



# Non-Cyanide Alkaline Copper and Silver Plating

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# The push for non-cyanide copper

- In USA Challenge:
  - Department of Homeland Security ranks cyanide as a potential terrorist weapon
  - Insurance costs
  - Fire departments
  - Employee Health
  - Employee Safety
  - Eliminate the toxic release inventory report of cyanide to government



# Benefits of cyanide

- Excess cyanide corrodes anodes
- Controls cathodes efficiency
- Breakdown products  $\text{NH}_4$  and  $\text{CO}_3$
- Cleaning



# Cyanide Copper

- Plates up to 1.3 times faster than non-cyanide copper
- Wide operating window



# Cyanide difficult to replace

- High metal concentration
  - Reservoir
  - Stops anode polarization
- Low metal ion concentration at cathode
  - Small crystals– bright
  - Increased throw



# Cyanide Challenge

- Two tanks – Strike and plate tank
- Carbonates
  - Sodium bath – 90 grams/liter
  - Potassium bath – 120 grams/liter
  - Dilute the bath to solve carbonates



# Cyanide Challenge

- Watch caustic level – too high, blisters
- Cyanide contamination in acid copper



# Cyanide Challenge

- Less throwing power than alkaline non-cyanide copper
- Cost more in waste treatment costs for higher copper concentration and cyanide destruct





# Goal in formulation

- Need to find a compound to replace cyanide which acts as a common anion and also as a complexer .....
- But without strong chelators to shut down waste treatment systems



# Non-Cyanide Copper Plating Advantages

- Analysis and bath control
  - Titrate for copper metal
  - pH
  - Electrolyte: Control by Amp Hours, IC, Hull Cell



# Benefits of Non-Cyanide Copper

- Eliminates the inherent dangers of cyanide in the workplace and improves employee health & safety.
- Eliminates the concern for a catastrophic accidental acidification of cyanide
- No cyanide in F006 sludges




# Benefits of Non-Cyanide Copper

- No danger of cyanide if a fire occurs in a plant
- Reduces waste treatment costs for destroying cyanide
- Eliminates the use of hazardous chlorine or sodium hypochlorite to treat cyanide
- Meet government regulations





# A proven bath available which plates on:

- Steel and iron
- Brass and copper
- Stainless steel
- Zincated aluminum
- Zinc Die-cast
- White metal castings
- Both rack and barrel
- Lead bullets 



# Alkaline non-cyanide copper process

- Pyrophosphate
- Proprietary





# Pyrophosphate:

- Pyrophosphate
  - Steel and iron
  - Brass and copper

# Pyrophosphate:

- Pyrophosphate Issues
  - Breakdown products
  - $\text{P}_2\text{O}_7^{-4} + \text{H}_2\text{O} \rightarrow 2\text{HPO}_4^{-2}$
  - In a concentration 40–60 grams/liter level of orthophosphate results in poor adhesion and banded deposits.







# 1<sup>st</sup> Generation Proprietary Alkaline Non Cyanide Copper:

- Proprietary Non-Cyanide Alkaline Copper
  - Steel and iron
  - Brass and copper
  - *Stainless steel*
  - *Heat Treat Stop Off*
    - Boeing Approved BAC 5722
  - *Works as both a Strike and a Plate bath*
  - *Easy to control*





# Non-Cyanide Copper Plating

- Only three main components
  - Liquid copper concentrate, 30–60%
  - Liquid electrolyte replenisher
    - One liter / 500–1000 amp hours
  - pH adjuster, used at 7% on make up. Also used to raise the pH if necessary
- Secondary
  - High current density booster–Heat Treat Stop Off



# Non-Cyanide Copper Plating

- Copper metal 0.8–1.5 oz/gal
- pH 9.0 to 10.0
- Temperature 100 to 140°F
- Agitation Vigorous air with racks
- Anode Current 10 to 20 ASF
- Cathode Current 5 to 20 ASF
- Voltage Rack 4 to 6, barrel 15 to 18 volts
- Anodes CDA (Copper Development Association) 101 or 102
- Filtration Continuous carbon. Use carbon without silica/quartz. Coconut shell base.



# 1<sup>st</sup> Generation Proprietary Alkaline Non Cyanide Copper:





# 1<sup>st</sup> Generation Proprietary Alkaline Non Cyanide Copper:

- Issue with 1<sup>st</sup> Gen
  - Does not work well on zincated aluminum
  - Zinc die-cast





# 2nd Gen Proprietary Non-Cyanide Alkaline Copper Process:

- Proprietary Non-Cyanide Alkaline Copper
  - Steel and iron
  - Brass and copper
  - Stainless steel
  - *Zincated aluminum*
  - *Zinc Diecast*
  - Heat Treat Stop Off
    - Boeing Approved BAC 5722
  - Works as both a Strike and a Plate bath
  - Easy to control





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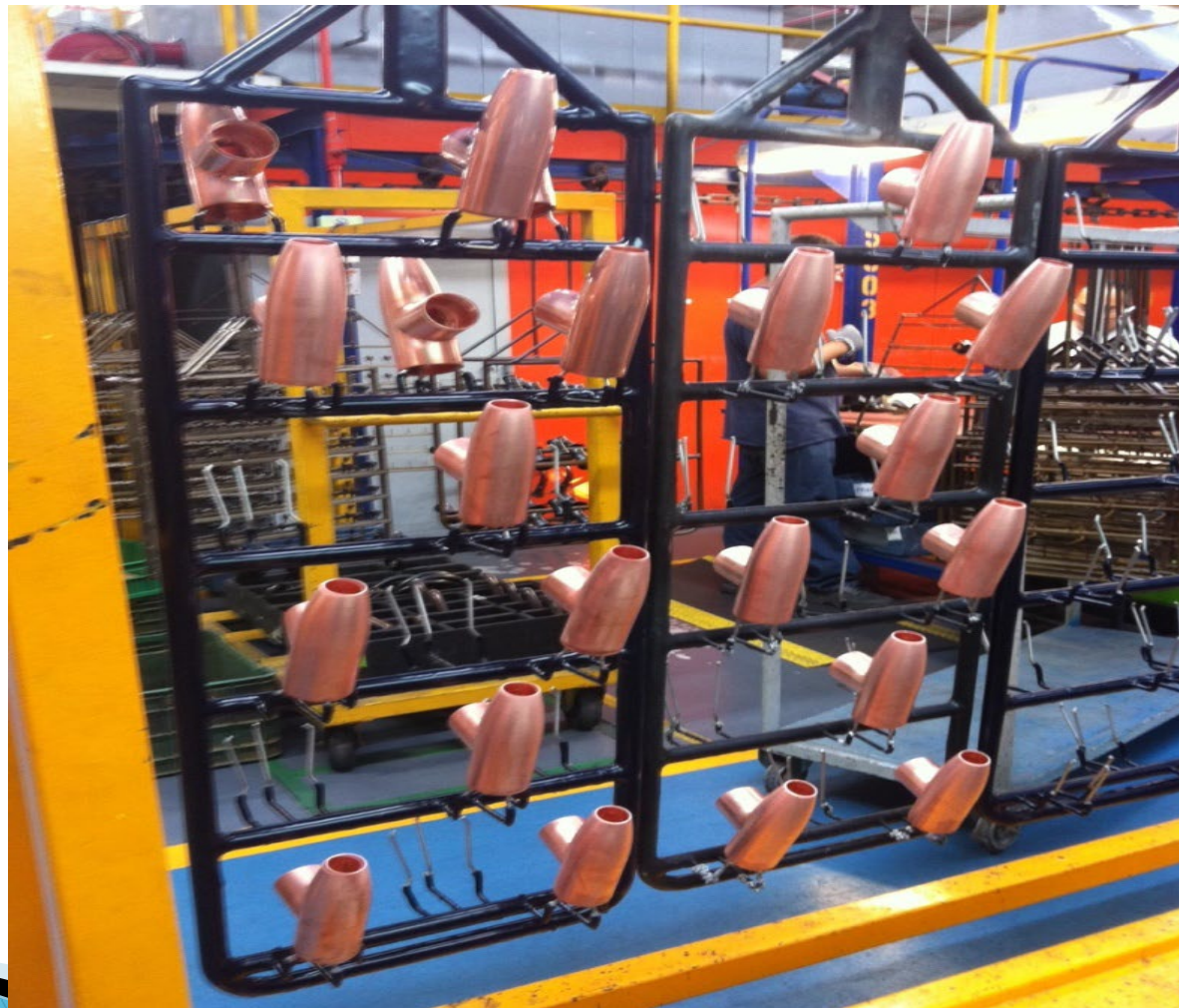
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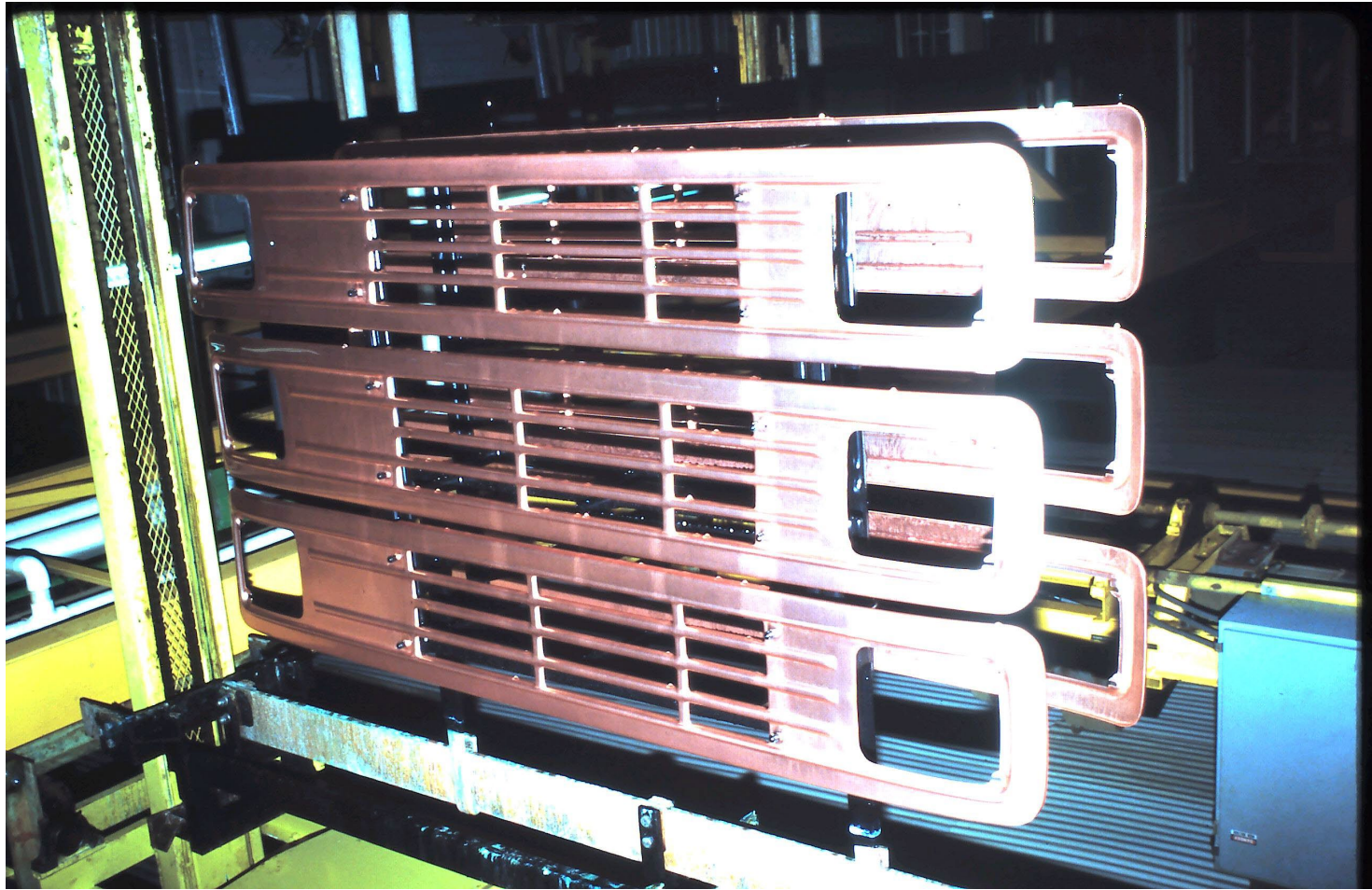


# Zinc die cast plumbing parts





# Peterbilt Aluminum Truck Grill





# 2nd Gen Proprietary Non-Cyanide Alkaline Copper Process:

- Issues with 2<sup>nd</sup> Gen
  - Barrel Plating Zinc





# Latest Non-Cyanide Proprietary Alkaline Copper Processes:

- Proprietary Non-Cyanide Alkaline Copper
  - Steel and iron
  - Brass and copper
  - Stainless steel
  - Zincated aluminum
  - Die cast Zinc
  - *Rack and Barrel plating of Zinc*
  - Works as both a Strike and a Plate bath
  - Easy to control





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  - Liquid copper concentrate, 30–60%
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# Latest Non-Cyanide Proprietary Alkaline Copper Processes:

- Proprietary Non-Cyanide Alkaline Copper
  - Eliminated the immersion copper challenges
  - Immersion copper that adheres reliably
  - Passed the quench test
    - Baked at 325F/160C for 60 minutes followed by cold water quench





# Latest Non-Cyanide Proprietary Alkaline Copper Processes:

- New alkaline non-cyanide copper is formulated to provide a larger window before immersion copper takes place.
- The immersion copper is very adherent versus other processes.







# Latest Non-Cyanide Proprietary Alkaline Copper Processes:





# Other improvement in Non-Cyanide Alkaline copper:





# Plating Lead Bullets

- Plating on lead a challenge
- Process for plating on lead without lead contamination problems
  - *Additional Components necessary to plate on lead*
    - *These components are used to help improve the copper plating deposit and adhesion in the presence of lead.*
- Alkaline Non-Cyanide copper plated as a strike
- Passed the smash adhesion test and has been test fired.



# Plating on Magnesium

- Pre-Treatment
  - Requires a zincate
  - Requires more steps
- Finer/Dense grain structure
- Higher corrosion resistance



# Alkaline Non-Cyanide Copper Conclusion

- Alkaline non-cyanide copper has been in use for 30+ years
- Understand the challenges with Alkaline Non-Cyanide
  - High Quality copper anodes (CDA 101 or 102)
  - Continuous Carbon Filtration
  - Better cleaning and pre plate process
- Viable commercial process for eliminating cyanide from facilities





# Non-Cyanide Silver

- Eliminate Cyanide silver strike tank
- Plate directly to copper, copper alloy
- Plate directly to nickel





# Silver electroplating applications

- Decorative: Silverwares, Jewellery
- Electronics: Switches, connectors



# Design Considerations

- Environmental Friendliness
- Stable bath chemistry
- Plates over different metal substrates
- Excellent adhesion
- Uniform white deposit with no yellow hues





# Break through technology of non cyanide silver electroplating

- Plate directly on nickel as well as copper alloys
- Stable bath chemistry
- Bright silver for electronic, industrial and decorative applications
- Cost effective: plate silver entirely from dissolving silver anodes
- Exceptional covering and throwing power
- Fine-grained, smooth, dense silver deposit with low porosity
- Brilliant white deposit and better anti-tarnishing properties than other non-cyanide silver processes
- Easy maintenance and room temperature plating



# Plating Specifications

- Silver metal: 9.5–17 g/l (1.25–2.25oz/gal)
- pH: 9.5–10.5
- Temperature: 16–24 °C (60–75F)
- Cathode current density: 3–10 ASF
- Anode current density: 2–10 ASF
- Silver anode: slab or popcorn anodes in polypropylene basket
- Filtration: continuous filtration with 1 micron filter
- Agitation: air agitation on the cathodes



# Solution Make-Up and function of components

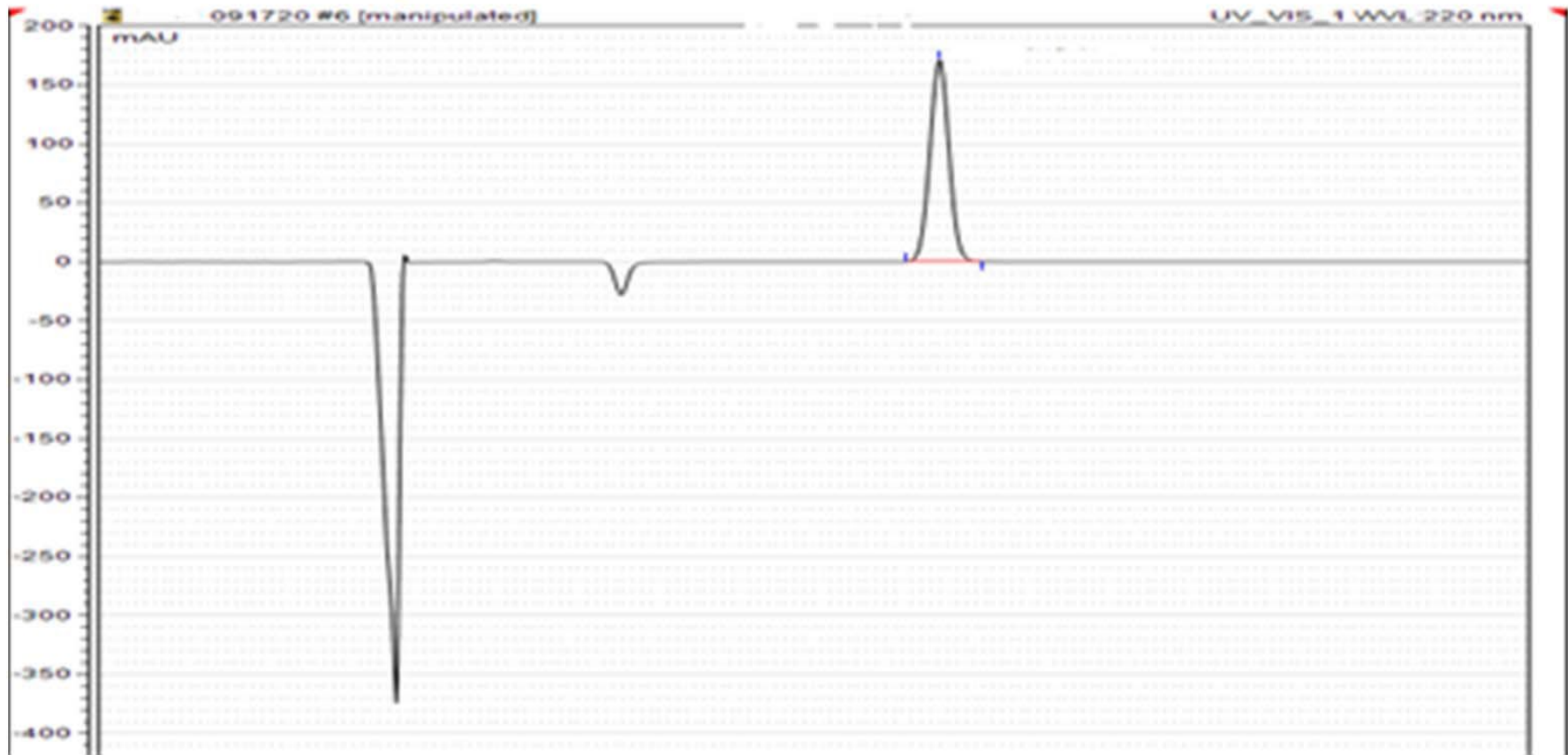
- Liquid silver concentrate 30% by volume
  - provide initial silver ions
- Maintenance electrolyte 30% by volume
  - Maintenance electrolytes: complex silver ions, dissolve silver anode, and ensure great adhesion between silver and metal substrates
- Brightener 1% by volume
  - Brightener: refine silver grain and control crystal orientation
- Remainder DI water 39% by volume



# Maintenance of plating solution

- Silver metal: titration, AA or ICP. Entirely replenished by dissolving silver anode
- Maintenance electrolyte: Hull cell test for adhesion, HPLC analysis, consumed based on ampere hours
- Brightener: hull cell test and ICP analysis, consumed based on ampere hours
- pH: 9.5–10.5; lower pH with nitric acid, raise pH with 50% KOH
- Filtration: continuous filtration with 1 micron filter
- Agitation: air agitation on the cathodes

# HPLC analysis of maintenance electrolyte



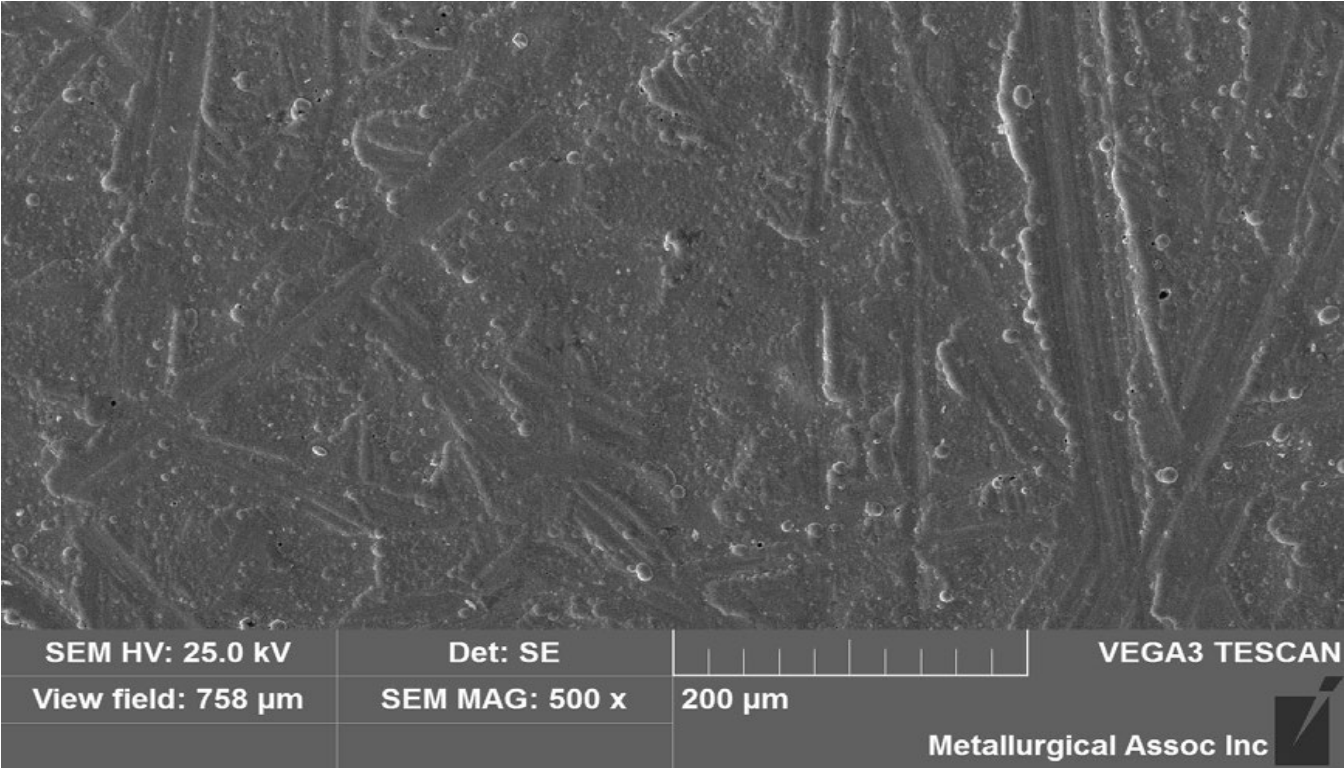


# Plating speed of non cyanide silver

Cathode Current Density (ASF)	2	5	10	15	20
Plating Rate micro-inches/min	6.4	15.4	26.2	33.3	40.3



# SEM picture of silver deposit





# Properties of Silver deposit

- Purity of silver deposit: over 99.9%
- Hardness: 150–200 KHN50 with a Knoop diamond indenter at a load of 50 grams
- Electrical resistance: 3.0–3.5 microhm–cm
- The wear resistance: better than cyanide silver deposit; the wear test performed by Taber Abrader is to abrade the silver deposit with the load of 250 grams.





# Silver plating conclusion

- The silver deposit has a brilliant white color and shows a better anti-tarnishing properties than other non-cyanide silver processes.
- The new chemistry is very cost effective and it plates entirely out of silver anodes.
- The bath is extremely stable. The solution pH is buffered and remains stable during plating and when idle.
- It can plate non cyanide silver directly on nickel surfaces (meeting all three types of ASTM B-700) as well as plate directly on silver, brass, bronze and copper and does not require a separate silver strike on these substrates.
- The plating bath is an alkaline, cyanide free plating solution, which can plate bright silver for electronic, industrial and decorative uses.



We have been plating alkaline non-cyanide copper for over 30 years now and alkaline non-cyanide silver for over 20 years. The chemistries are stable when the copper/silver plating abides with our instructions.

Our alkaline non-cyanide copper and silver are being used throughout the world!





# Thank you for time today!

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