METLON® PEARL BLACK

Environmentally Friendly Surface Modification to Blacken EN Coated Components for High Temperature Applications

ABSTRACT

As the demand for electroless nickel (EN) coatings increase for its excellent wear, hardness and corrosion resistance properties, there has been a growing demand for its black aesthetics for various applications. Black being highly absorbent makes it a very coating requirement for aerospace, firearms, military and defense, optics, solar panel, etc. To meet these industry requirements with sustainable chemistries, environmentally friendly water-based METLON® Pearl Black was developed to blacken EN coated components for high temperature applications. In this research, properties such as surface morphology, thickness, wear / abrasion, corrosion resistance and gloss were studied. It was found that Metlon® Pearl Black maintained deep black finish with excellent wear and corrosion properties at >800°C while maintaining excellent coating uniformity over complex geometries.

INTRODUCTION

• Apart from aesthetics, there has always been a demand for BLACK object / coatings absorbing all incoming light (all colors of visible spectrum)
• As such, black coatings have a potential for numerous applications such as solar, optical, automotive, defense, aerospace, decorative, etc.
• BLACK coatings should achieve:
  - Uniform coating to avoid post coating mechanical operations
  - High absorbance (a > 0.95) with ability to store and transmit energy (to transport medium)
  - Minimal thermal loss.
  - Excellent mechanical properties such as adhesion, abrasion resistance, hardness and
  - Good resistance to corrosion.

METLON® Pearl Black

• Extremely simple & economical, room temperature operation dip chemistry with 5-10 min. processing time
• Is a RoHS compliant, Metal Free, Environmentally Friendly Blackening Process
• Provides intricate Surface Modification to EN coated components by offering controlled micro-etching.
• Results demonstrate METLON® Pearl Black maintains EN’s inherent properties. Hence, offers excellent

CORROSION TEST

PROVIDED BY TAPE TEST

ADHESION TEST

GLOSS TEST (RHO-POINT Analysis)

SURFACE MORPHOLOGY

ABRASION TEST PROFILOMETER

CURRENTLY ADOPTED METHODS

BLACKENING TECHNIQUES / DEPOSITIONS

LIQUID PHASE

VAPOR PHASE

PROPOSED

TITANIUM / ALLOY BASED CARBON BASED

METLON® PEARL BLACK

• Result: Pass

THICKNESS TEST

THICKNESS GAUGE (Digital Micrometer):

• Coated samples with Electroless Nickel (EN) to achieve (15 microns thickness confirmed by Thickness Gauge)
• Immersion EN coated components for environmentally friendly Sustained Pearl Black for 5-10 hours
• Remove samples, rinse in clean DI water, dry at 300°C and measure thickness with the Thickness Gauge.

Result: Pass

MICRO-HARDNESS TEST (Mitutoyo):

• Thickness decreases averaging ~2 microns for 10 minute immersion time.
• METLON® Pearl Black offers controlled & precision etching (~0.2 microns (0.0079 mil) / minute)

Micro-Hardness test METLON® Pearl Black was not measured as it is anticipated that this surface modification should not affect the hardness.

CONCLUSION

• METLON® Pearl Black is a simple & economical process that can be adopted to blacken almost any substrate – Aluminum, Copper, Steel, etc. post Electroless Nickel (EN) Plating at Room Temperature
• Chemistry developed is water-based Environmentally friendly, RoHS compliant with no metals
• Controlled micro-etching ~ 2 microns / 10 minutes of the surface allows optimum process control & ability to achieve uniform coating, thus eliminating post coating mechanical operations.
• Surface modification offers:
  - High Rate of Absorption (a = 0.98) as per Rho-Point analysis post METLON® Pearl Black
  - Strong adhesion (passed ASTM D3539 - METHOD A);
  - No significant changes in Micro-hardness (anticipated)
  - Excellent Corrosion resistance (passed 48 hours Humidity Test and Low Wear (Wt. Loss - 5 mg / 100 Cycles for EN + METLON®: 2 mg / 100 Cycles EN+METLON® with CS10)
  - Excellent color stability and adhesion up to 400°C
  - Client testing confirmed excellent color stability and adhesion at >800°C
• METLON® Pearl Black can be removed without damaging the substrate as compared to black-anodized aluminum.