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# Mechanical Polishing Stainless Steel and High Nickel Alloys



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20Ra

Do You Think This Surface is  
Easier to Clean or.....

100  $\mu$ m  $\times$ 150 15kV

20RA MP

20Ra

Would This Surface Be  
Better?

100  $\mu\text{m}$  ×150 15kV

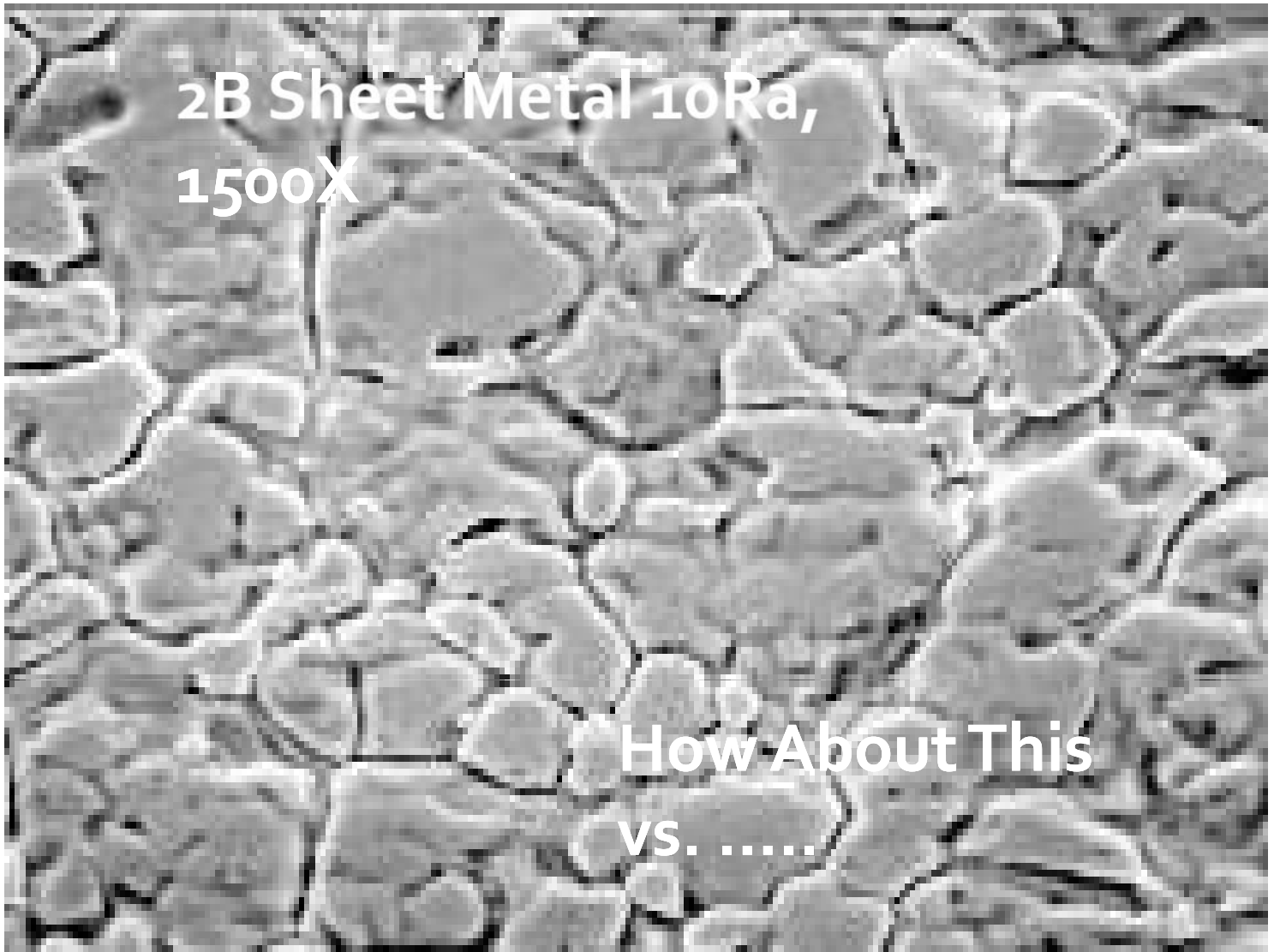
20RA EP

# Surface Roughness

- The previous two slides both measure 20 Ra.
- To achieve this I had the electropolished coupon sanded to and 80 grit (35 Ra) then electropolished to the 20Ra seen.
- 20 Ra mechanically polished coupon was sanded to a 180 grit.
- **The purpose is to illustrate that Ra is not as critical to performance as is the micro-surface finish!**

2B Sheet Metal 10Ra,  
1500X

How About This  
vs. ....



2B – Electropolished  
7Ra, 1500X

This?

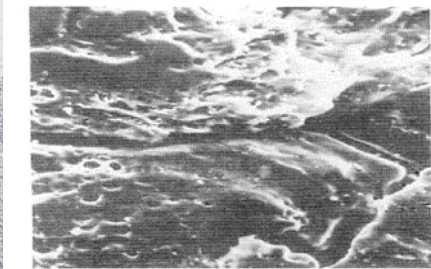
# Mechanical Polishing -Sanding



To achieve a specified Ra on product contact surfaces most fabricated products must receive some form of mechanical sanding, grinding, or polishing.

# Mechanical Polishing -Sanding

MILL FINISH - Hot Rolled Annealed 316 Plate Material



HRAP #1 S.S. Plate As Received

Most alloy plate material used in fabrication is purchased in this condition.

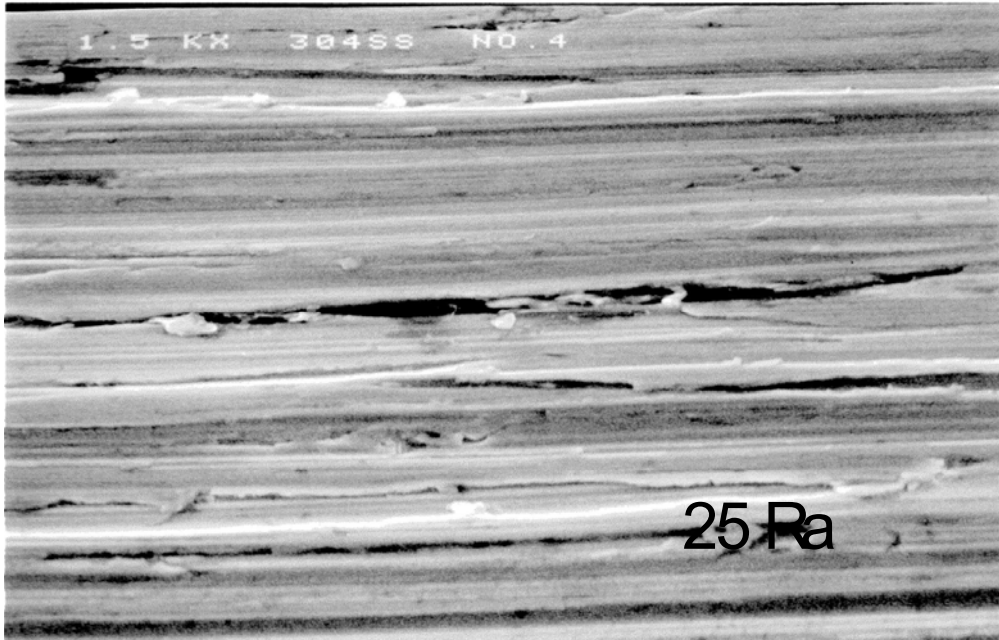
120 Ra





# Mechanical Polishing – Sanding

SEM 1500X – 180 grit 304 Stainless Steel



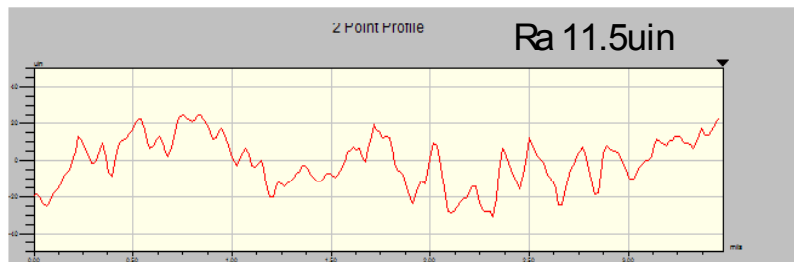
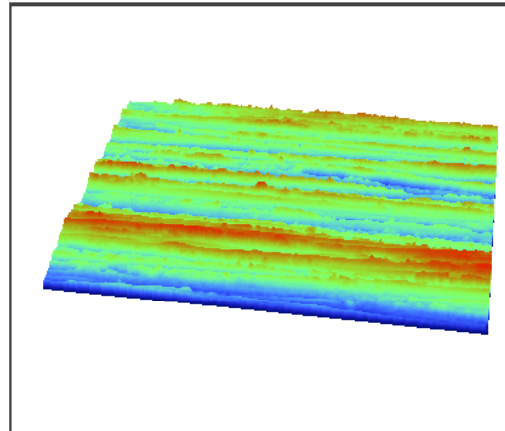
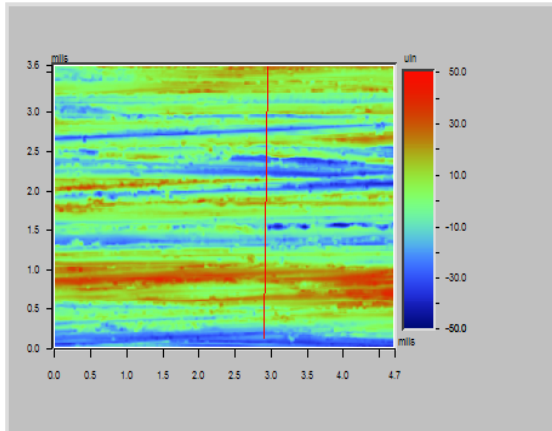
All mechanical operations impart a finish similar to the surface shown here.



# Mechanical Polishing - Sanding

Title: Area 3 (#4) 05

Note: 3/16 Stainless Steel Sheet Metal



## Surface Parameters

Ra: 11.5 µin  
Surface Area: 1.75e+007 µin<sup>2</sup>  
Sdr: 4.304 %



# The Bielby Layer

Mechanical finishing is performed to achieve required Ra on metal surfaces resulting in crystal fractures and other structural changes.

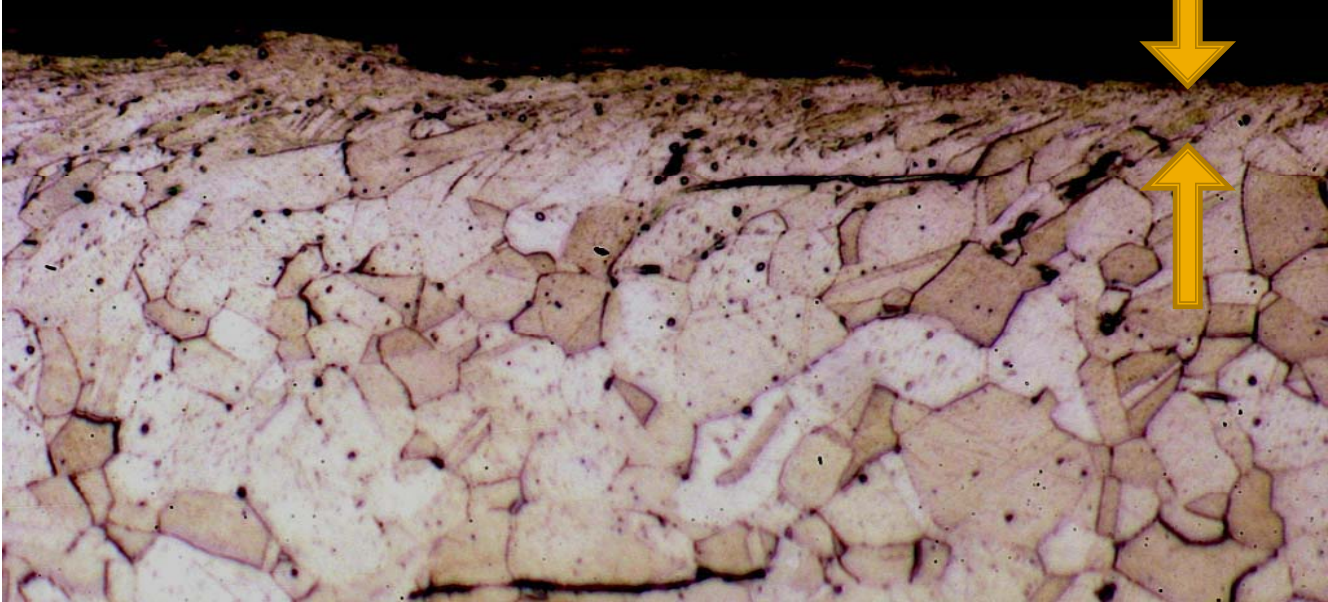
These conditions allow the formation of surface corrosion cells.

This condition is known as the Bielby layer.

Electropolishing can completely remove this damaged layer which is believed to be the biggest contributire to rouge formation in WFI systems.

# Mechanical Polishing -Sanding

- Mechanical Polishing/Sanding/Grinding to achieve a specific Ra will cause a damaged layer and/or heat effected zone (Bielby Layer) to be produced.



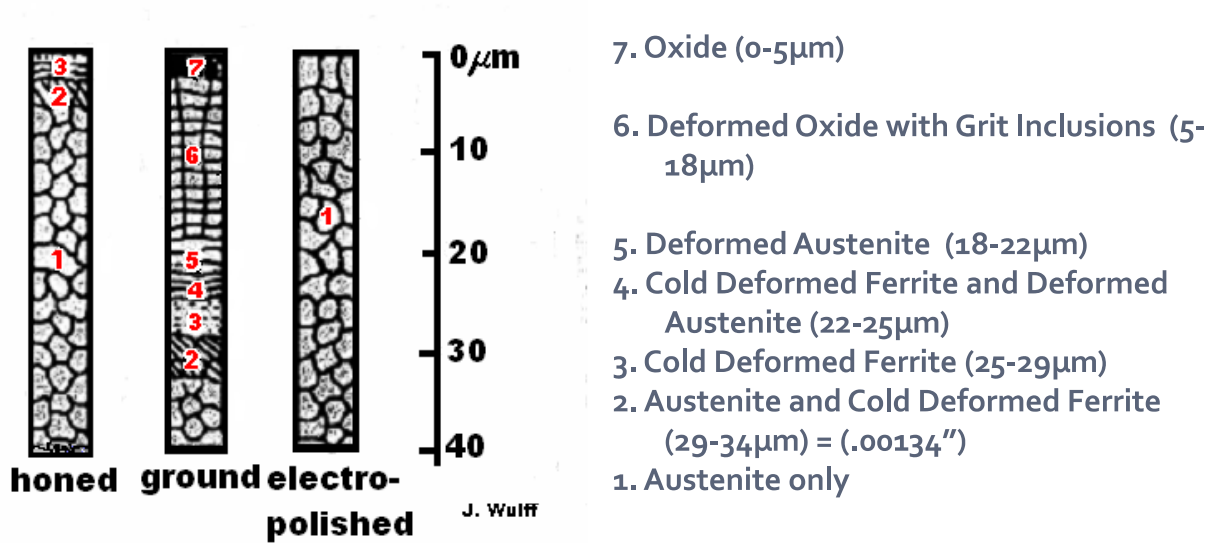
# Mechanical Polishing -Sanding

- This damaged layer will include material smeared over impurities such as:
  - Abrasive material/compounds
  - Iron or other contamination from handling/forming equipment
  - Paint, dye, grease, adhesives
- Mechanical finishing operations all cause damage to the material for some depth below the surface. The depth of this damage will vary depending on how aggressively the material was worked.

## J. Wulff illustrates this damage on honed, ground, and electropolished samples of 18-8 CrNi.

On the honed sample a layer of "Austenite and Cold Deformed Ferrite" sits atop of a layer of "Cold Deformed Ferrite" to a depth of  $5\ \mu\text{m}$  (.00002"). The ground sample had seven distinct layers of non-austenite material atop the pure stainless.

The seven layers top to bottom;



# Conclusions

1. Mechanical Polishing including buffing, even if cleaned and passivated can be a source of product contamination from the manufacturing process, bacterial contamination due to surface profiles that can harbor bio-films making them very difficult to remove, easily form rouge when exposed to high purity water (PW,WFI) or clean steam.
2. Surface roughness (Ra) is not a suitable method of specifying product contact surfaces.