

SURFACE FINISHING & ELECTROPOLISHING STAINLESS STEEL

What is Stainless Steel?

Why Finish Stainless Steel?

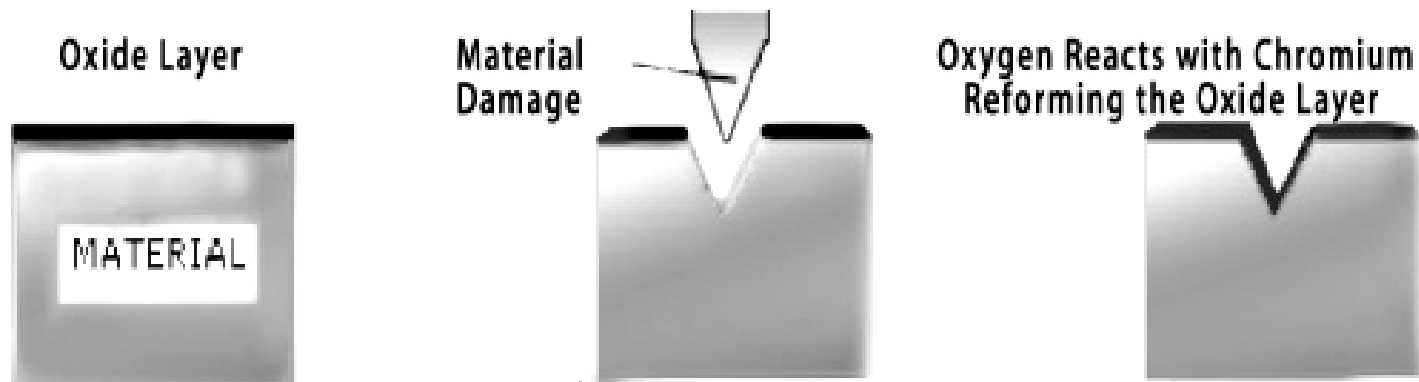
Electropolishing - Advantages

How Does Electropolishing Methods

Post Treatment

What is Stainless Steel

Group of corrosion resistant steels containing more than 11% Chromium



Schematic of Stainless Steels Self Repairing Mechanism giving the Corrosion Resistance

Stainless Steel Material Composition as per ASTM A240

Grade	C (Max)	Mn (Max)	P Max)	S (Max)	Cr	Ni	Mo
304L	0.03	2.0	0.045	0.03	18 - 20	8 - 12	-
316L	0.03	2.0	0.045	0.03	16 - 18	10-14	2 - 3

Outokumpu name	EN	ASTM		C	Cr	Ni	Mo	N	Others
		Type	UNS						
Key products									
Core 304/4301	1.4301	304	S30400	0.04	18.1	8.1	–	–	–
Core 304L/4307	1.4307	304L	S30403	0.02	18.1	8.1	–	–	–

304L Application is for non product contact parts

Outokumpu name	EN	ASTM		C	Cr	Ni	Mo	N	Others
		Type	UNS						
Key products									
Supra 316/4401	1.4401	316	S31600	0.04	17.2	10.1	2.1	–	–
Supra 316L/4404	1.4404	316L	S31603	0.02	17.2	10.1	2.1	–	–

316L Application is for product contact parts

“L” Low Carbon is important

Why Finish Stainless Steel

No Surface Finishing = No Product to Sell !

Changes, Damage & Contamination Caused by Manufacturing & Manipulations Processes



Machining



Welding & Heat Treatment



Grinding & Polishing

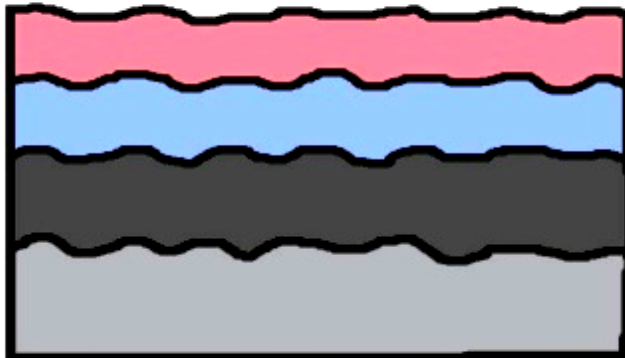


Bending & Folding

Effects to Upper Surface Layers

One common feature of manufacturing processes – Heat !!!

Typical composition of Scale and thermal oxides formed in the welding process



a) Hard layer made up of Fe_2O_3

b) Intermediate layer made up of Fe_3O_4

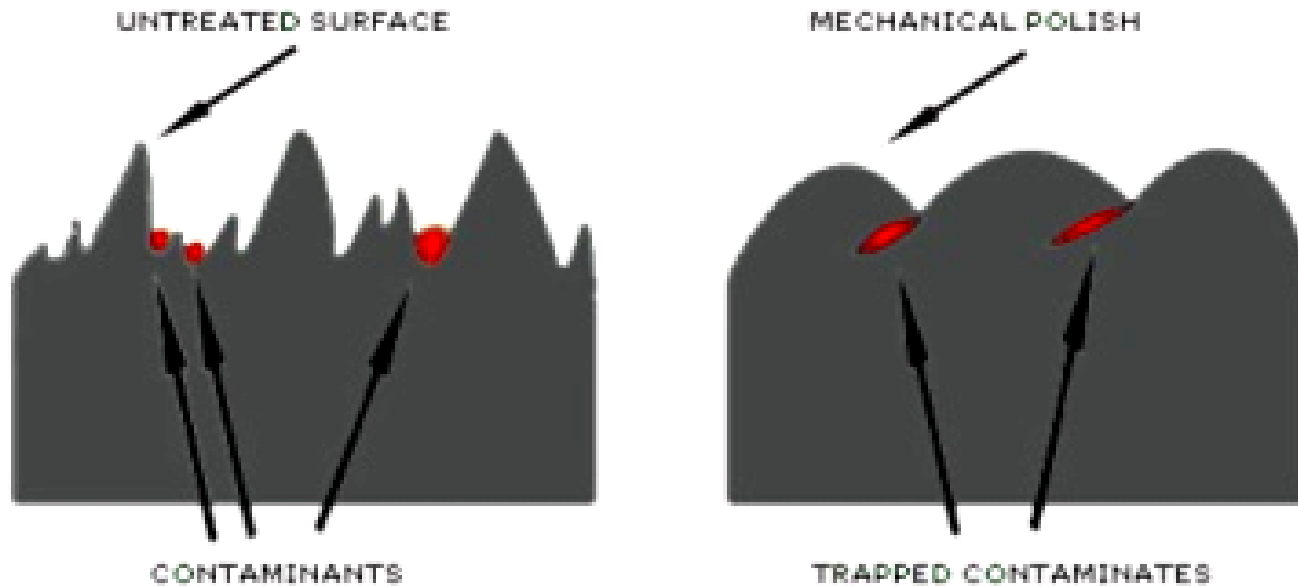
c) Soft base layer made up of FeO

d) Base Material

The upper hard layers are more difficult to chemically dissolve & mechanically remove

Effects to Upper Surface Layers

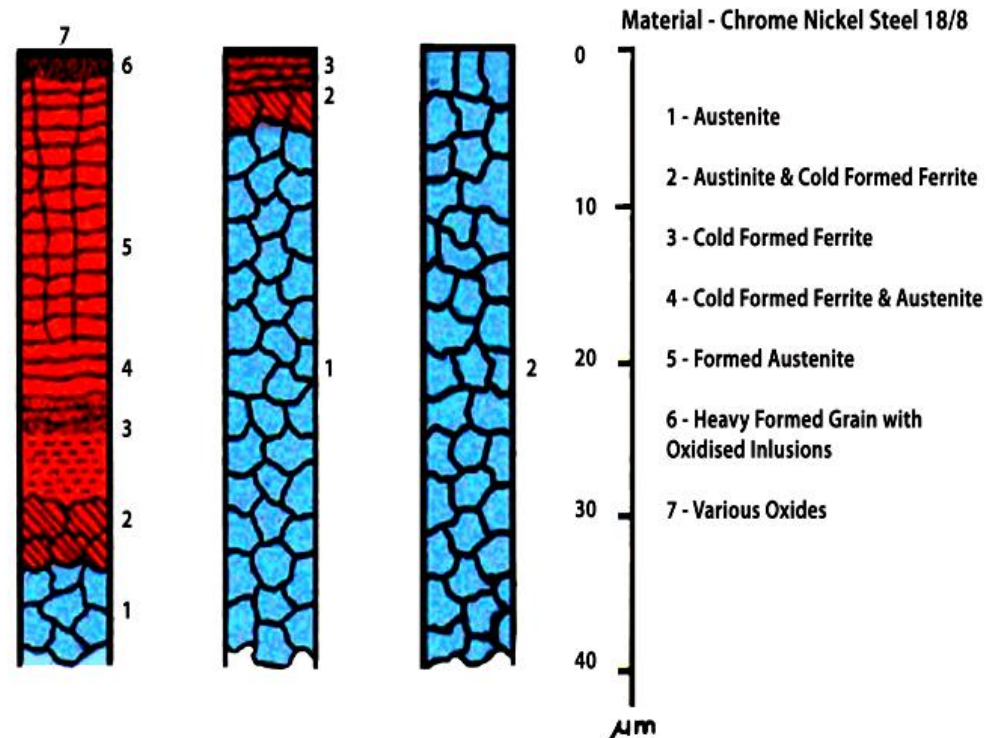
As material plasticises, easily entrapping particles & contaminants



Effects to Upper Surface Layers

Upper Surface Layer Damage

Influence of Surface Treatment on Depth of the Mechanical Modified Layer



According to J. Wuff, The Metallurgy of Surface Finish Cambridge / Mass

Electropolishing - Advantages

Non Impact Method

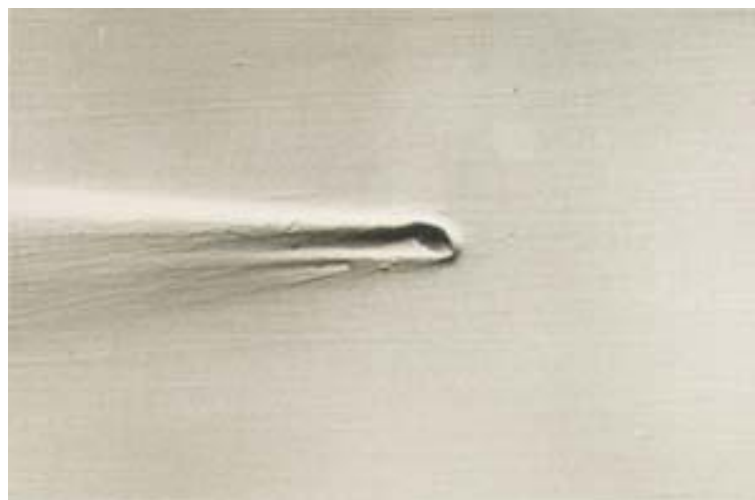
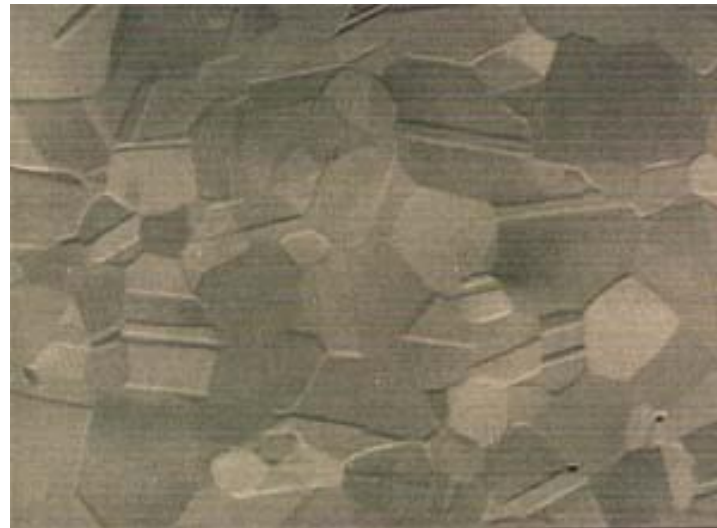
Removes Contaminants

Increases Corrosion Resistance

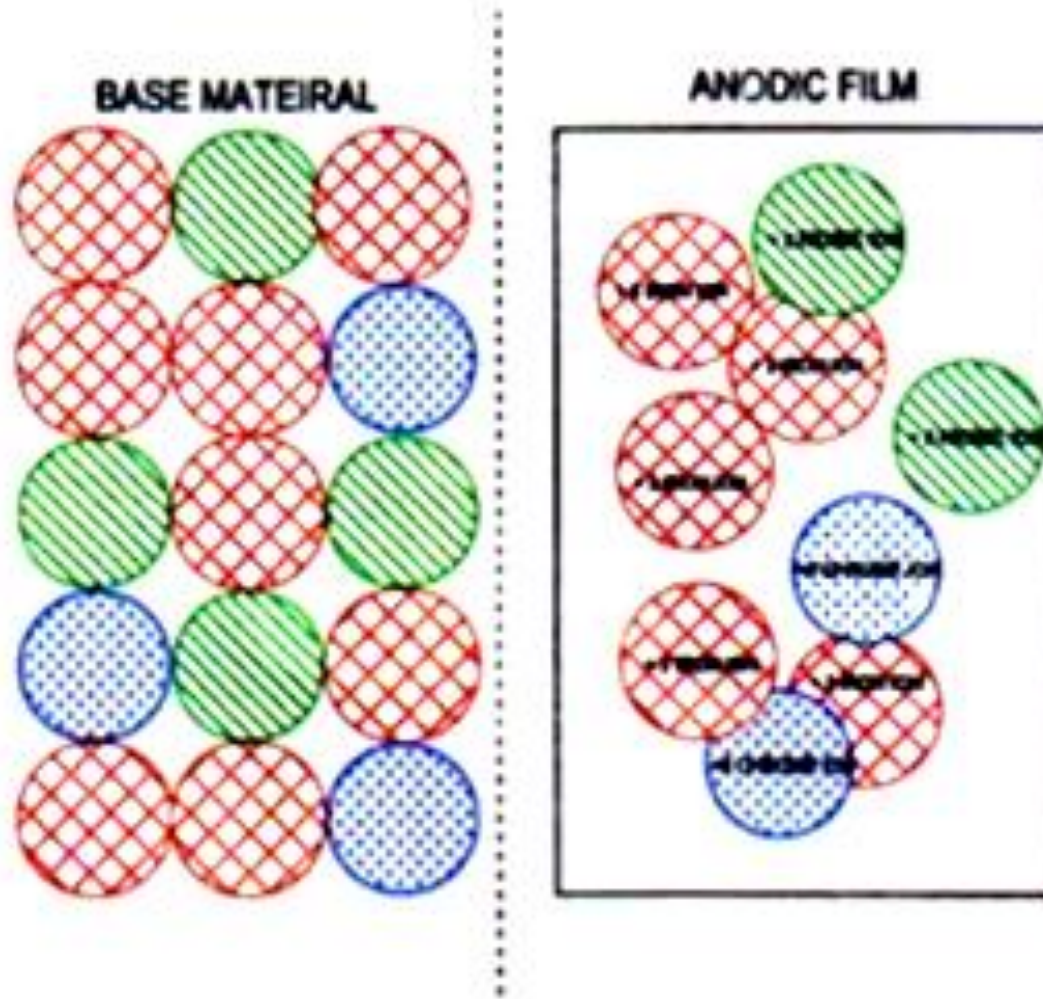
Micro Smooth & Reduces Surface Area

Clean ability

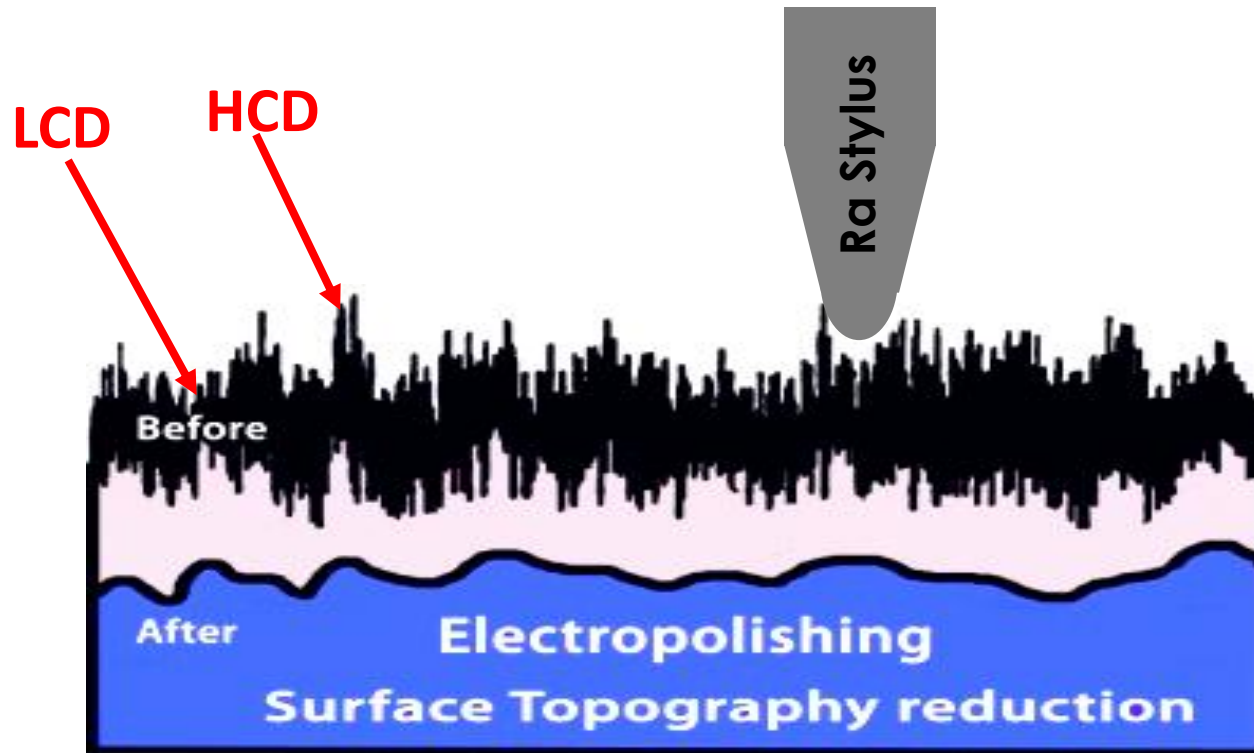
Removes Contaminants



Increase Corrosion Resistance



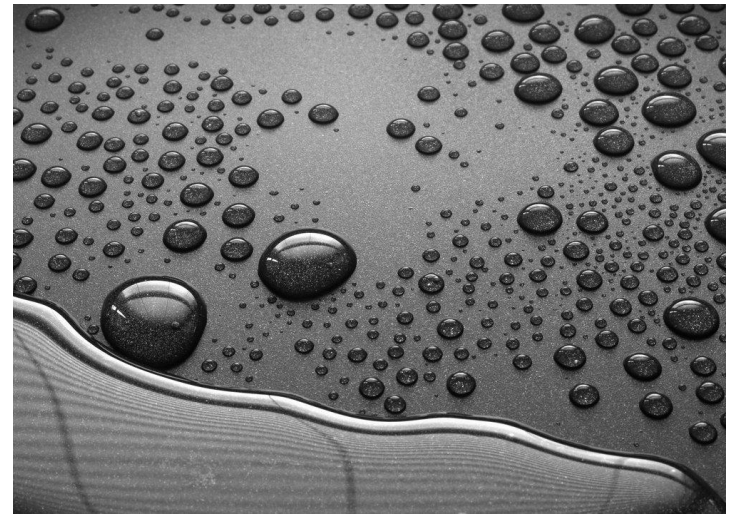
Micro Smooth



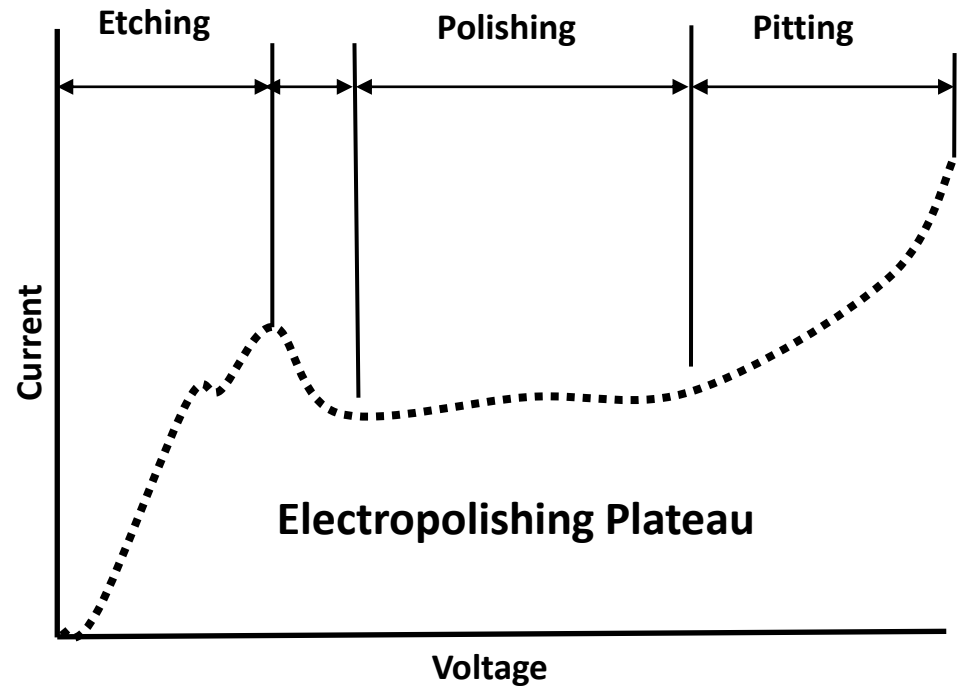
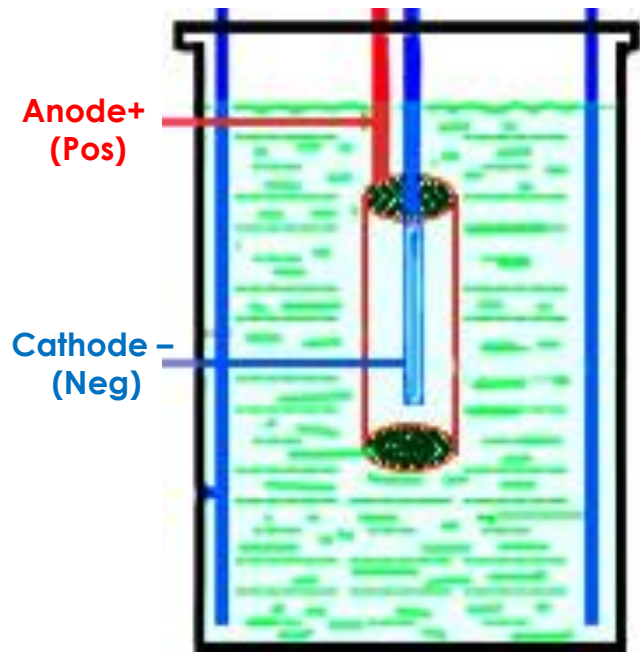
Reduces Surface Area = 15 – 18:1

Typical Ra Reduction 50%

Easy Cleaned – Non Stick



Electropolishing Mechanism



Electropolishing Methods for Tubes

Vertical, Flash & Progressive Horizontal

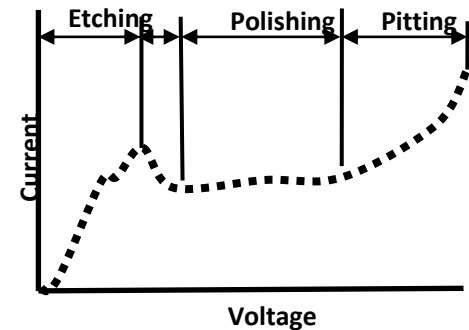
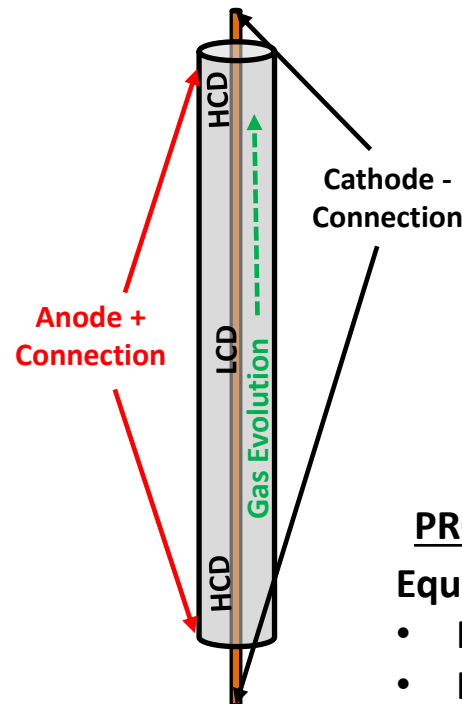
VERTICAL

NON Equal & Stabilized Throughout

- Power / Current
- Electrolyte Flow & Gassing
- Temperature
- Uniformity & Levelling
- Material Removal Rate
- Potential Shorting
- Unpolished Areas from Insulators

FLASH

- Insufficient Material Removal
- Contaminants left in Upper Surface
- Not Acceptable as per ASME BPE SF-2.5

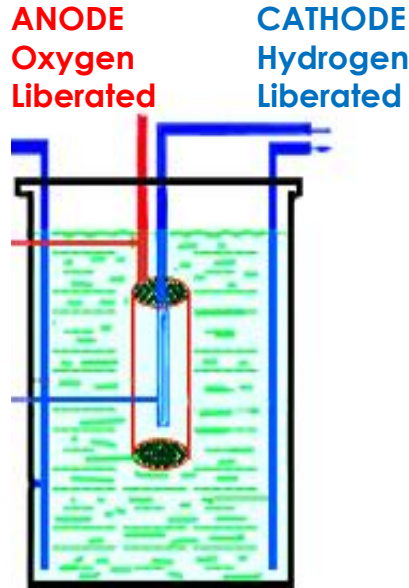


PROGRESSIVE HORIZONTAL

Equal & Stabilized Throughout

- Power / Current
- Electrolyte Flow & Gassing
- Temperature
- Uniformity & Levelling
- Material Removal Rate
- Non Shorting Risk

Post Treatment



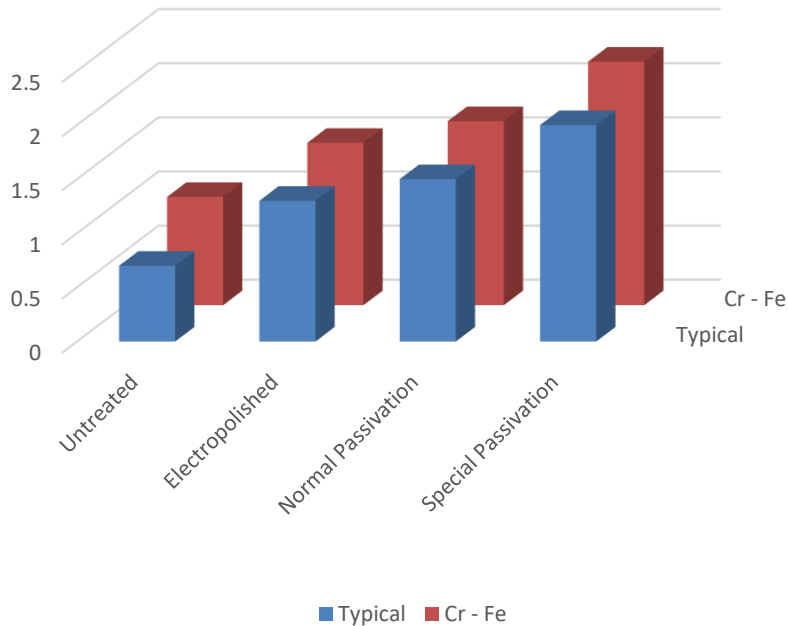
Higher Ratio of Chromium Oxide to Iron Oxide = Already Passive!

Complex Chromium & Nickel Salts – Not Readily Dissolved in Water

High Temperature Passivation Processes can increase Cr Oxide to Fe Oxide Ratios

Passivation & Passive Layer

Cr/Fe



Chromium / Iron Ratio

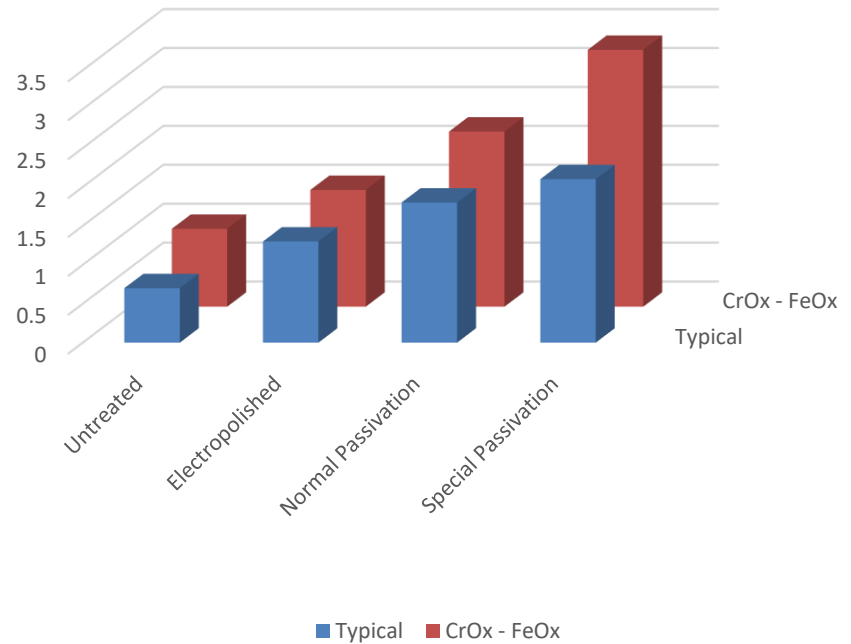
Depth Oxide Enrichment

Electropolished – 20 -25Å

Normal Passivated – 15 – 20Å

Special Passivated – 25 – 30Å

CrOx/FeOx



Chromium Oxide to Iron Oxide Ratio

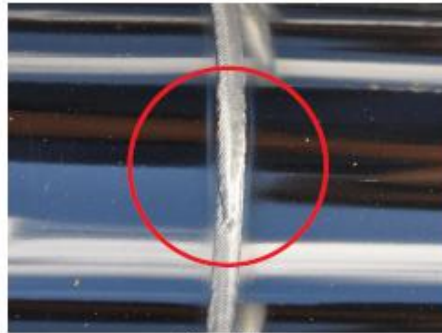
ASME BPE Requirements

Cr/Fe – 1.3 or greater (XPS)

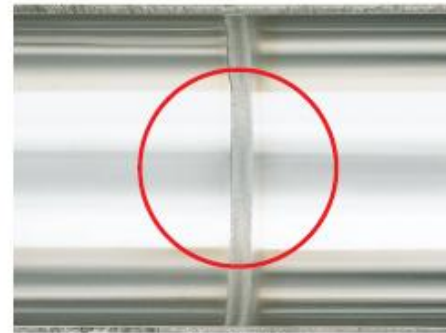
CrOx – FeOx – Min 1:1 or better

Oxide Depth 15Å

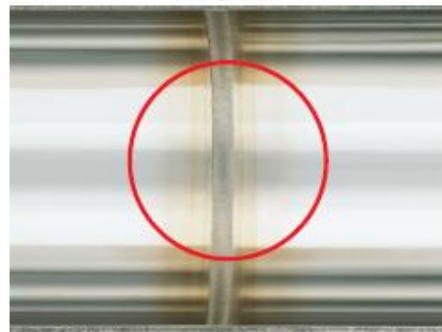
Orbital Welding Electropolished Tube



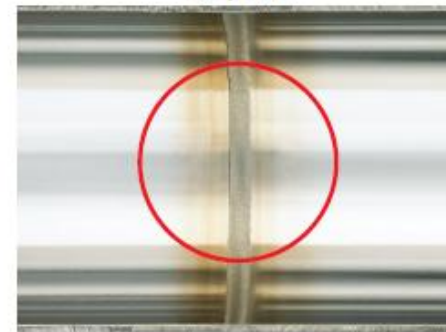
Sample #1a



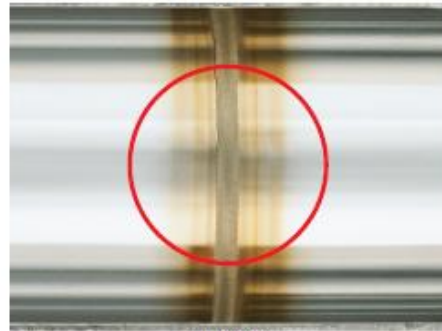
Sample #1b



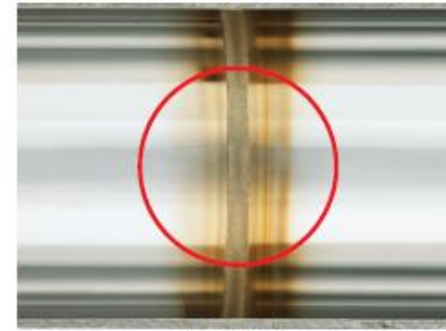
Sample #2



Sample #3



Sample #4



Sample #5

Not Acceptable

Rouge & De-Rouging

Causes

Design of system (traps, long hold times etc.)

Dirty System

Poor welds in system

Poor Passive Layer

Chlorides & Halides

High Purity Water & Steam Systems

Prevention

Clean System & High Level of Passivation

Increased CrOx-FeOx

Exclusion of Poor materials / devices in system

Cleaning (De-Rouging)

Degrease, Clean & Re-Passivation

New Enzyme Technology Cleaning & Re-Passivation



THANK YOU