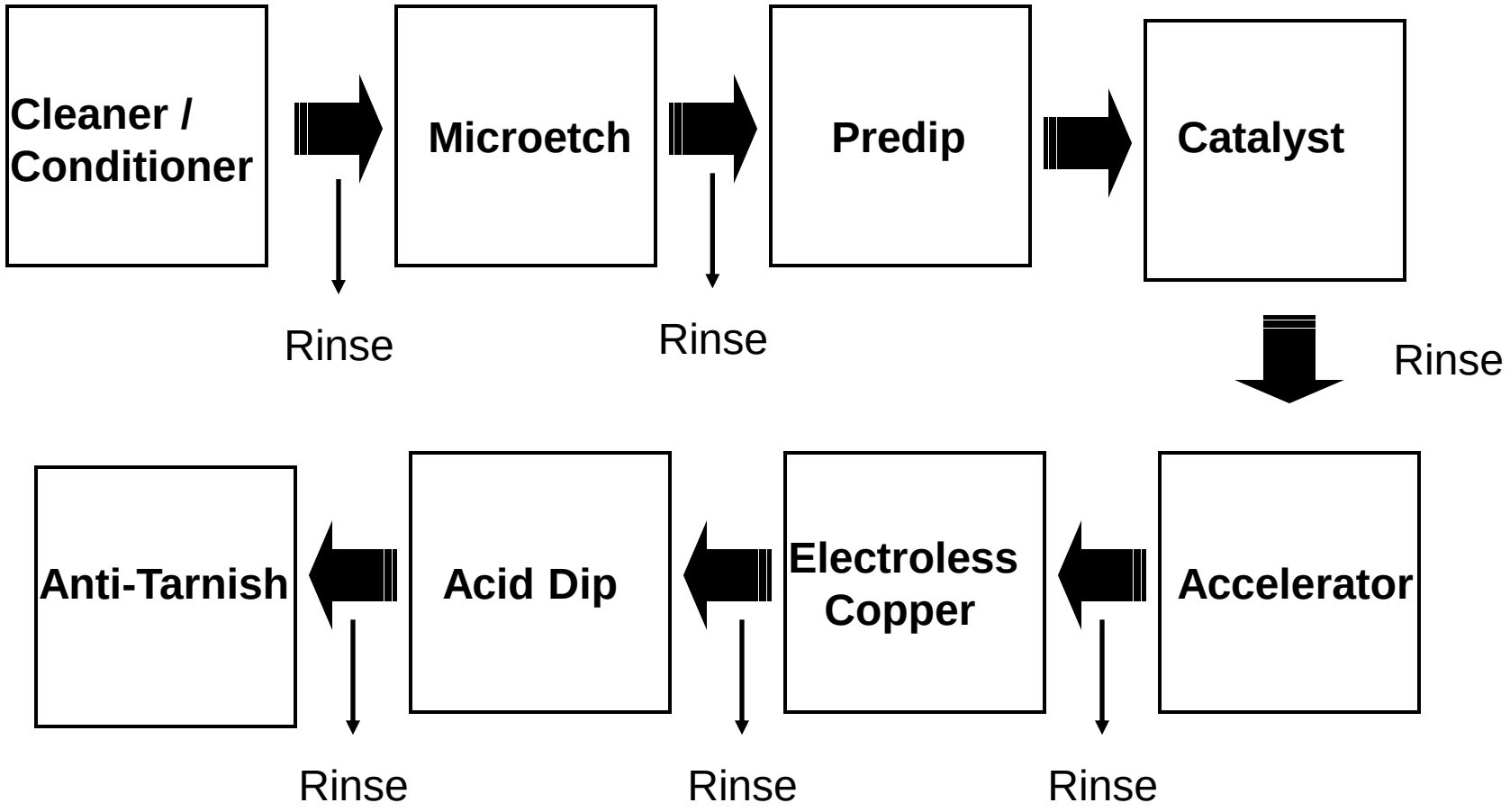
- Improved Worker Health
  - Eliminate Formaldehyde
  - Enclosed systems reduces worker exposure
- Faster Production
  - Direct Metallization 2-8 times faster
  - Reduce start up time
- Reduced Water and Energy Consumption
  - Reduce number of process steps
  - Fewer Rinses

Why Eliminate Electroless Copper

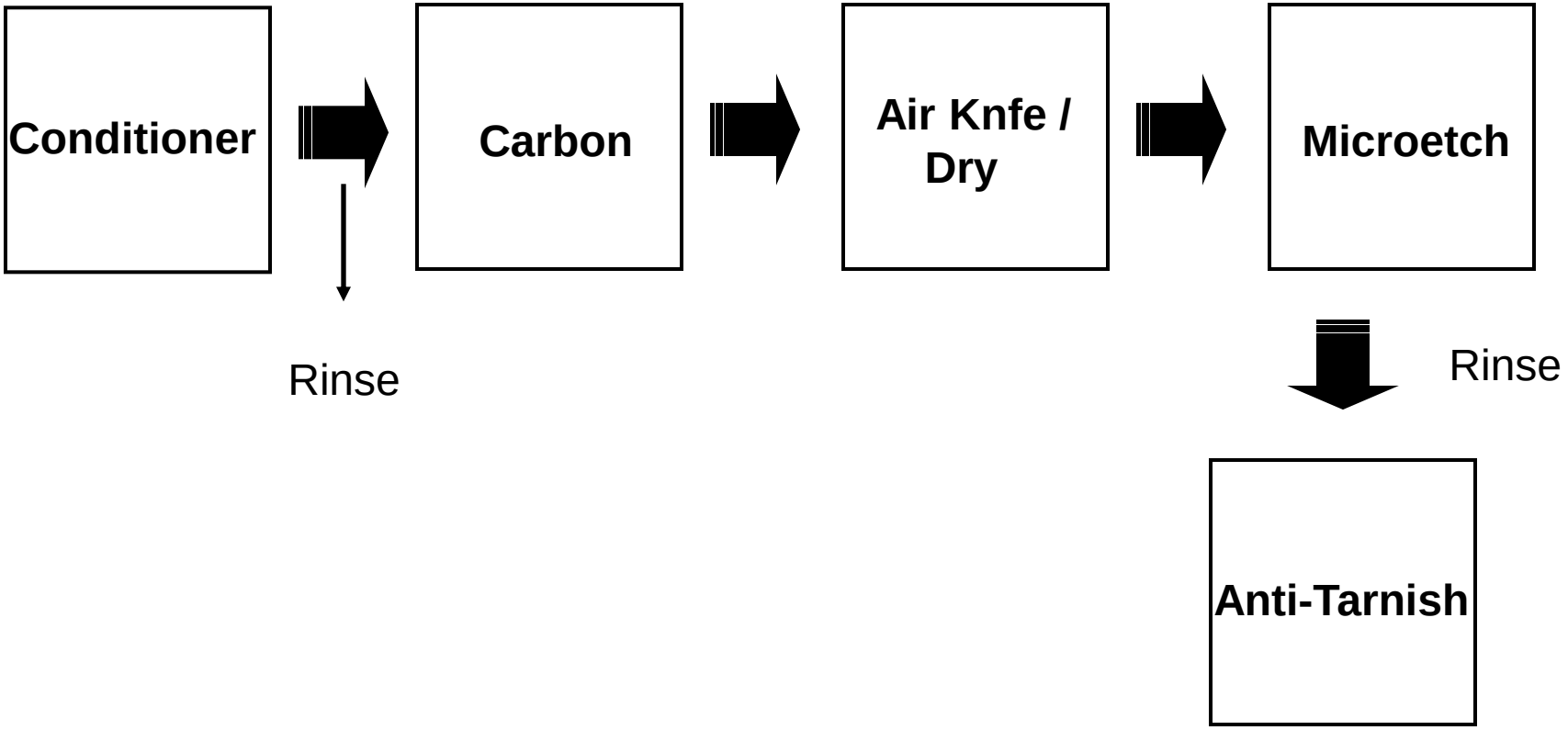
- Simplified Waste Water Treatment
  - Electroless Copper use chelating agents (EDTA)

- Reduced Waste Generation
  - Less copper in waste stream
  - Less sludge generation

Typical Electroless Copper Process



Carbon-based Direct Plate Process

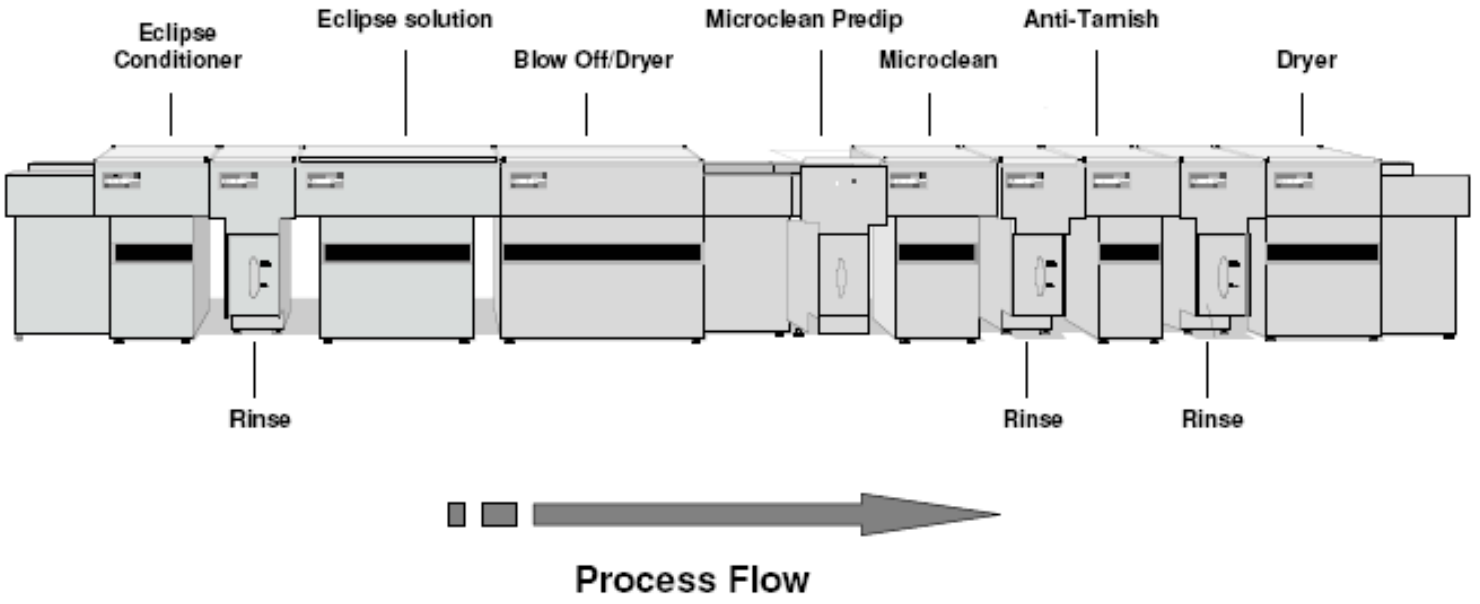


Eclipse: Modified Carbon Black System

Eclipse (Carbon-black)

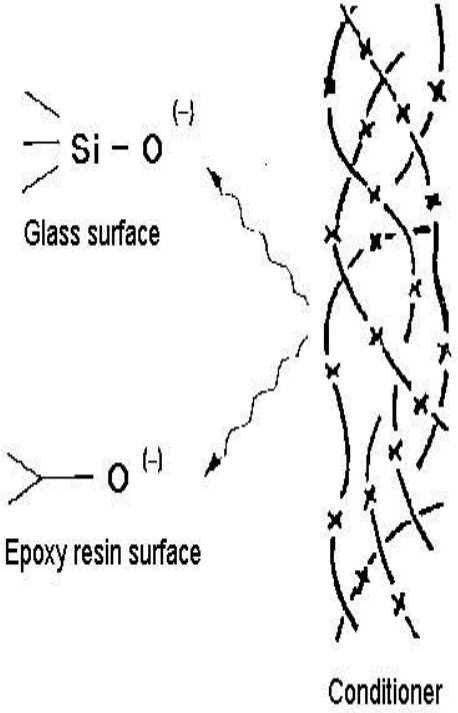
- Alkaline Carbon-Black Dispersion
  - Particle Size 200-300nm
  - Easy to Control, Stable Dispersion
  - No Sludge, Long Bath Life
  - Ammonia Free
- No Strong Chelators
  - Easy Waste Treatment
- No Heavy Metals
- No Formaldehyde, No Cyanide

Equipment

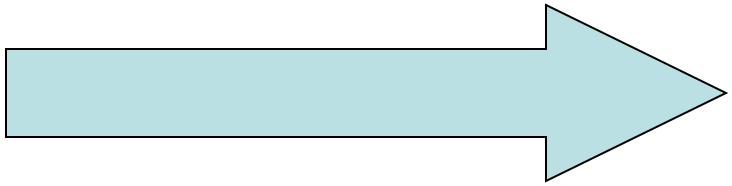


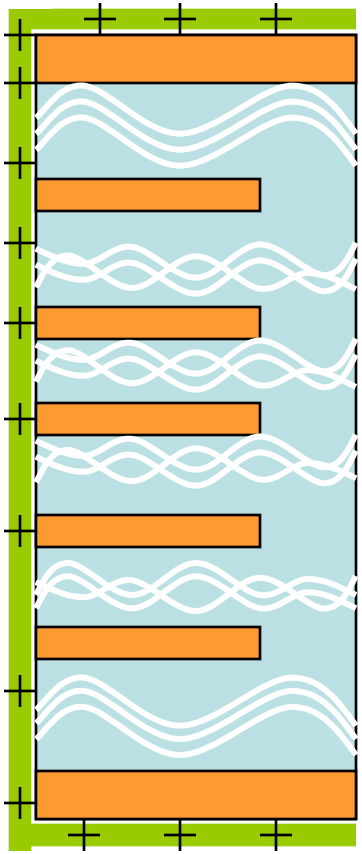
YES WE CAN

Conditioner



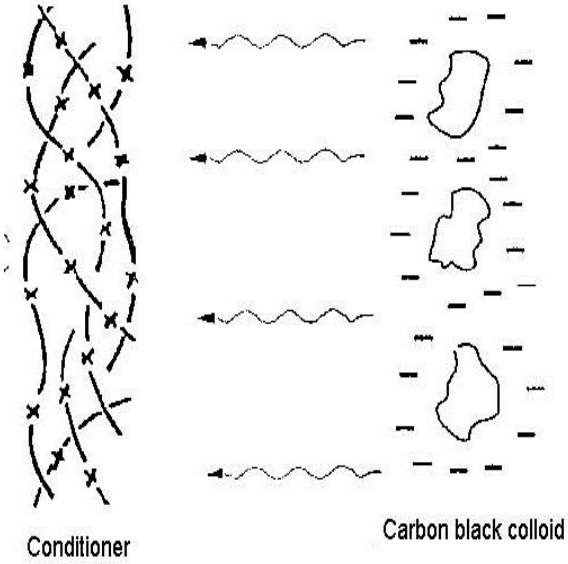
- **Conditioner wets the holes**
- **Changes the surface charge of the substrate**



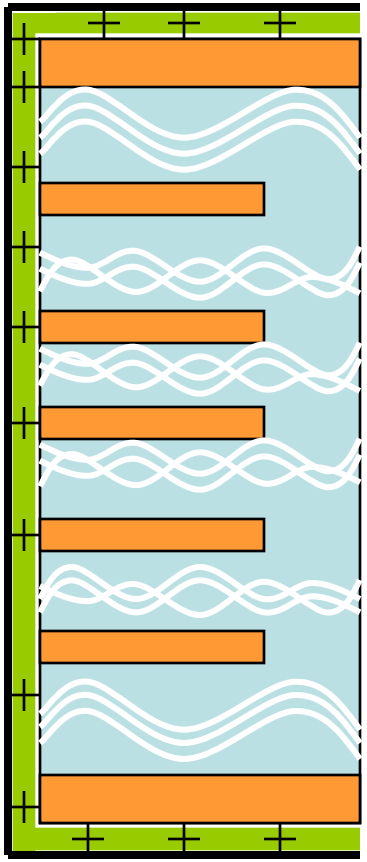


Electrostatic adsorption onto all surfaces of the panel

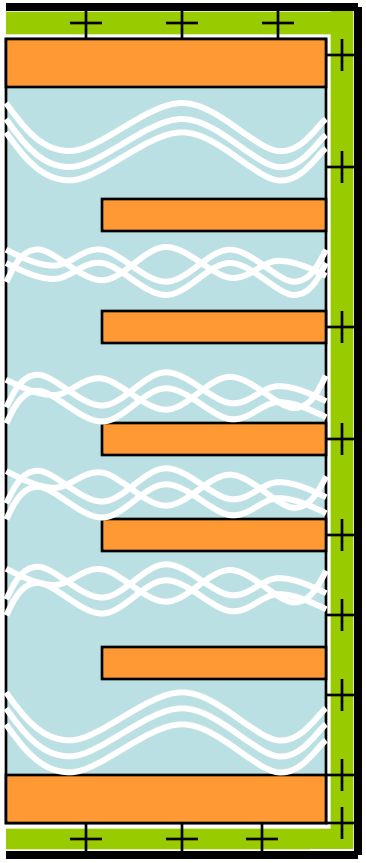
Treatment



Carbon particles adsorbed onto all conditioner surfaces

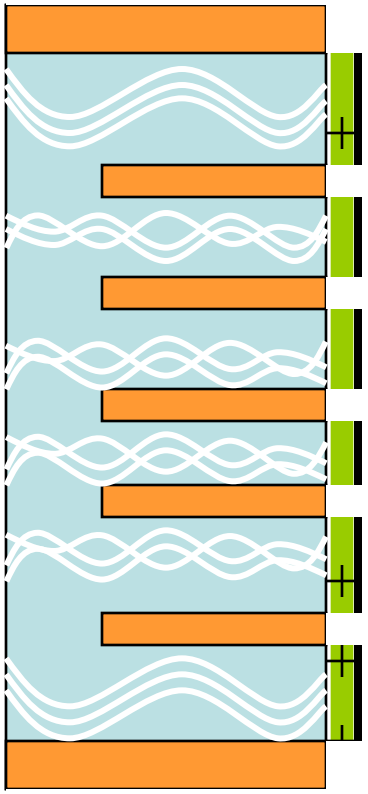


Microclean



Carbon particles removed
from all copper surfaces only

Etch



* Thickness of adsorption exaggerated for illustration

Making the Decision To Go To Direct Plate

- How will it impact worker safety?
- What performance can I expect?
- Will it reduce my cost?
- How does it compare to electroless copper?

MHC Chemicals of Concern

Chemical	**Electroless Copper**	**Eclipse**
Copper Chloride	X	
Ethanolamine	X	
Formaldehyde	X	
Sodium Hydroxide	X	X
Methanol	X	
Formic Acid	X	
Sulfuric Acid	X	X
Floroboric Acid	X	

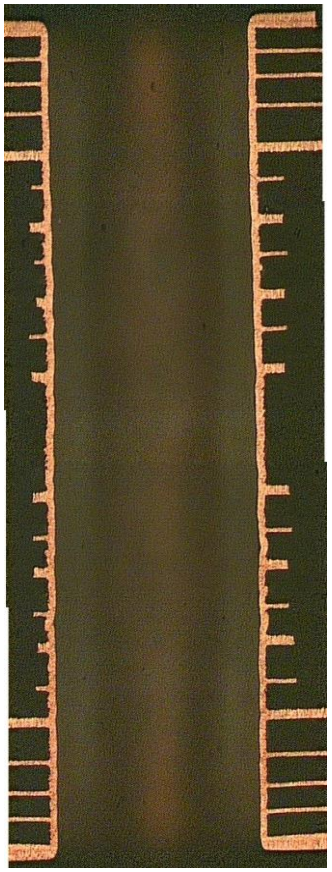
Performance Criteria

- PTH Plating Uniformity
  - No plating voids, hole wall adhesion
- IST (Interconnect Stress Test)
  - IST creates a uniform strain from within the substrate, the interconnects ability to distribute and redistribute this strain provides an indication of integrity.
- Thermal Shock

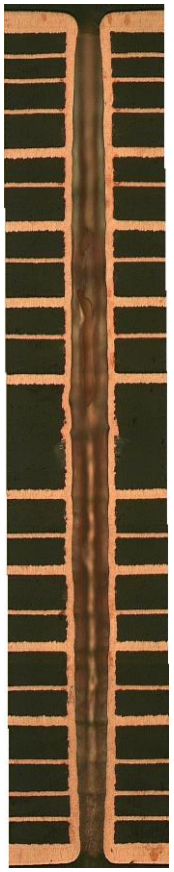
Enhanced Propagation

Eclipse treatment

- Enhanced propagation yields improved copper distribution
- High aspect ratio holes with mixed copper foil thickness exhibit uniform copper thickness

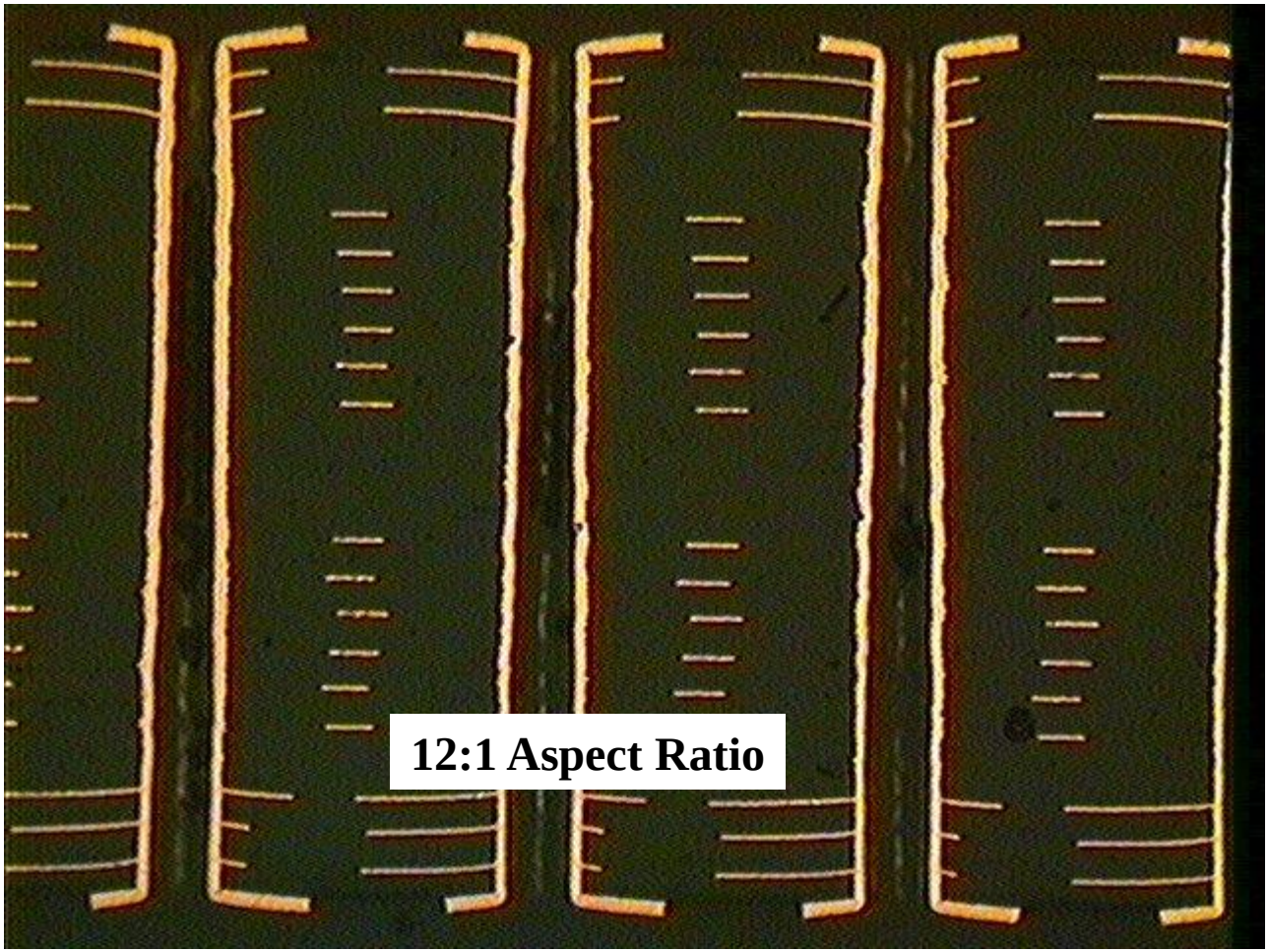


1 mm



0.25 mm

Small Hole Coverage



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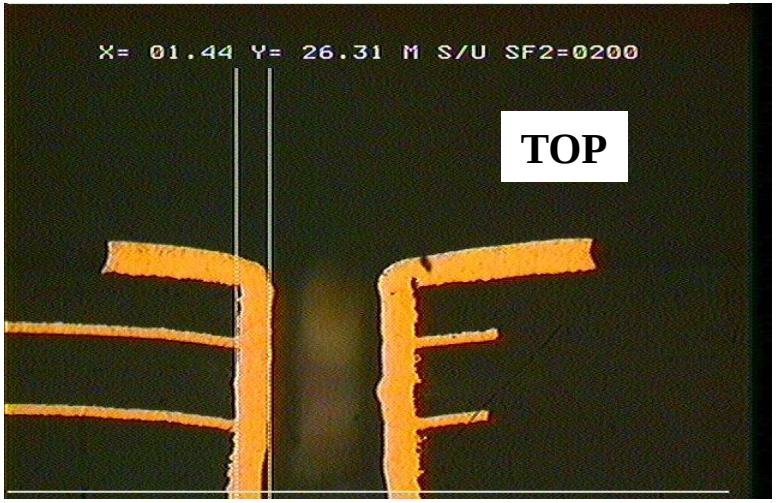
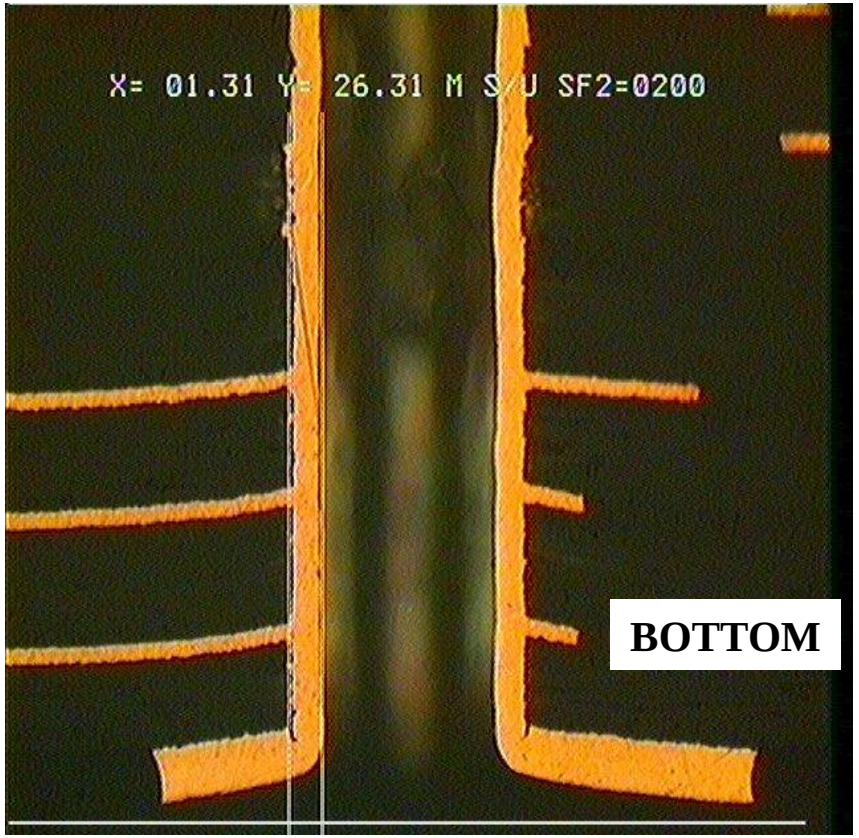
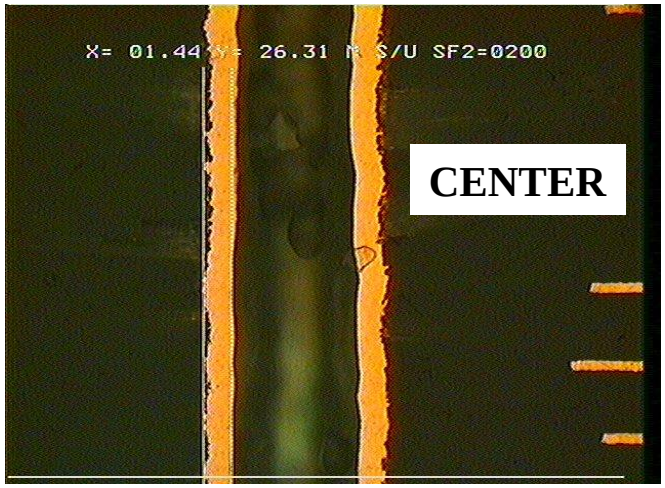
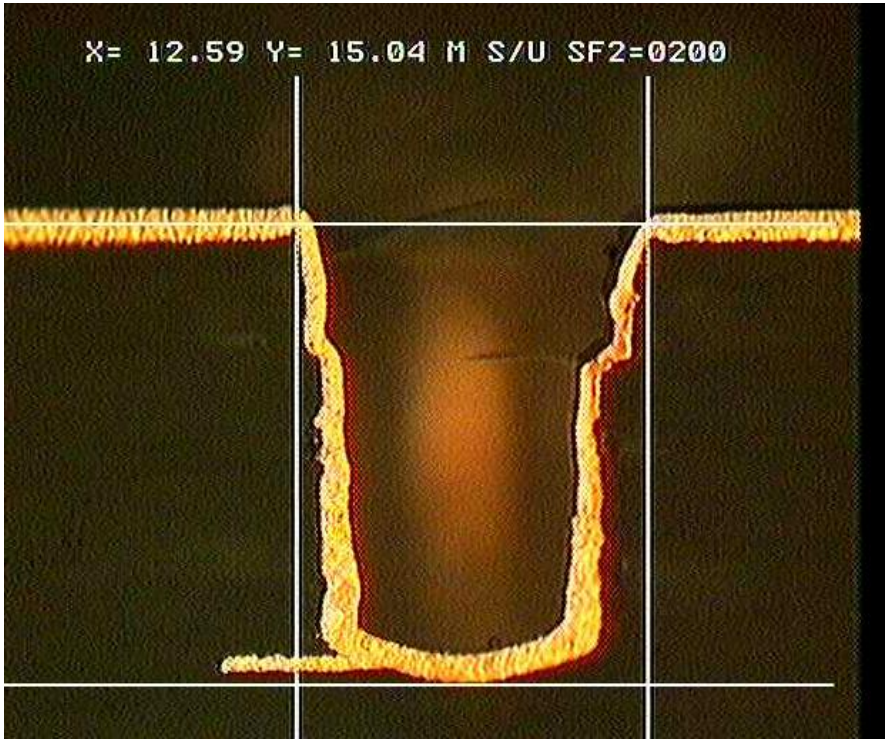




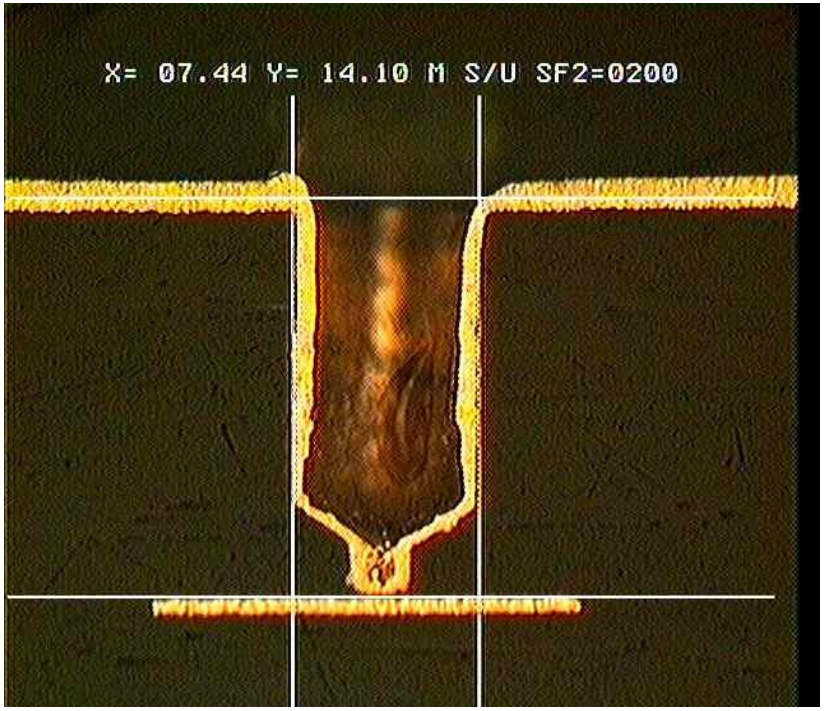


Controlled Depth Drilling



1.4:1 Aspect Ratio

2:1 Aspect Ratio



Eclipse Direct Plate Reliability

Interconnect stress test

- IBM design “Fred” panel
- 22 layer- FR-406 material Tg 170ºC
- 5x preconditions
- 4080 test coupon

Thermal stress

- 6X solder float according to IPC TM 650-2.6.8
- Cross section and visual inspection for defects

Interconnect Stress Test

- Data from production site
- Based on 32 coupons processed over 3 weeks

IST cycles to failure	Eclipse			E'less Copper		
	P2%	Cycles	S2%	P2%	Cycles	S2%
Ave	0.6	500	0.2	1.3	455	6.1
Min	0.3	500	-0.2	0.2	409	0.7
Max	0.9	500	0.7	1.2	500	11.0
STDEV	0.3	0	0.5	1.9	52	5.7

Mil Spec Reliability Requirements

- MIL PRF 55110-G
- Testing performed by Microtek Laboratories Anaheim, CA

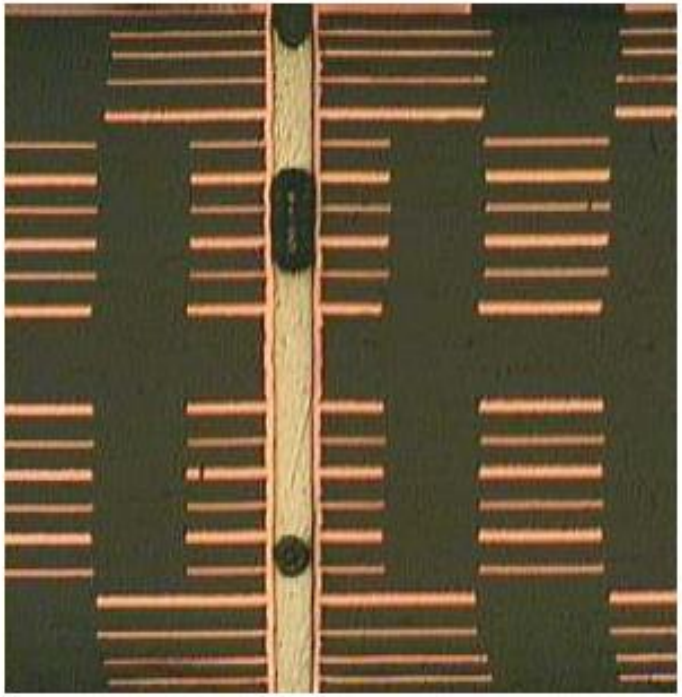
- Plating adhesion – Pass
- Rework Sim. – Pass
- Solderability – Pass
- Surface peel – Pass
- Thermal Stress – Pass
- Thermal Shock – Pass

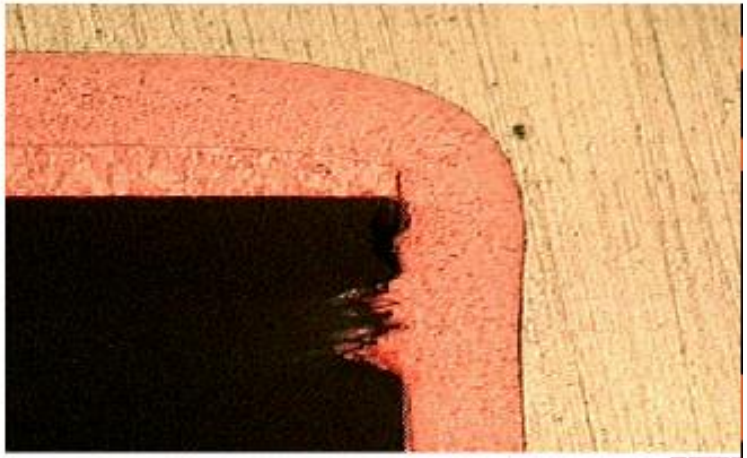
Eclipse is approved by numerous US Avionics and Military OEMs

6x Solder Shock

6 x solder shock at 288ºC

- No innerlayer separation
- No corner cracks





Cost Reduction

- Lower unit costs
  - 25-30% lower operating cost\
- Reduced Water Consumption
  - Electroless Copper 11.7 Gal/SSqFt
  - Eclipse 1.3 Gal/SSqFt
- Reduced Energy Consumption
  - Electroless Copper 0.12 kW hours/SSqFt
  - Eclipse 0.51 kW hours/SSqFt

Comparison to Electroless Copper

Characteristic	E'less Cu	Eclipse	
Start Up Time	60 Minutes	10 Minutes	83% savings
Cycle Time	120 Minutes	25 Minutes	80% savings
Chemical Consumption	4400 Gal./Day	715 Gal./Day	84% savings
Water Consumption	15480 Gal./Day	2838 Gal./Day	82% savings
Waste Treatment	13200 Gal./Mo.	2640 Gal./Mo	80% savings

* Based on 8600 ft2/day

Actual Case Study

- US PCB facility
- Eclipse installed Nov. 2006
- Wide variety of laminate materials
- Typical panel sizes 18x24 and 21x24
- Avg. layer count - 10
- Approx. 2400 ft.2 / day

- Start up – 75% savings
- Cycle time – 80% savings
- H2O consumption – 75% savings
  - $50,000.00 / year
  - $250,000.00 first year SAC charge savings
- Waste Treat – 75% savings
- No queue needed for start up

Questions?

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