

# High corrosion resistance plating process for magnesium substrates

NASF Technical Conference

Cleveland, OH

August 15<sup>th</sup>, 2007

# Magnesium Plating Process

- Magnesium is the metal of the future because of engineering properties and its light weight character.
- It is replacing zinc die cast, aluminum castings, plastics, and even carbon fiber.

# Magnesium Plating Process

- History of Magnesium
- When I first was approached about magnesium, by Bill Giebel all that I could think of is MAG WHEELS.
- Do you remember MAG WHEELS?
- Mark Karner ABQC Milwaukee, WI

# Mag Wheels Story

- These wheels were not plated!
- Mother's Polishing Compound removed the oxidation and then would wax the wheels
- This would be done every two weeks otherwise pitting would occur
- In winter you change to your stock tires and the mag wheels would go in the basement with bees wax on them

# Why magnesium as a substrate?

- Thinner wall castings 0.08 inches which makes for a stronger part yet lighter part
- Dies last 2-3 times longer than aluminum
- Saves casting energy costs one pound of Mg 1800 BTU's and AL 2500 BTU's

# Why magnesium?

- Lower casting pressures for Mg vs. Al
- Easier to machine Mg 500, AL 300, and B1112 steel 100.
- Longer tool life decreasing tooling costs

## Petacchi Breaks Out the Power Tools!



The world's fastest cyclist has a new advantage for 2007: the DMT MagForce, the first cycling shoe with a full magnesium sole. It offers greater structural rigidity than carbon fiber, meaning more power is transferred to the pedals. Ale-Jet will be more aerodynamic too. The SL-SF Concept (seamless + sockfit) upper is truly one piece, providing increased comfort and a lower drag coefficient.

Alessandro Petacchi  and MagForce

DMT MagForce: Save the carbon for your bike.

 **GITA**<sup>GO</sup>  
think fast.

 **DMT**<sup>®</sup>

[www.dmtshoesUSA.com](http://www.dmtshoesUSA.com)

# Magnesium vs. Zinc

- One pound of magnesium costs \$1.21/pound. To cast the same area of zinc die cast you would need 3.6 pounds of zinc die cast. A cost of \$0.495/pound equals \$1.782 total cost, therefore you will save about 32%, plus save 2.6 pounds in weight. (numbers as of the date of the submission)



# What is holding back magnesium?

- Finishing it to achieve a coating like on zinc diecast and aluminum castings.
- Corrosion protection and bake adhesion tests results.
- Present processes use cyanide copper and electroless nickel processes.

# Cyanide copper process

1. Soak Clean
2. Rinse
3. Acid Activation
4. Rinse
5. Zincate
6. Rinse
7. Cyanide Strike
8. Cyanide Plate
9. Remainder of nickel/chrome process

# Cyanide Copper

Cyanide copper has two challenges

- 1) Corrosion protection is less than process proposed
- 2) The future of cyanide. Homeland Security has listed sodium and potassium cyanide as one of the potential terrorists chemicals on Appendix A.

# Cyanide Copper

If you have 2000 pounds of a cyanide compound at your facility you will need to have to perform security plan according to your tier.

China's federal government has asked finishers to get out of cyanide plating processes.

# Electroless Nickel

- 1. Soak Clean
- 2. Rinse
- 3. Acid Activation
- 4. Rinse
- 5. Zincate
- 6. Rinse
- 7. Electroless Nickel
- 8. Rinse
- 9. Acid Copper, Nickel, and Chrome

# Electroless Nickel

- Defense industry is looking for a high corrosion resistance.
- Present results are 48-96 hours salt spray using EN.
- High costs of nickel metal.

# Alkaline non cyanide copper process

- The standard non cyanide copper process did not work on the magnesium process.
- A reformulation in the process that improves adhesion and the salt spray hours.

# Alkaline non cyanide copper process advantages

- Tighter grain structure than cyanide copper allows it to be used as a heat treat stop off to replace cyanide copper.
- Lower pH value of alkaline non cyanide copper solution is 9.4-9.8 versus cyanide copper 10.3-11.5
- Zincate for magnesium has low pH 10.2-10.6



# Alkaline Non Cyanide Process

- 1. Soak Clean
- 2. Rinse
- 3. Acid Activation
- 4. Rinse
- 5. Zincate
- 6. Rinse
- 7. Alkaline non cyanide copper
- 8. Rinse
- 9. Acid Copper
- 10. Buff Acid Copper
- 11. Nickel and Chrome plating

# Alkaline non cyanide copper process

- Soak Cleaner
- First thought is that aluminum cleaner can be used.
- High caustic cleaner with out silicate does not etch magnesium like it does aluminum.

# Alkaline non cyanide copper process

- Acid Activation
- Proprietary Process that removes the oxides and prepares the magnesium for the zincate process.

# Alkaline non cyanide copper process

- Zincate
- pH 10.0 -10.8
- Temperature 150-180 F
- Immersion Time 5-10 minutes
- Filtering extends bath life

# Alkaline non cyanide copper process

- Alkaline non cyanide copper
- Minimum thickness 0.5 mils (30-40 minutes)
- Higher thickness of alkaline copper does improve corrosion protection and allows to bake the part at 350F with up to 1.0 mil thickness (60-70 minutes)

# Alkaline non cyanide copper process

- Acid Copper Plating of two mils and then polishing the plated magnesium part improves the appearance of the part
- Opportunity for improvement in castings

# Challenges for magnesium

Casting quality needs to be improved for decorative appearance standards

Use magnesium buffing compounds not aluminum buffing compounds

Vapor degreasing seems to work better than alkaline spray washers

# Biggest Challenge

- Unpolished surfaces, for example the back of the part that is not seen by the eye, seem to result in Swiss Cheese effect.
- Areas that are polished exhibit acceptable cosmetic finish and excellent salt spray results.



# What's next?

- The goal is to get the OEM, metal finisher, buffing compound supplier, chemistry supplier and casting supplier work together to make this happen.

# Salt Spray Results

- Magnesium w/ Alkaline non cyanide copper, acid copper, bright nickel, and chrome provide up to 96- 120 hours of salt spray.
- Magnesium w/ alkaline copper and high phos electroless nickel achieved 400 hours of salt spray.

# Thanks to

- Bill Geibel of Linetec in Wausau, WI
- Info on magnesium go to [www.magnesium.com](http://www.magnesium.com)