



insights into

**ELECTROPOLISHING
& MECHANICAL POLISHING**
Technology

ASTRO PAK.

DEFINITIONS

Anode – the positive electrode into which metallic anions flow *off of* the work-piece or component

Cathode - the negative electrode from which cations flow *onto* the copper conductor

Electrolyte – the ionic solution (usually phosphoric acid blend) that carries the metal ions from the anode towards the cathode

Electropolish – An electrolytic polishing process that removes metallic ions from the anodic work-piece in a reducing environment through an acidic solution



POLISHED SURFACES ATTRIBUTES

Mechanical Polishing

- Scratches
- Surface imperfections

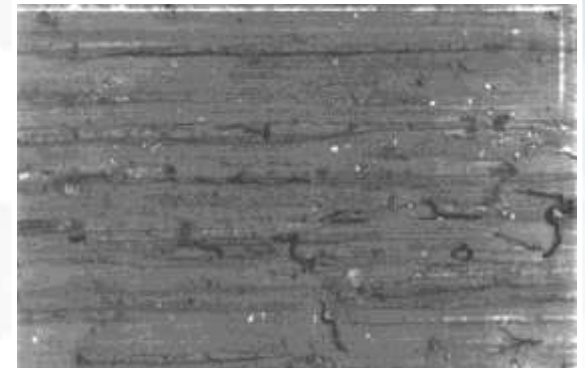
Electropolishing

- Cleanability
- Featureless

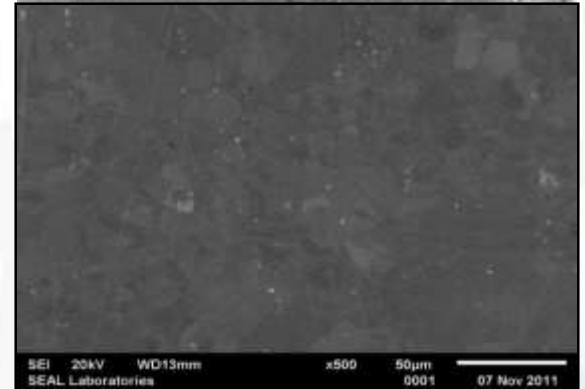
Microscopic Appearance

Ra readings = 15 Ra_{max}

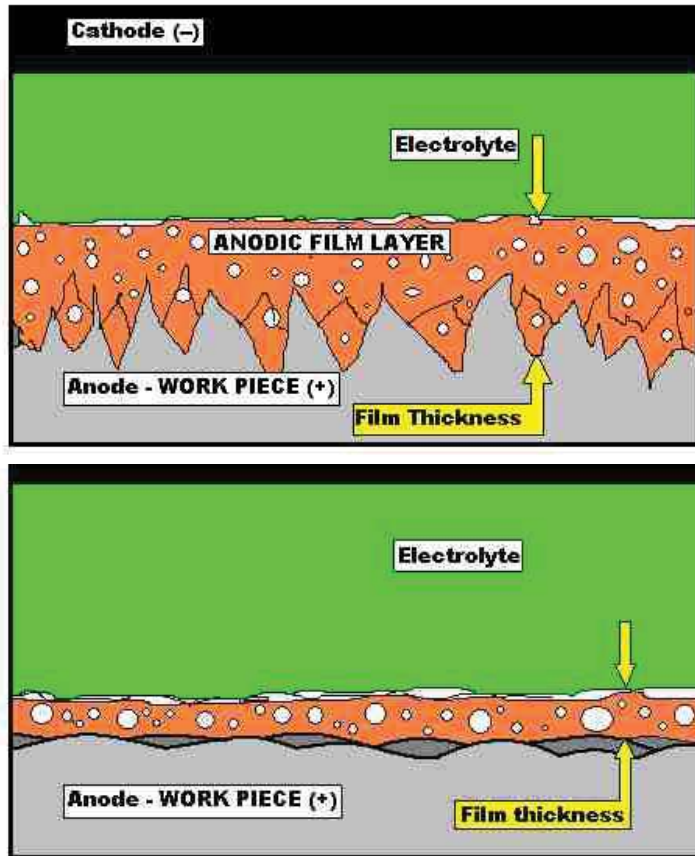
MP



EP



EP PROCESS TECHNOLOGY



- Electrical power forms anodic film
- Film thickness regulates speed of material removal
- Peaks are removed faster than valley areas – anodic leveling
- Surface becomes smooth and featureless
- Removes surface damage



TOPICS COVERED

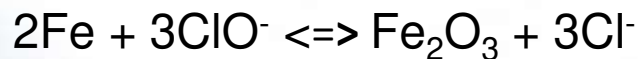
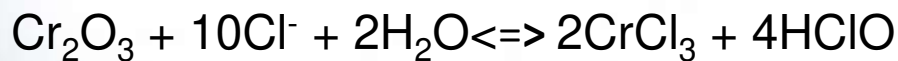
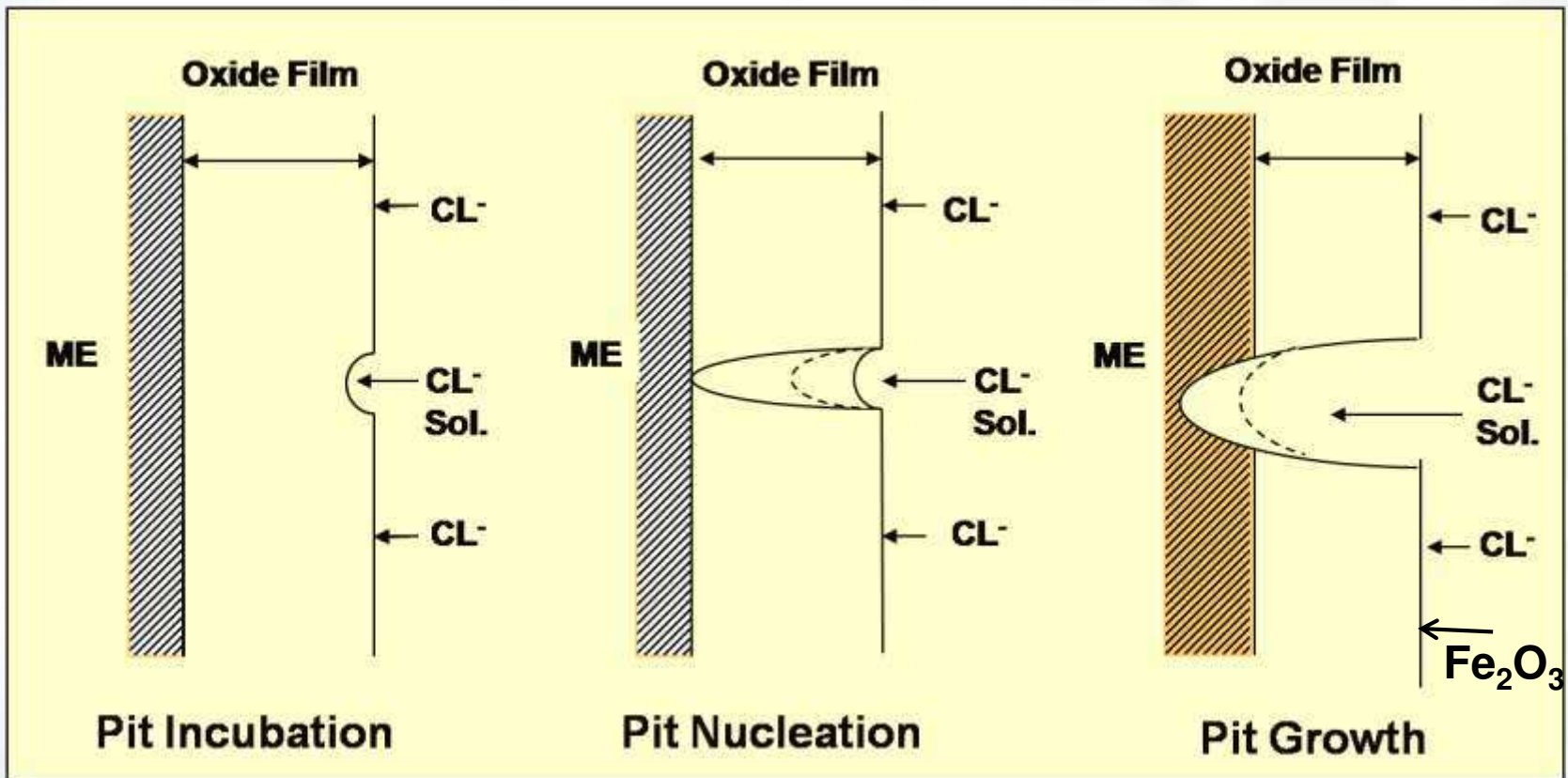
Surface Conditioning Services

- Passivation
- Rouge (Iron Oxide) Removal
- CO₂ Ice Pellet Impingement Cleaning
- Abrasive Blasting
- Mechanical Polishing
- Thermal Arc Spray Metal Deposition



PASSIVATION

Mechanism of Chloride Pitting



MECHANICAL POLISHING

Mechanical Polishing (ASME BPE approved for 2014 edition): a process by which abrasive media is applied to a surface with intent to smoothen until a desired and/or specified surface roughness (Ra) is achieved.

Process

- Sanding operation
- Aluminum oxide abrasive used to restore original surface Ra
- Required Utilities: 110V electric and or compressed air (100 psi)

Where Applicable

- Where restoration of original metal surface Ra is required
- After Dry Ice Blasting, Bead Blasting or, Thermal Arc Spraying

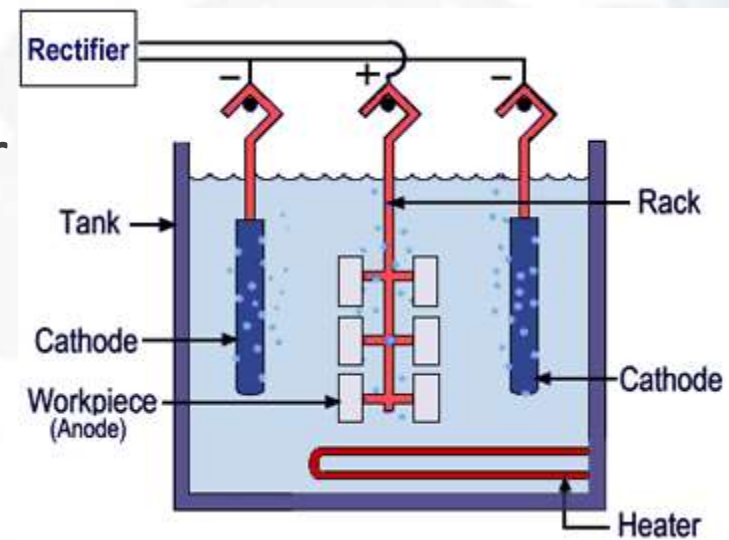
Benefits

- Process used to meet specific Ra or aesthetic requirements



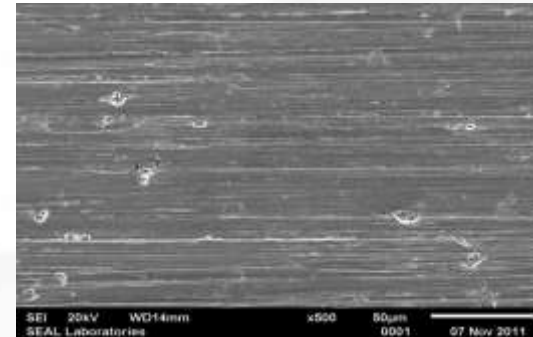
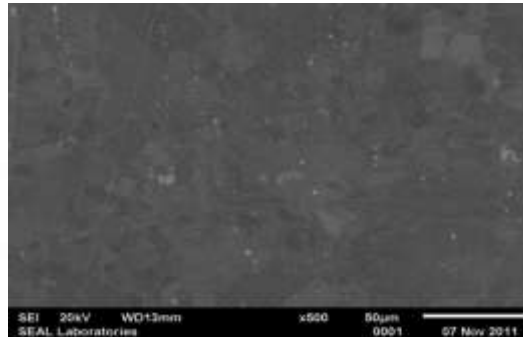
BENEFITS OF EP SURFACES

- Optimum surface finish
- Higher corrosion resistance
- Removal of Bielby damage layer
- Minimizes surface area
- Improves cleanability
- Featureless microscopic surface
- Lowered rouge formation
- Improved sterility

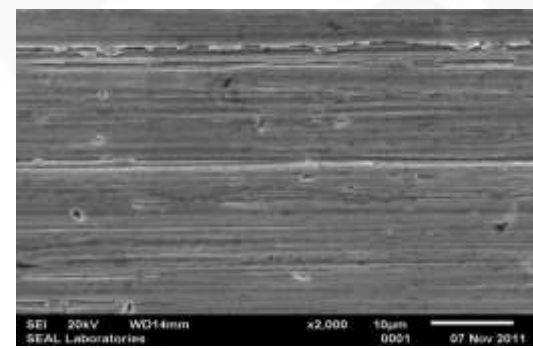
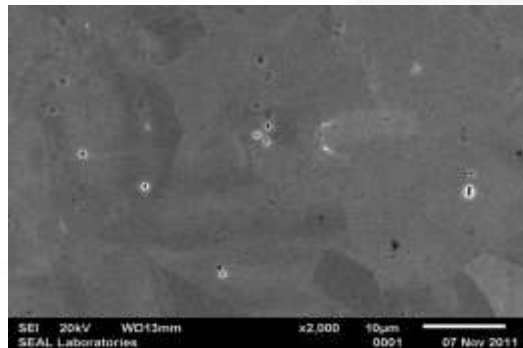


COMPARISON OF MP vs. EP

500x



2000x



ELECTROPOLISHED

MECHANICAL POLISHED



MECHANICAL POLISHING



MP technique performed in-situ in vessel

MECHANICAL POLISHING

Inspection



- Inspection after derouging will show areas that need MP to resolve pitting or scratches
- Rouge removal prior to Electro-Cleaning allows closer inspection of surface.
- White streaks or heavy hazed areas require MP prior to Electro-Cleaning or EP
- Visible pitting will require MP



MECHANICAL POLISHING

Debris on Surface

- Polishing debris consists of stainless steel particles, abrasives and adhesives
- Wipe test of surface illustrates its presence
- Removal of debris from surface – wiping with alkaline cleaner
- EP removal of surface damage – includes MP debris, cold worked surface cracking, and microscopic scratches

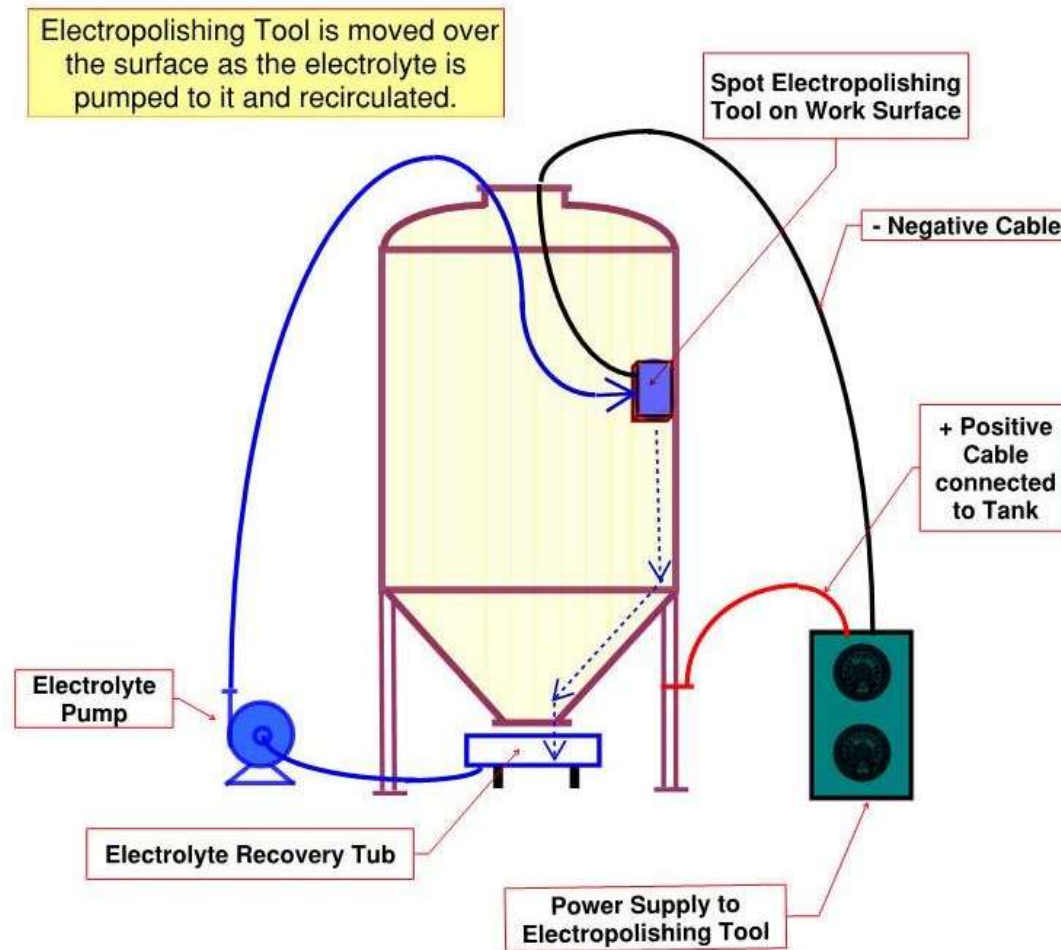


BUFFING – DETRIMENTAL EFFECTS

- Entraps stainless particles, polishing debris and organic compounds
- Decreases corrosion resistance
- Not recommended for high purity applications
- Smears damage into the surface
- Looks shiny, but surface damage is hidden



IN-SITU EP OPERATIONS



IN-SITU EP OPERATIONS



Electropolishing of vessel interior

REASONS TO EP IN-SITU

- Reduce downtime and subsequent re-validation because no removal / replacement is needed
- Customer can monitor work progress and provide immediate approval for return to service
- Repair corrosion damage
- Remove small scratches and shallow pitting
- Smooth microscopic surface
- Improve cleanability
- Reduce corrosion potential
- Restore original factory surface condition



ELECTROLYTIC CLEANING

Process access is required

- Tank Entry Safety Program
- May be completed from outside vessel

What does it remove?

- Light levels of rouge or discoloration
- Smooths surface imperfections

What does it not remove?

- Electrically insulating residue
- Heavy rouge deposits (slow)
- Pits



BENEFITS OF ELECTROLYTIC CLEANING

- Removal of light rouge
- Removal of corrosion effects that generated the rouge
- Microscopic pitting/roughness is smoothed
- Smoother surface reduces corrosion rate
- Decreases frequency of derouging



BEFORE AND AFTER EP REPAIR



BEFORE



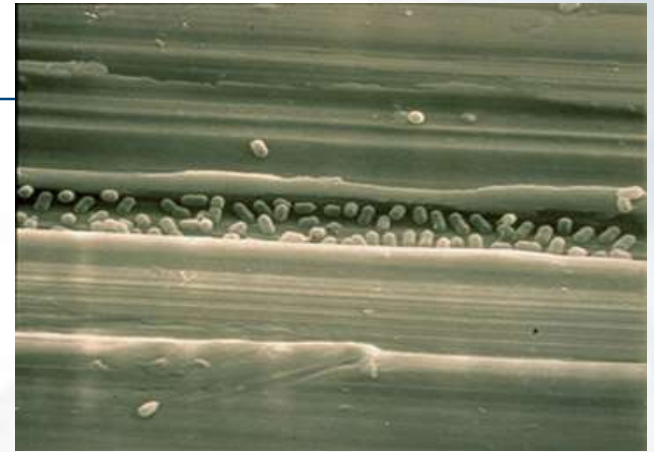
AFTER



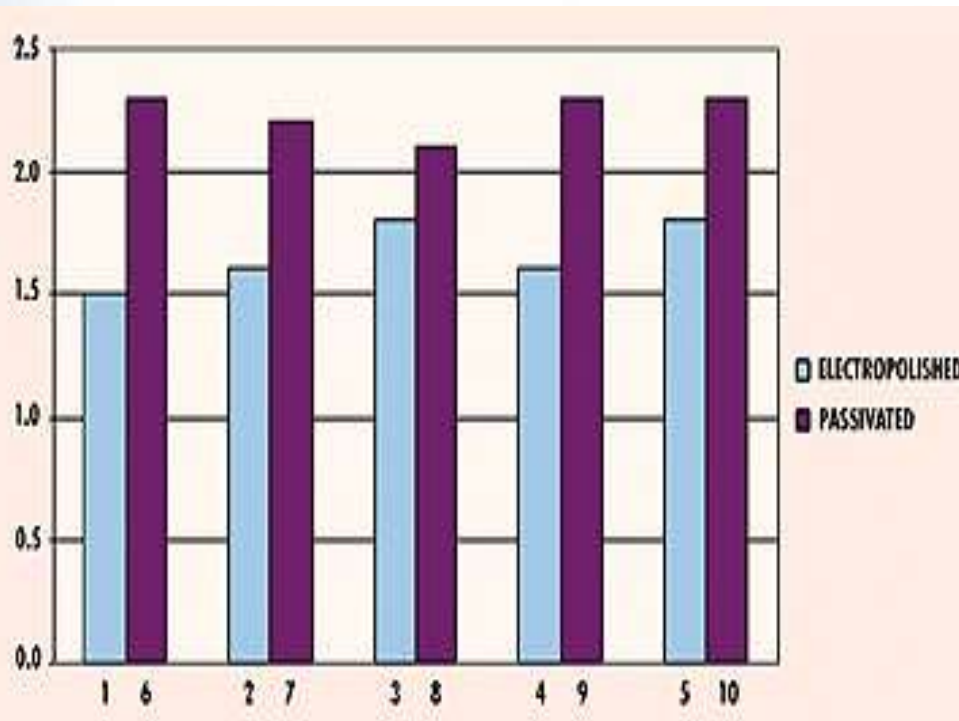
BIOFILM AND ROUGE

Surface Contamination on Product-Contact Surface

- Organic contamination, and in severe cases “biofilm”, occurs when bacteria form protective clusters on the metal surface.
- Surface roughness and porosity caused by corrosion promotes bio-colonization.
- Chemical cleaning and passivation can correct contaminated surfaces.



PASSIVATION AFTER ELECTROPOLISHING



- Chromium to Iron ratio testing with AES
- Passivation's dramatic improvement
- Corrosion resistance increased

ASME BPE REQUIREMENTS

BPE SF-2 Acceptance Criteria

- Blistering None Accepted
- Buffing None Accepted (following EP)
- Cloudiness None Accepted
- Haze None Accepted
- End Grain Effect Acceptable, if Ra max is met
- Fixture marks Acceptable, if Electropolished
- Orange Peel Acceptable, if Ra max is met
- Stringer indications Acceptable, if Ra max is met
- Weld whitening Acceptable, if Ra max is met



ASTM B-912

Passivation Using Electropolishing

ASTM B-912 Acceptance Criteria	
Metal removal	Between 10 and 50 microns
Fixture marks	Acceptable, with approval
Visible defects such as pits, roughness, striations, or discoloration	None Accepted
Current density	Measured and followed per procedure
Post dip or Passivation	Nitric acid 10-30% v/v or
Passivation testing per ASTM A-967 or A-380	Citric based UltraPass Passivation
Inspection, Testing & Documentation	Meet requirements <ul style="list-style-type: none">• Reference B-912, test method, quantity and location• Operator name and test date• Testing Results



BPE

Electropolish Procedure Qualification

Procedure Method

Written Quality Control Program

- Pre-polish inspection process
- Pre-cleaning process
- Specific gravity range for electrolyte bath
- Conductivity of rinse water

Essential Variables

- Amperage/time
- Temperature range
- EP process
- Final rinse and clean process
- Final inspection

Documentation

- SEM photos of process qualification sample
- XPS data of 1.0 or greater
- Qualification samples for inspection
- Process control records
- EP procedure used
- Final Ra

Certificate of Compliance

- Vender company
- Customer name
- Description of component
- EP procedure used
- Final surface finish report



SUMMARY - CONCLUSIONS

- MP or Buffing can be a source of particles and corrosion
- Ra measurement does not reveal microscopically featureless surface
- EP Results in:
 - Removal of damaged layer
 - Removal of embedded polishing debris and abrasives
 - Featureless surface condition
 - Resistance to corrosion, rouge formation, and bioburden attachment
 - Meets ASME BPE requirements and ASTM B-912



QUESTIONS

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