sifco asc

Improved Process Capabilities for Groove Repair

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Who We Are

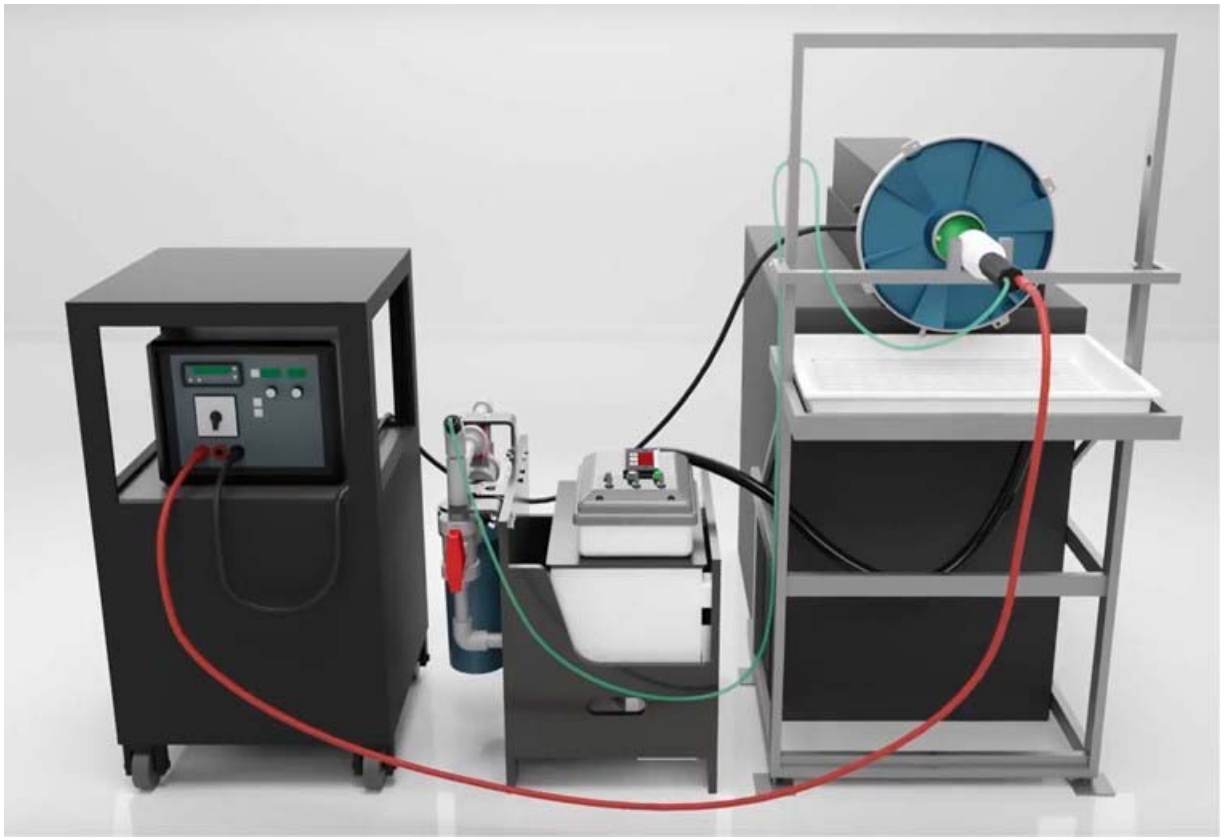
- SIFCO Applied Surface Concepts
  - Founded in 1959
  - Headquartered in Cleveland, Ohio, USA
  - Acquired as part of the Surface Coatings Division of Norman Hay in 2012.
  - 4 US and 3 European Locations
    - USA: Ohio, Texas, Connecticut, & Virginia
    - Europe: UK, France, & Sweden
- Norman Hay Group
  - Founded in 1940 doing Chromium Plating and Hard Anodizing
  - Headquartered in Coventry, UK
  - Ultraseal International, Surface Technology, and NHE

Overview

- What is Selective Plating (AKA Brush Plating)
- Specifications
- What is a groove?
  - Groove configurations
- Groove Plating Advancements
  - Case Studies
  - Challenges
- Conclusion/Future Work

What is Selective Plating/Brush Plating?

- The SIFCO Process® is a portable method of electroplating localized areas without the use of an immersion tank.



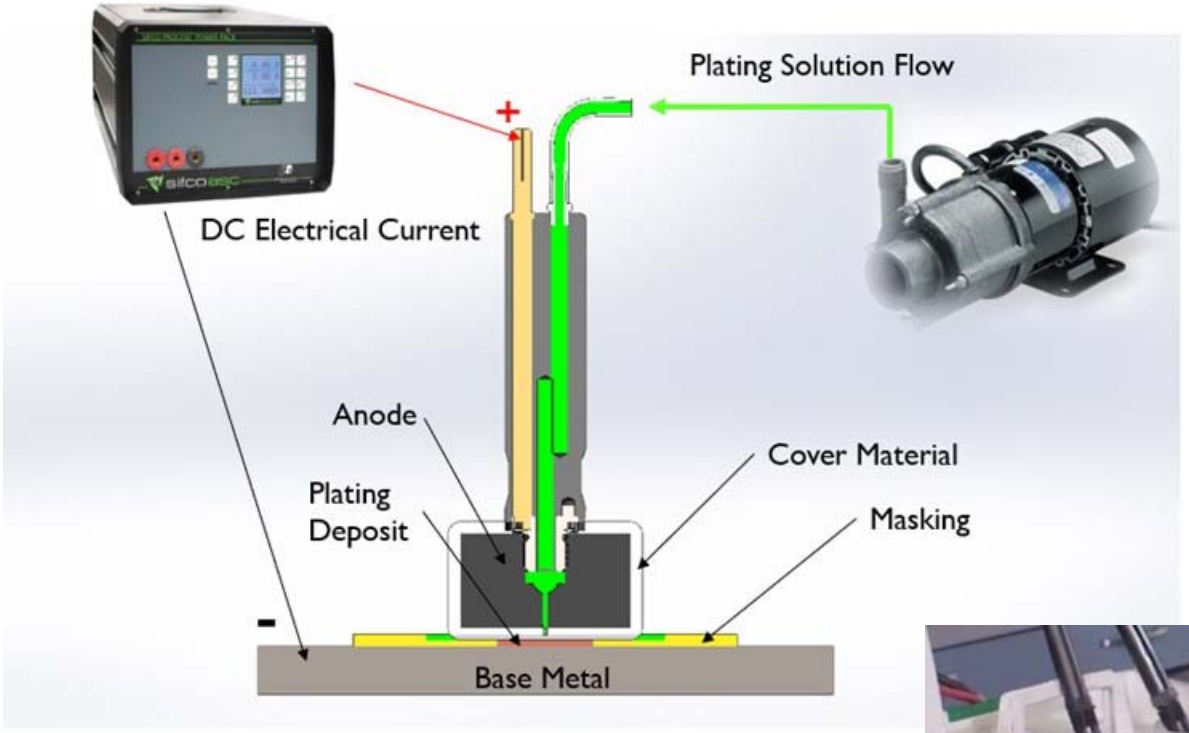
Key Requirements:

1. Workpiece
2. Power Pack
3. Plating Tools
4. Solution

Other:

- Solution Flow System
- Masking Materials
- Auxiliary Equipment

Selective Plating/Brush Plating



Surface Preparation

- Pre-Clean
- Electroclean
- Etch
- Desmutting
- Activation
- Preplate
- Plate

Selective Plating/Brush Plating Features

- Higher current density plating because of….
  - Higher metal concentrations
  - High solution velocity replenishment of metal ions at the surface
  - Brushing action disturbs the hydrodynamic boundary layer at the surface resulting in faster solution movement.
  - Hydrogen gas bubbles are removed by the brushing action and high solution velocity.
- Brushing action levels the deposit as it builds.
- Selective plating allows for easily controllable application of the coating just where it is needed on the part / component

Selective Plating Specifications

FINISHES	DESCRIPTIONS	MILITARY	AMS	FEDERAL/AMS REFERENCE
Brush Plating	Selective Electrodeposition - US Air Force	MIL-STD-865		
Brush Plating	Selective Plating - US Navy	MIL-STD-2197 (SH)		
Brush Plating	Plating, Brush General	MIL-STD-865	2451	
Brush Plating Nickel	Nickel Brush Plating		2451/1	QQ-N-290 & AMS 2403
Brush Plating Nickel	Nickel Low Stress, Hard Brush Plating		2451/2	AMS 2423
Brush Plating Nickel	Nickel Low Stress, Low Hardness Brush Plating		2451/3	AMS 2424
Brush Plating Cadmium	LHE Cadmium Brush Plating		2451/4	QQ-P-416 & AMS 2400/2401
Brush Plating Chromium	Chromium Brush Plating		2451/5	
Brush Plating Copper	Copper Brush Plating		2451/6	
Brush Plating Nickel	Nickel Low Stress, Medium Hardness Brush Plating		2451/7	AMS 2423
Brush Plating Silver	Silver Non-Cyanide Brush Plating		2451/8	QQ-S-365 & AMS 2412
Brush Plating Zinc-Nickel			2451/9	AMS 2417
Brush Plating Tin-Zinc			2451/10	AMS 2434
Brush Plating Cobalt			2451/11	
Brush Plating Tin		MIL-T-10727*	2451/12	AMS 2408
Brush Plating Silver	Silver Brush Plating		2451/13	QQ-S-365 & AMS 2412
Brush Plating Nickel Tungsten			2451/14	
Nickel Plate	Plating, Nickel General		2403*	QQ-N-290*
Nickel Plate, Hard			2423*	
Nickel Plate, Soft			2424*	
Copper Plate	Plating, Copper	MIL-C-14550	2418	
Gold Plate	Plating, Gold	MIL-G-45204	2422	
Cadmium Plate	Plating, Cadmium		2400/2401*	
Silver Plate	Silver Plating, Electrodeposited		2412*	QQ-S-365*
Zinc-Nickel Plate	Plating, Zinc-Nickel Alloy		2417*	
Tin-Zinc Plate	Plating, Tin-Zinc Alloy		2434*	
Tin Plate	Tin Plating, Electrodeposited	MIL-T-10727*	2408*	
Anodizing	Anodized Coatings	MIL-A-8625* TYPE I, II & III		

*Tank plating standard. SIFCO ASC does not perform tank plating, but manufactures many deposits that meet the performance requirements of the standard.

- MIL-STD-2197
- MIL-STD 865C
- AMS 2451C

COMMERCIAL SPECIFICATIONS (PARTIAL LIST)				
American Airlines	P12-16			
Bell Helicopter	BPS 4312	FW 1309		
Boeing	BAC 5854	BAC 5664	BAC 5849	HP 4-113
British Aerospace	BAe 146			
Douglas	P.S. 13113	DPS 9.89	DPS 9.89-1	DPS 9.28
Dowty Aerospace	PS118	PS137		
Goodrich	LGPS 1102			
Gulfstream	GAMPS 6103			
Lucas Aerospace	DPD 1000			
Messier Dowty	PCS-2141	PCS-2143	PCS-2144	
Parker	BPS 4511	LP 15		
Pratt & Whitney	SPOP 321	PWA 36953	PWA 36960	
Rolls Royce - Allison	EPS 10245			
Sikorsky	SS 8494	SS 8443	SS 8481	
TRW Aeronautical Systems	SPD 1000			

Types of Grooves

- O-ring grooves
- Packing grooves
- Snap ring grooves
- Retaining ring grooves
- Fluid control
- Keyways
- Splines
- Threads
- Gears

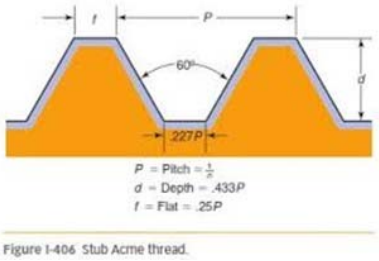
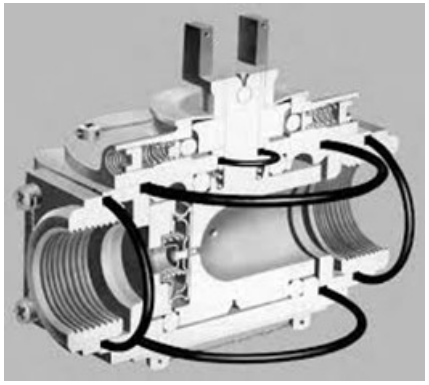
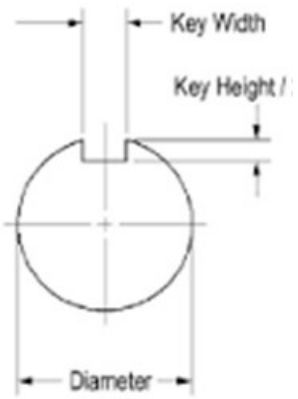
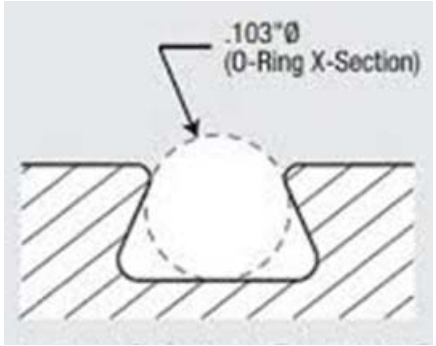


Figure I-406 Stub Acme thread.







Groove Plating Objectives

In an *ideal world*…

- Uniform deposit along all surfaces
- No post machining

The Challenge…

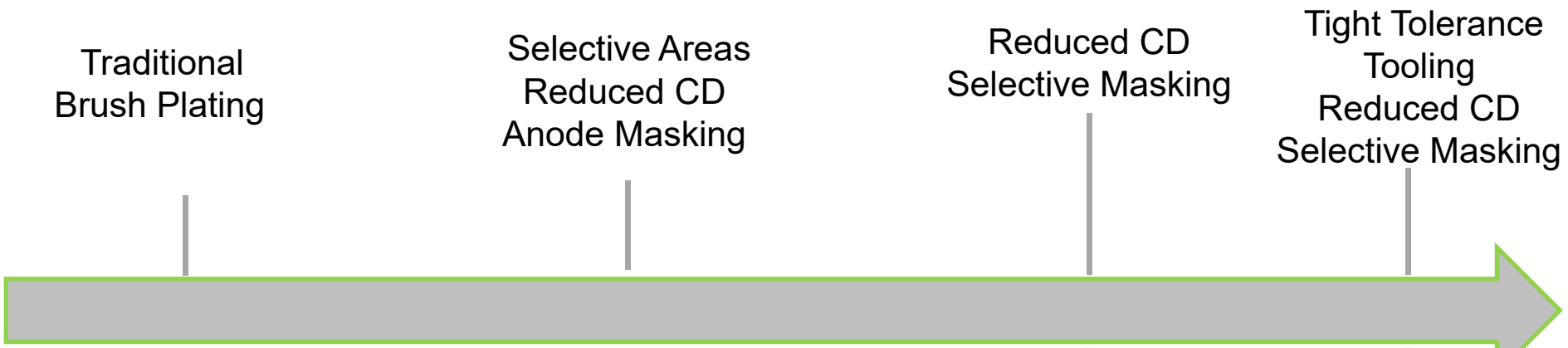
- Maximize plating into internal corners
- Minimize build-up at high current density edges
- Can require multiple applications

Requires OPTIMIZED plating parameters!

The Advancements….

Brush Plating

Wrap-Less Plating

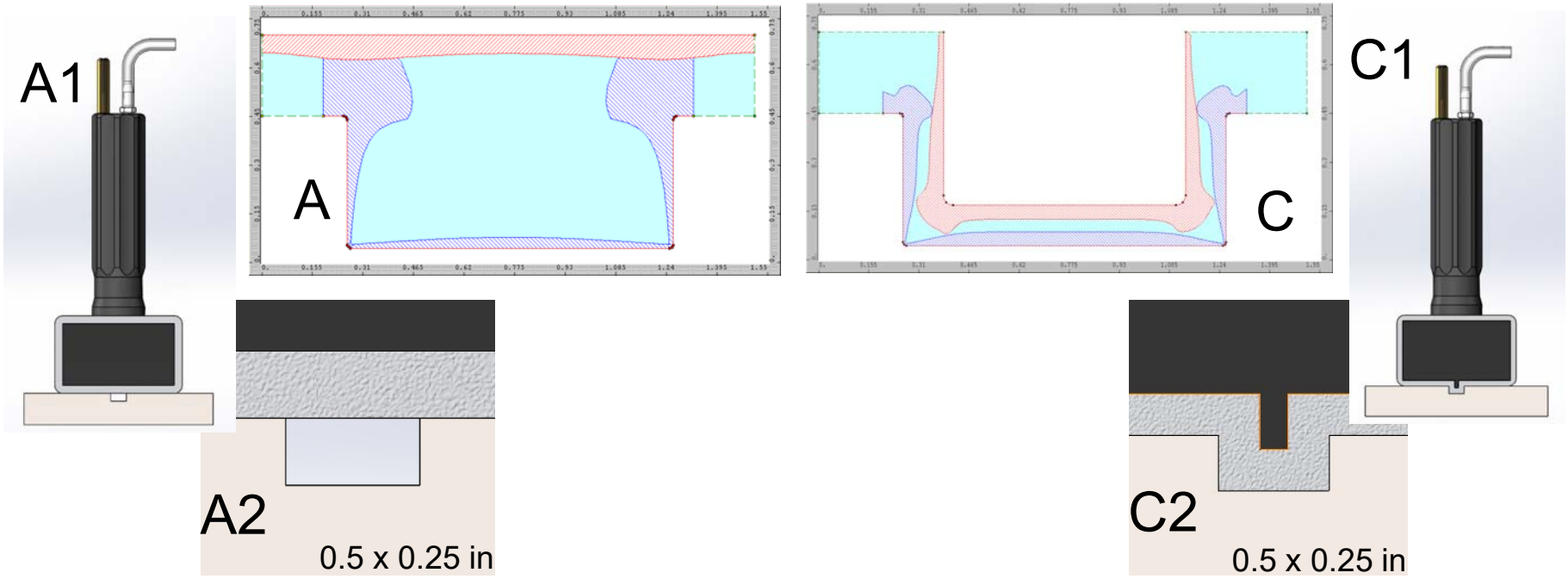


- High Current Density
- Non-uniform plating distribution
- Limited plating along internal radii
- Dendritic along external edges

- Less build-up along external edges
- Increased deposit throw along internal radii

- Minimal build-up along external edges
- 3x more deposit throw along internal radii
- Improved deposit uniformity

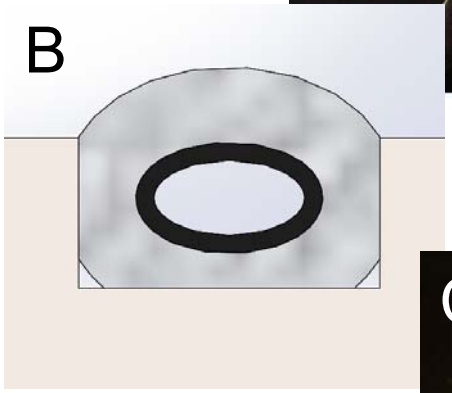
Traditional Selective Plating/Brush Plating



- Poor efficiency and time consuming
- Poor thickness distribution
- Limited throwing power along radial areas
- Excessive deposit build-up along external edges

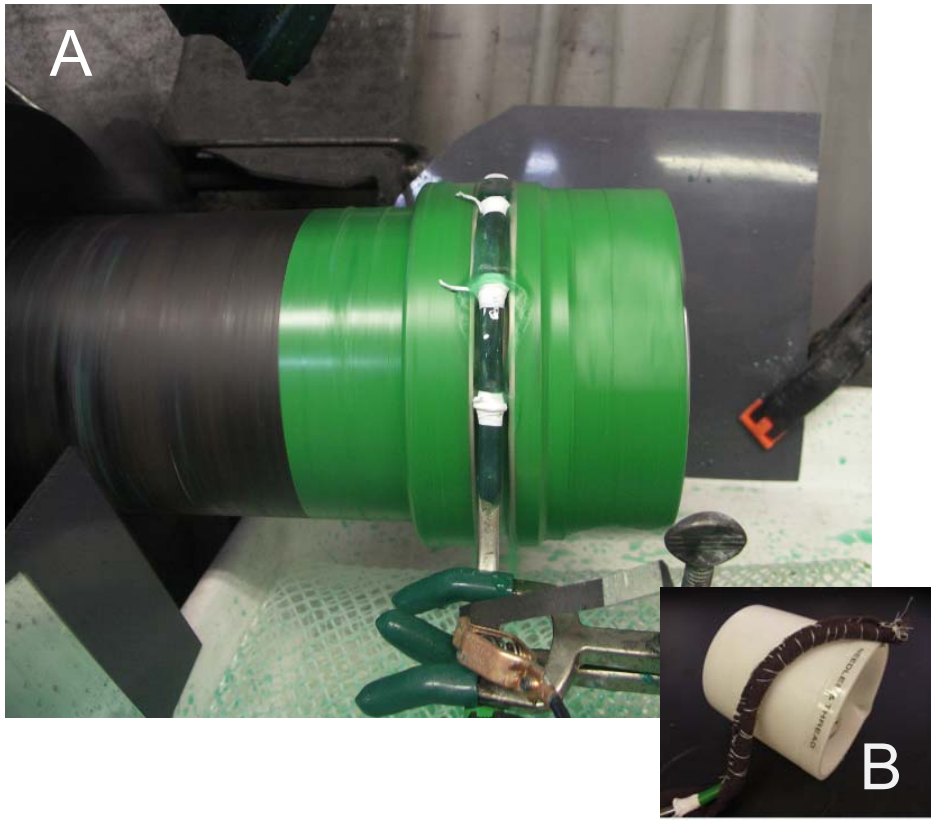
Case 1: Traditional Brush Plating

- Deposit: AeroNikl 250
- OD Groove
  - Diameter 6 inch
  - Groove Dimensions: 1/2 in x 3/16 in
- Plating Parameters
  - CD: 3-6 ASI
  - Thickness: 5.5 mils (18 AH)
  - Anode: Ni Tube with PTW
- Results
  - Could not maintain constant current
  - Low thickness
  - Excessive build-up of dendritic deposit along top corners
  - Numerous overloads and arcing during plating
  - Not reliable or repeatable



Case 1: Wrap-Less Groove Plating

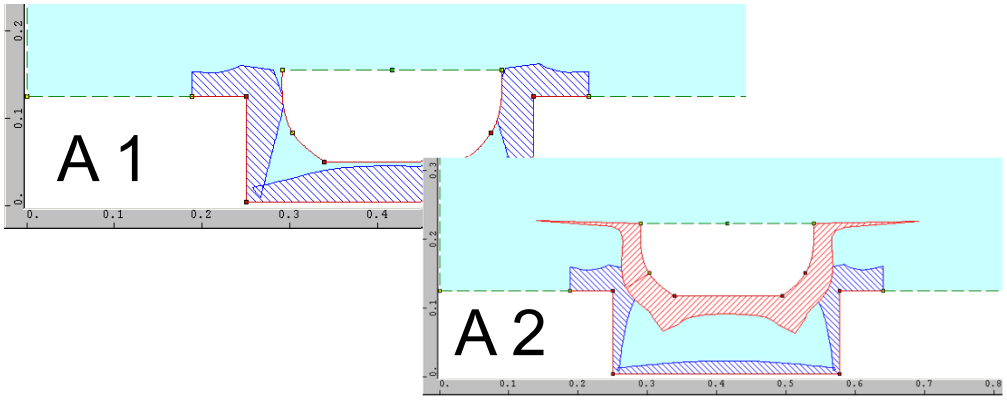
- Deposit: AeroNikl 250
- OD Groove
  - Diameter 6 inch
  - Groove Dimensions: 1/2 in x 3/16 in
- Plating Parameters
  - Thickness: 5.5 mils (18 AH)
  - CD: <1 ASI
  - Anode: Ni Tube **NO** Wrap
  - Selectively masked anode
- Results
  - Constant current maintained
  - Thickness: 8 mils after 8 AH of plating
  - Deposit build-up along external edges reduced
  - Good coverage along the internal radial areas

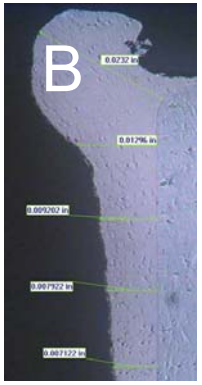


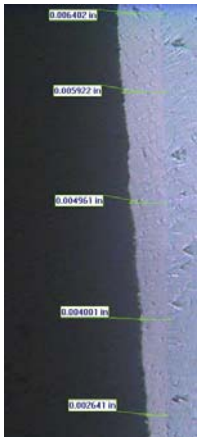
Case 1: Wrap-Less Groove Plating

Cross Section at 500x magnification

- Groove Bottom Max Thickness at Center: ~8 mils
- Internal Radius Thickness: ~ 1 mils
- External Corner Thickness: ~ 15 mils
- Throw Power into radius: ~10-12%

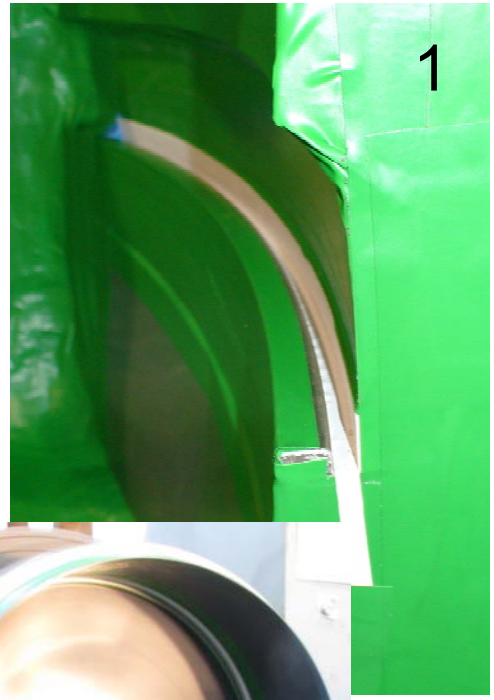


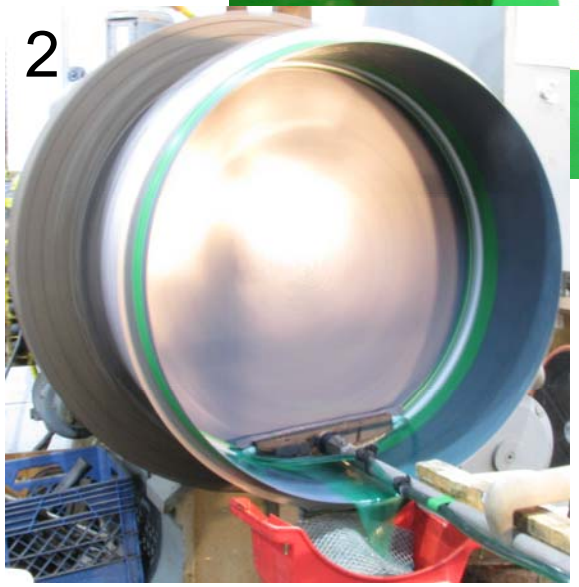


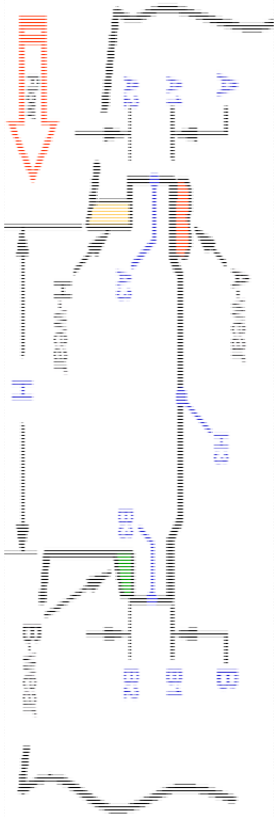


Case 2: Brush Plating Selective Areas

- Deposit: AeroNikl 575
- Groove Dimensions
  - Groove Width: ~1/4 inch
  - Groove Depth: 3/16 – 1/3 inches
  - Groove walls selectively plated
- Plating Parameters
  - Thickness: 5 - 13 mils
  - CD: 3 ASI
  - Anode: Dur-A-Form with RTW
  - Anodes selectively masked
  - Equipment Configuration
    - App. 1: Stationary part with moving anode
    - App 2: Stationary anode with rotating part







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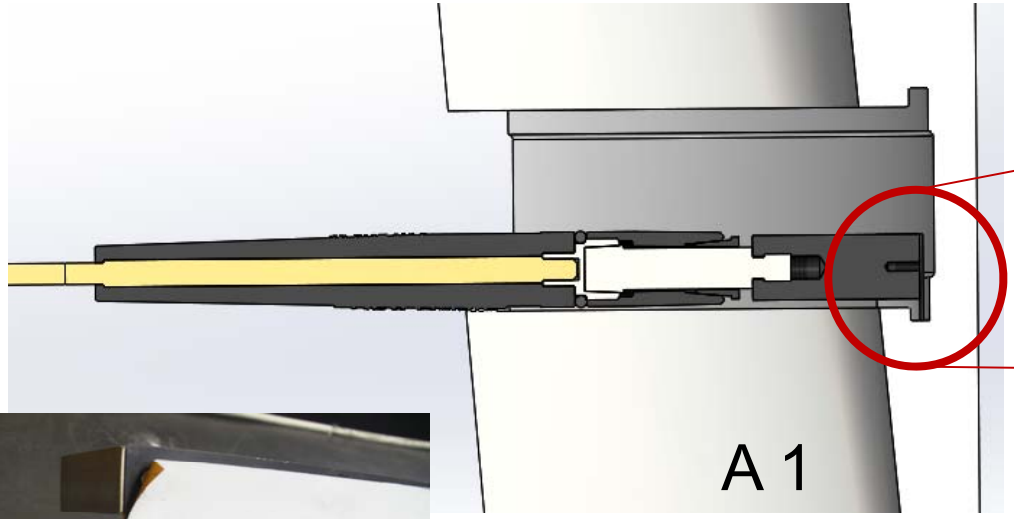
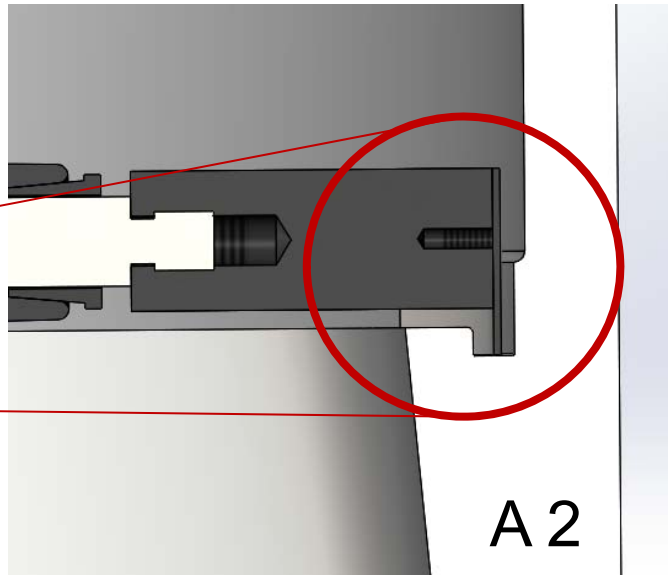
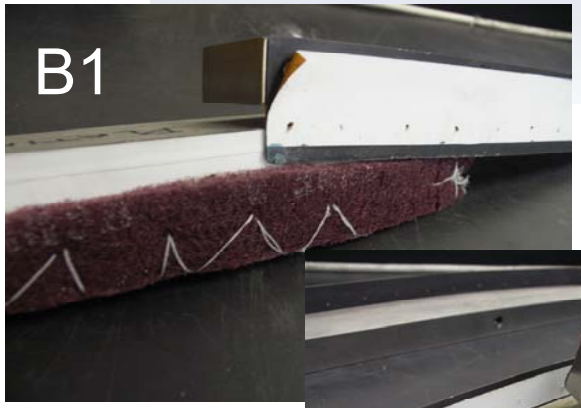
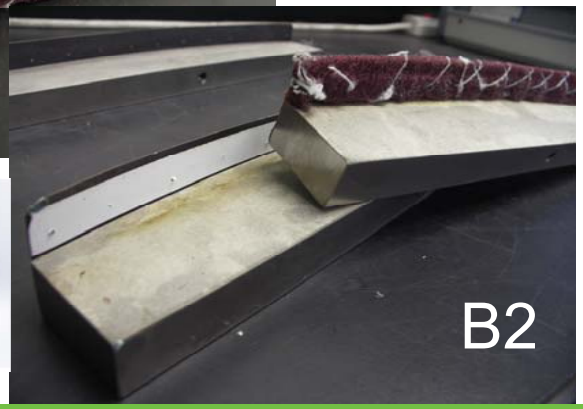
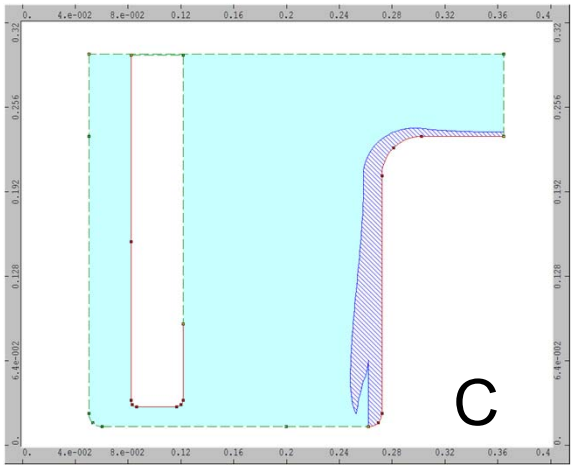
Case 2: Brush Plating Selective Areas – Anode Masking



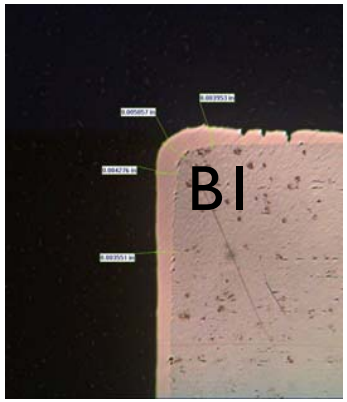


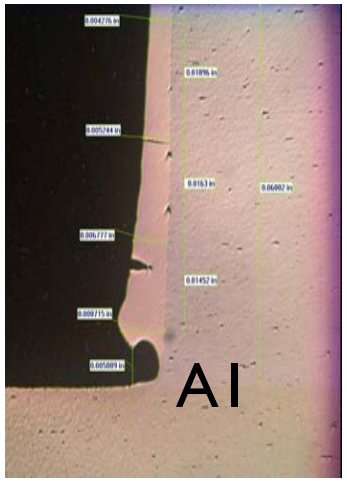




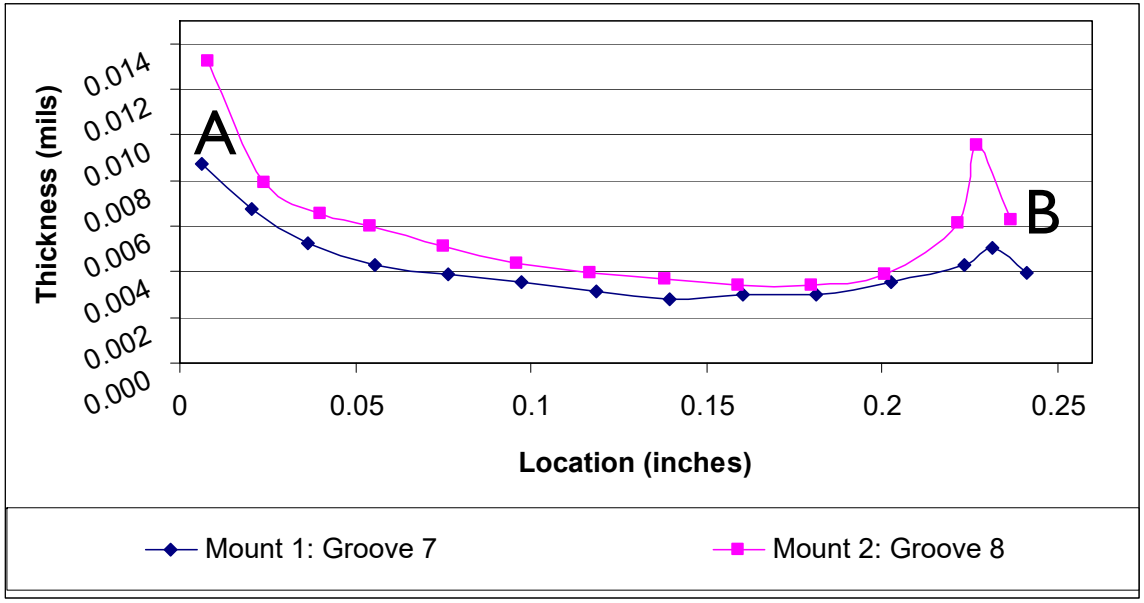


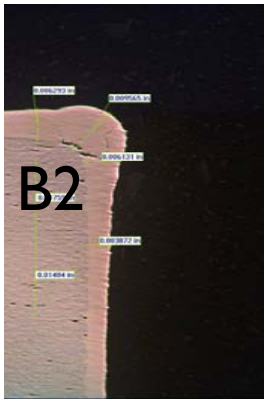
Case 2: Brush Plating Selective Areas

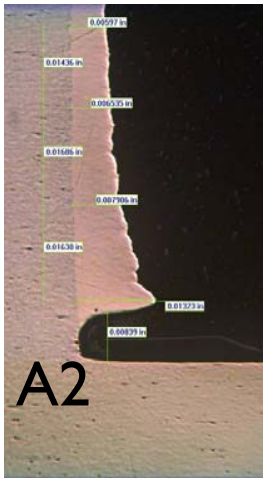




Groove 7







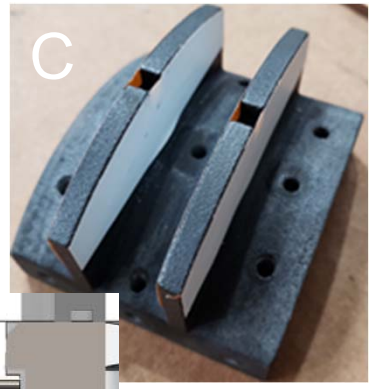
Groove 8

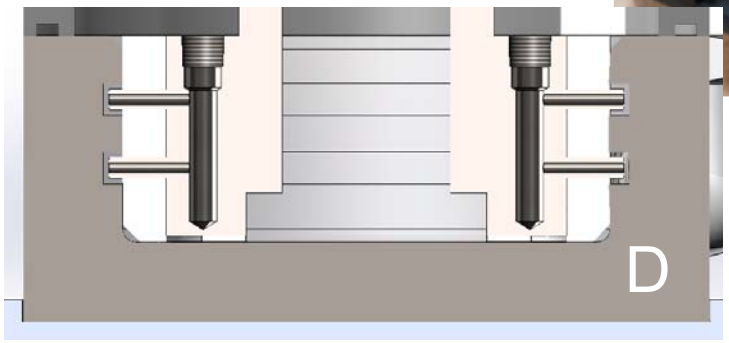
Results

- Plated to size, required no post machining
- Deposit is thicker at the bottom of the groove compared to the top of the groove

Case 3: Wrap-Less Groove Plating

- Deposit: AeroNikl 250
- ID Groove
  - Diameter: 4.5 inch
  - Groove Dimensions: 9/32 x 5/32 in.
- Plating Parameters
  - Thickness: 5 – 30 mils
  - CD: <1 ASI
  - Anode: Wrap-less Dur-A-Form
    - Selectively masked anodes
  - Tight Tolerance Tooling:
    - Defined anode to cathode gaps
  - Equipment Configuration
    - Stationary part with rotating anodes

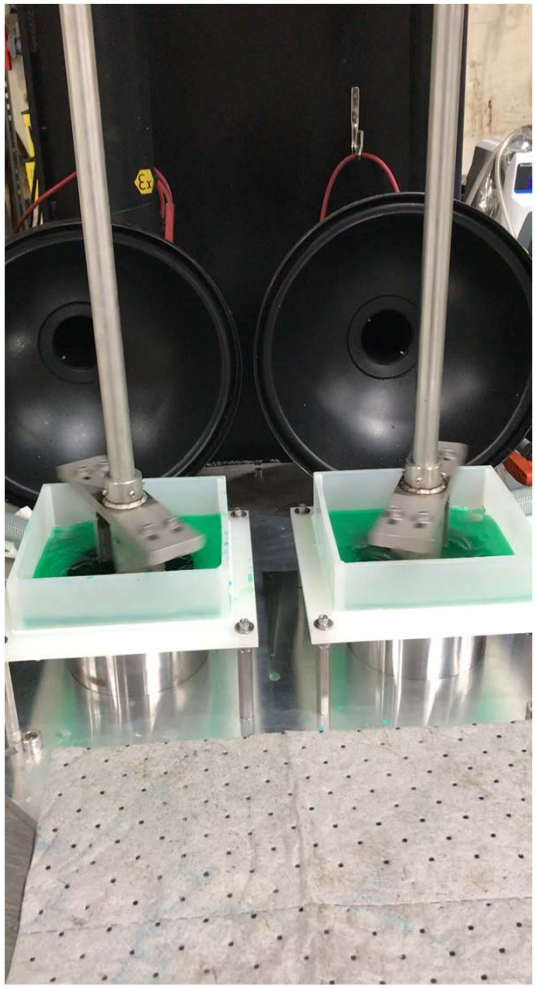


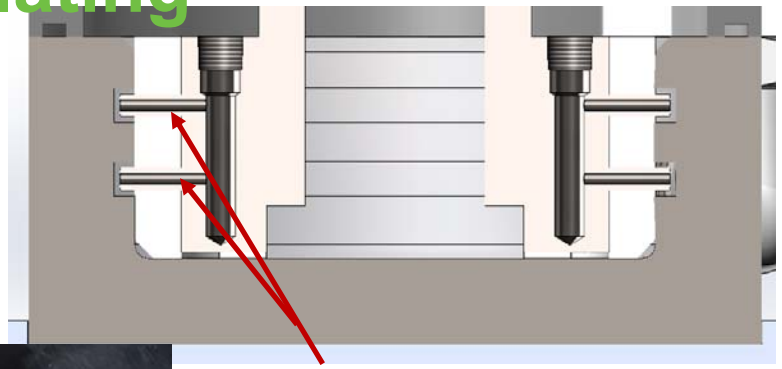


Case 3: Automated ID Plating, Rectifier Software & Data Logging

HMI/Software & Rectifier

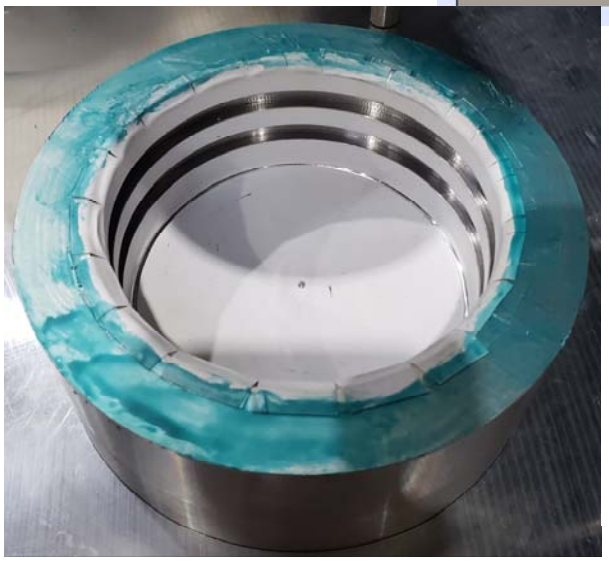
Case 3: Wrap-Less Groove Plating



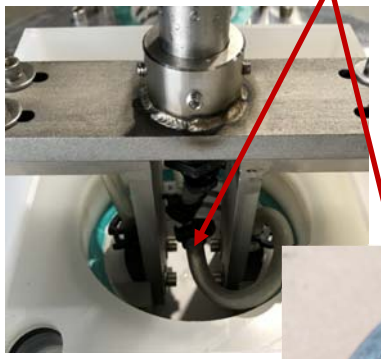


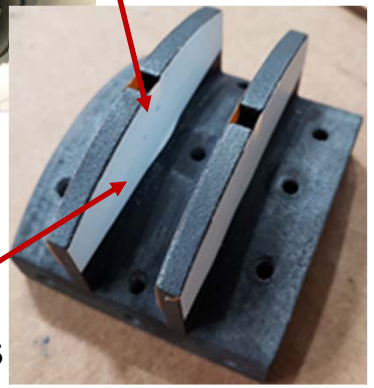
Anode Fins seated in Grooves.

Solution flowed through anode.



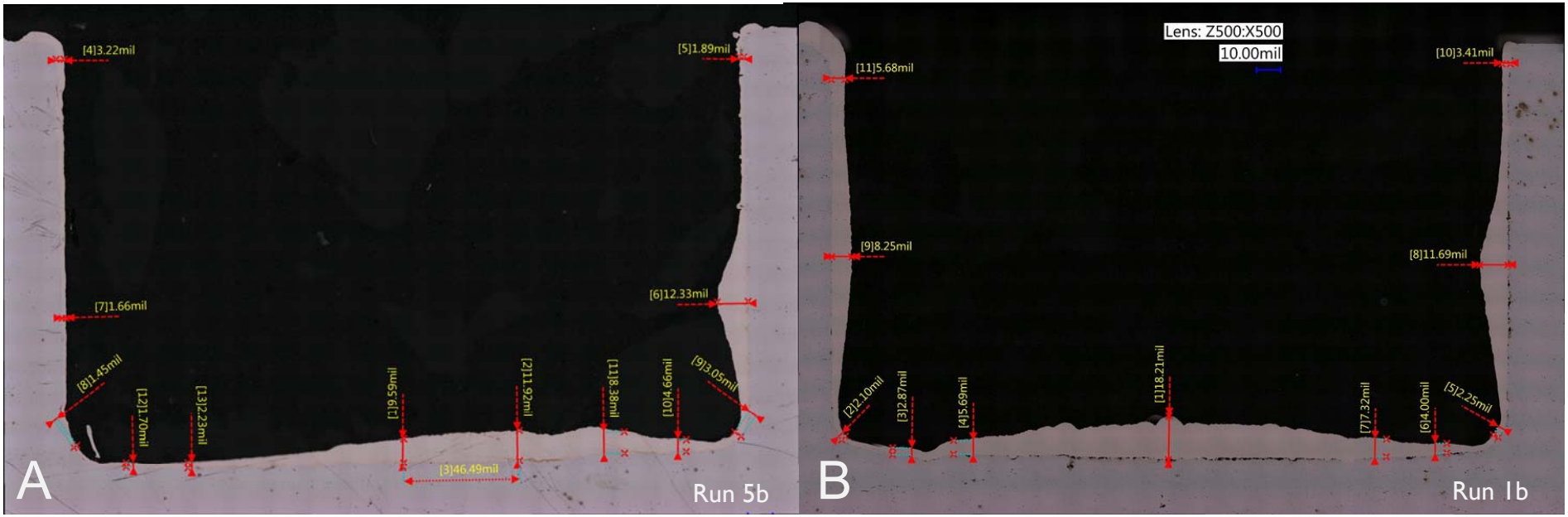
Masked Mock-up Grooves





Masked Anode Sides

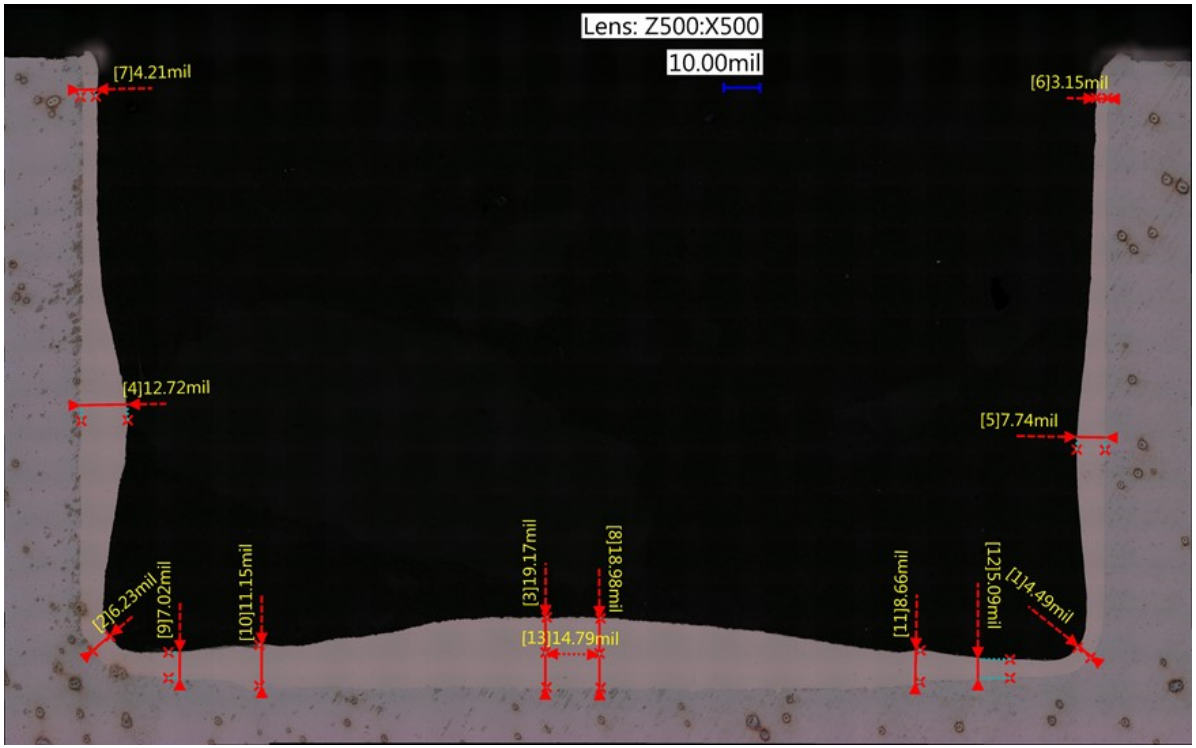
Case 3: Wrap-Less Groove Plating



- **Parameters Tested**
  - Anode to Cathode Gap
    - 0.0050 vs 0.075 inch
  - Current Densities
    - 0.5, 1 ASI, and 3 ASI
  - RPM

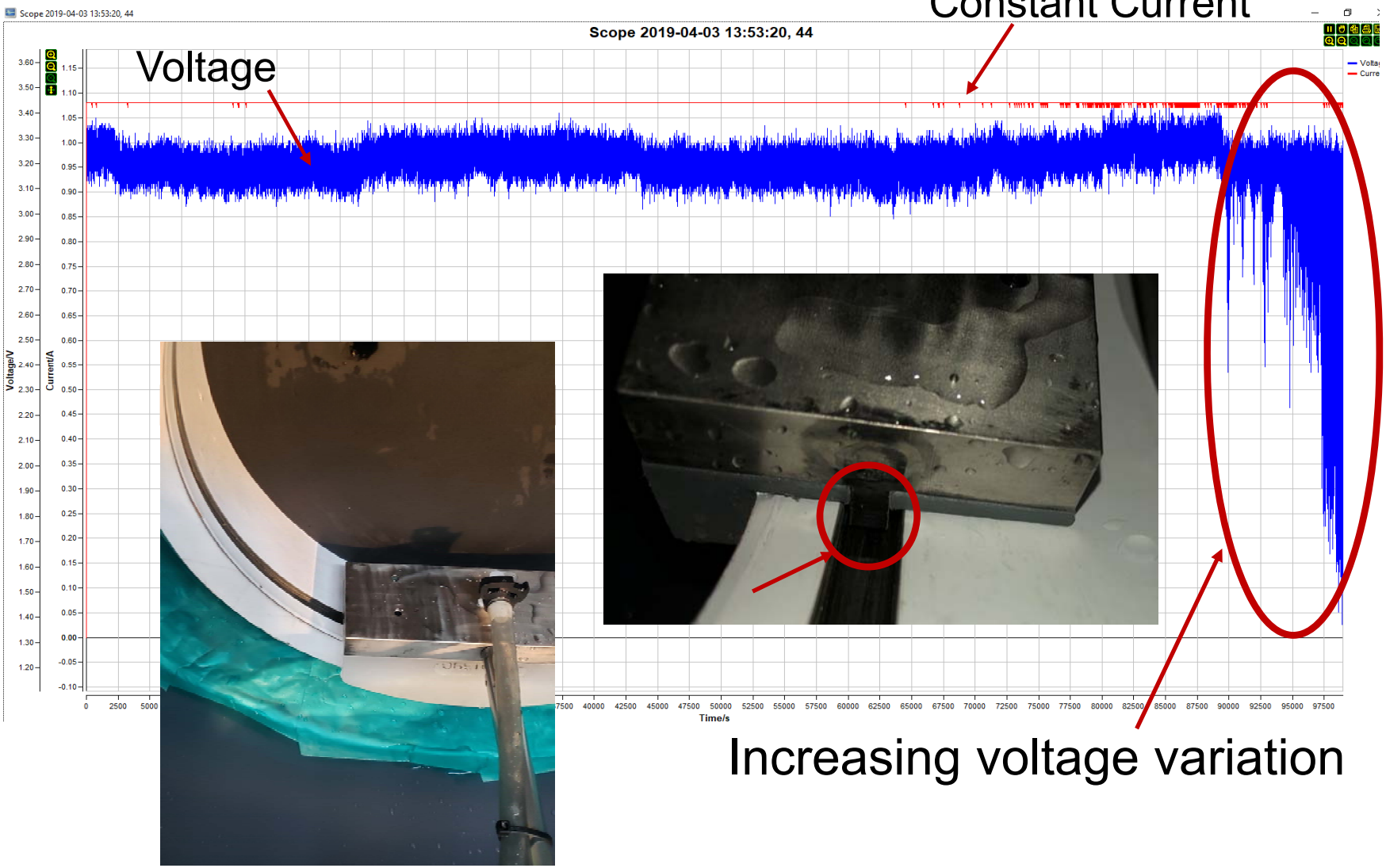
- **Increasing CD and Anode to Cathode Gaps…**
  - Diminished throw power 10-15%
  - Thickness variation from side to side
  - Rougher deposit

Case 3: Wrap-Less Groove Plating

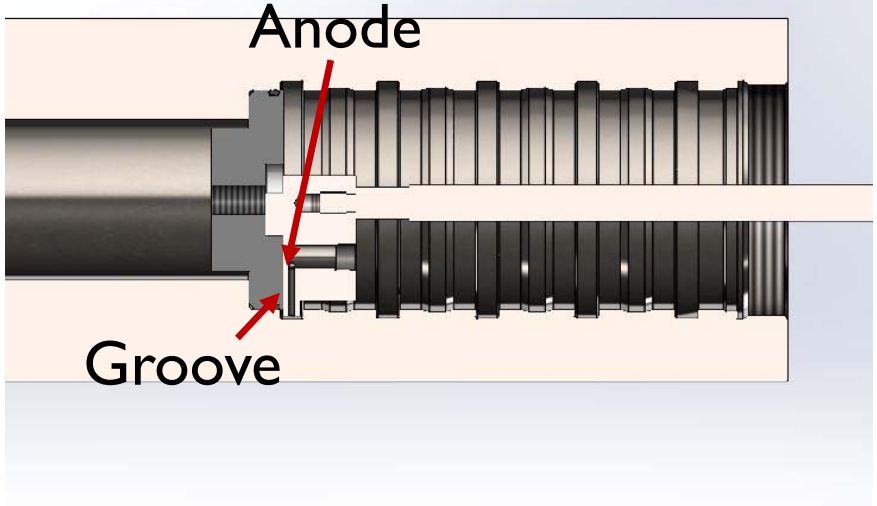


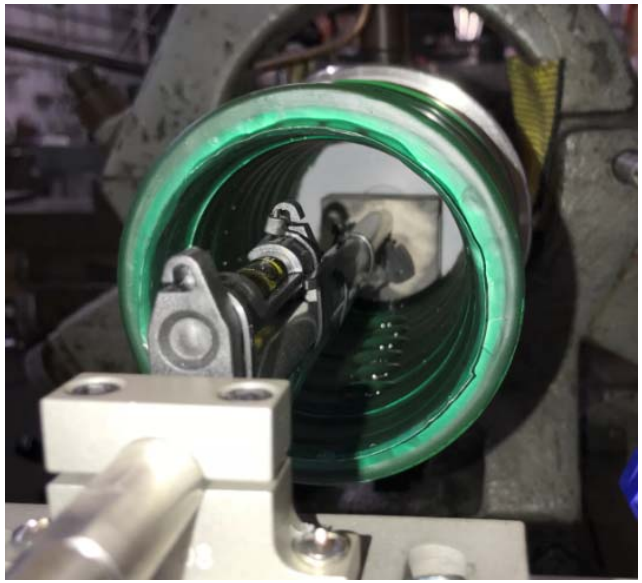
- Lower current densities and decreasing anode to cathode gaps …
  - Increased deposit throw power along internal radii by 3x
  - Reduced thickness variation from side to side
  - Smoother deposits allow for thicker deposits
  - Decreased deposit build-up along external edges

Wrap-Less Groove Plating – Data Logging



Wrap-Less Groove Plating





Conclusion & Future Work

Groove Considerations

- Groove Geometry
  - Location, depth, width
- Deposit Types & Specification Requirements
  - Deposit choice
  - Wear/Corrosion/Dimensional Restoration
  - Internal radius requirements, taper allowance, uniformity
  - Design modifications for chamfers and larger radii
- Post Finishing
  - Surface roughness
  - Machining

Plating Process Considerations

- Current Density
- Selective Masking
- Anode-to-Cathode Gap
- Anode & Fixture Design

Future Work/Considerations

- Continue to increase throw power into the corners
- Minimize machining in between applications
  - Pulse Plating
  - Additives

Acknowledgements

- Andy DeLeon – Contract Service Manager Houston
- Derek Kilgore – Mechanical Design Engineer
- Jeff McArthur – Technical Service Rep
- Sarah Medeiros – Corrosion Engineer
- Derek Vanek – Technical Manager
- Teri Zarnesky – Lab Technician

QUESTIONS?

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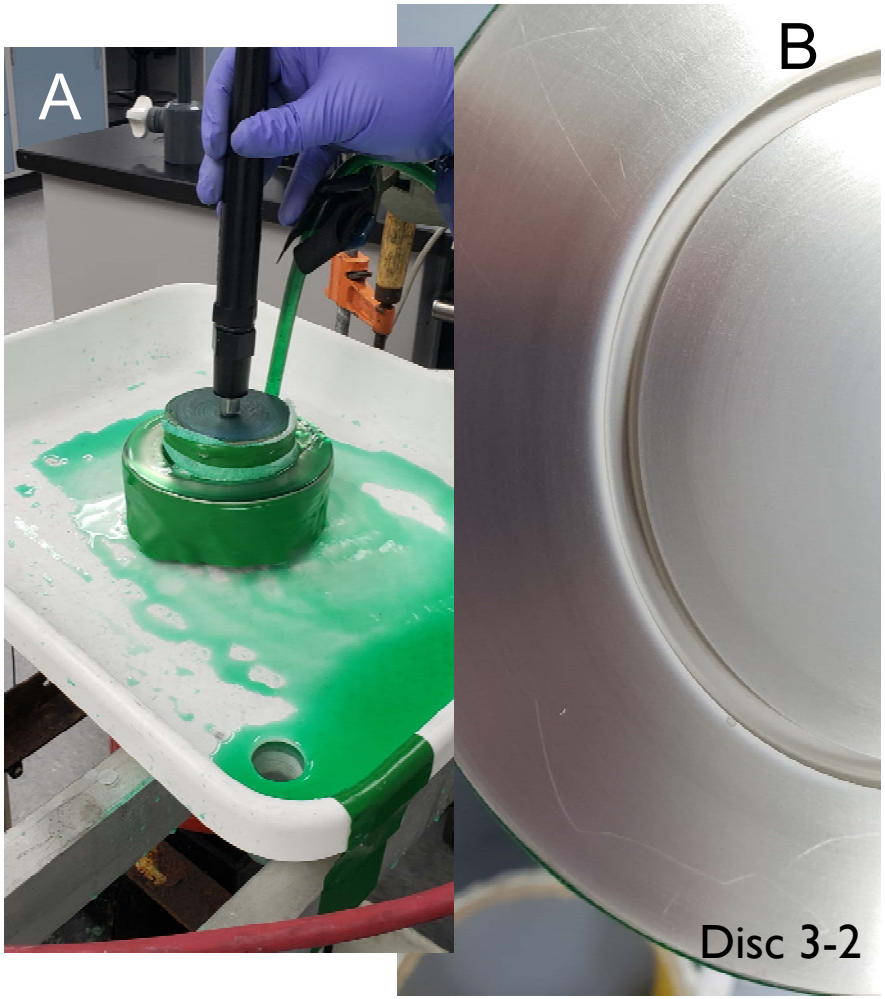
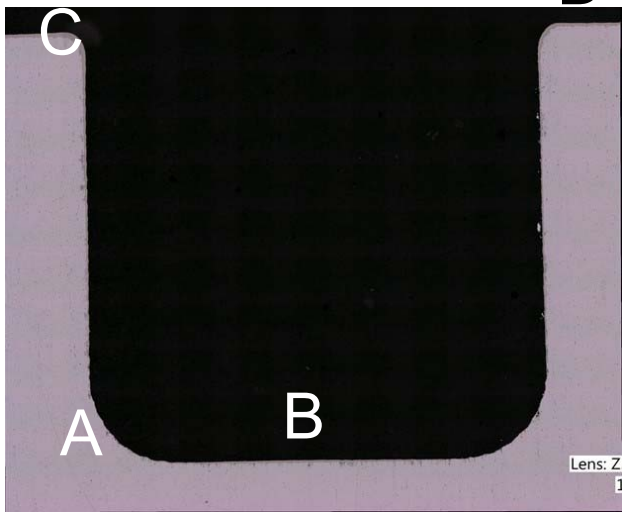
See us at Booth 330!

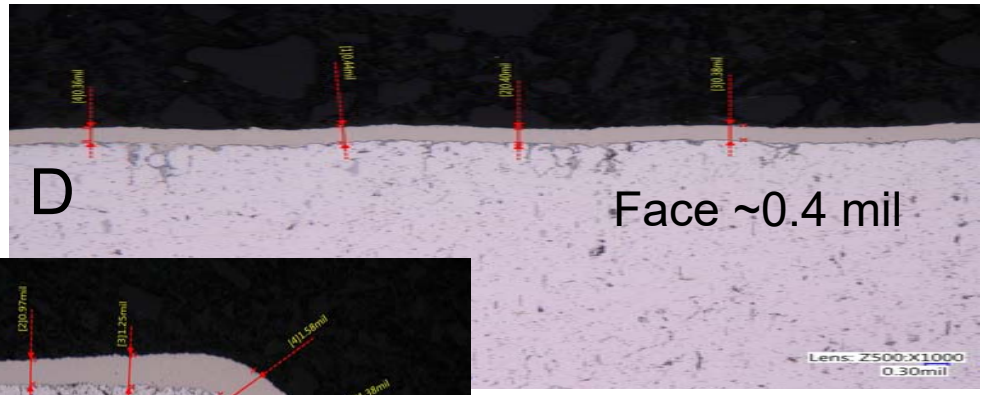
Brush Plating Small Features

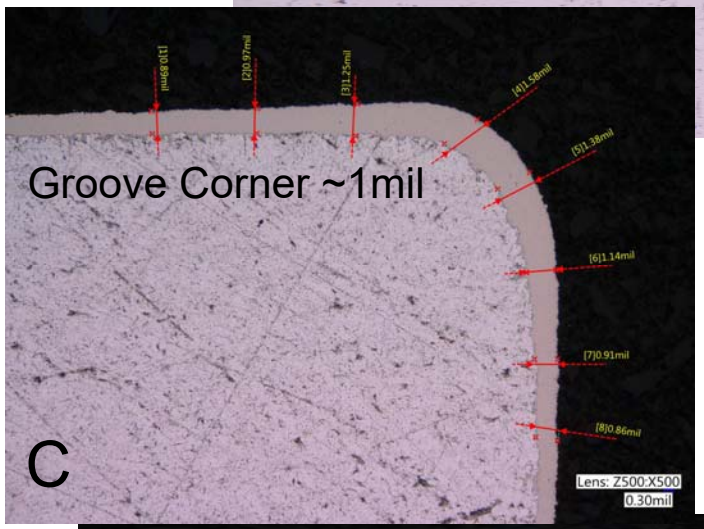
- Deposit: Nickel 2080 on Al
- Groove Details
  - U-Channel & Dovetail
  - Groove Dimensions: 1/8 x 1/8 in.
- Plating Parameters
  - Thickness: 0.2 – 0.7 mils
  - CD: < 1 ASI
  - Two-step plating process
  - Anode selectively masked
  - Equipment Configuration
    - Rotating part with stationary anode

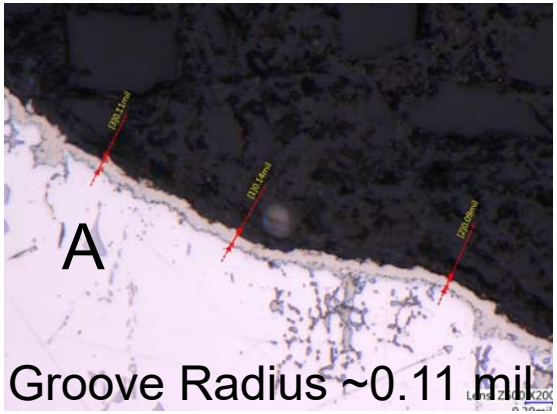


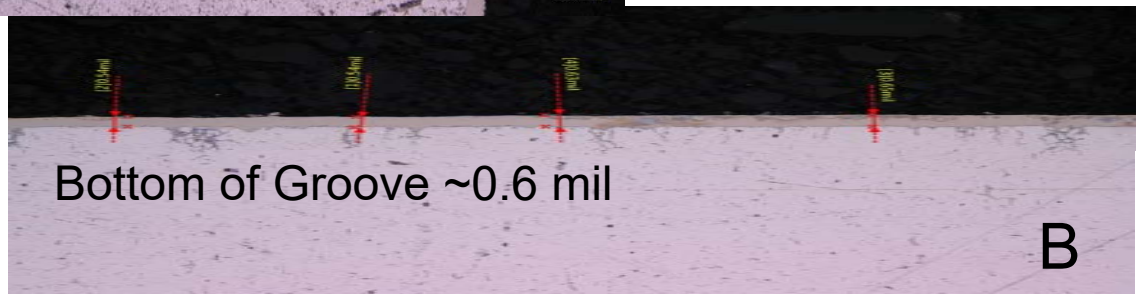
Brush Plating Small Features (U-Channel)

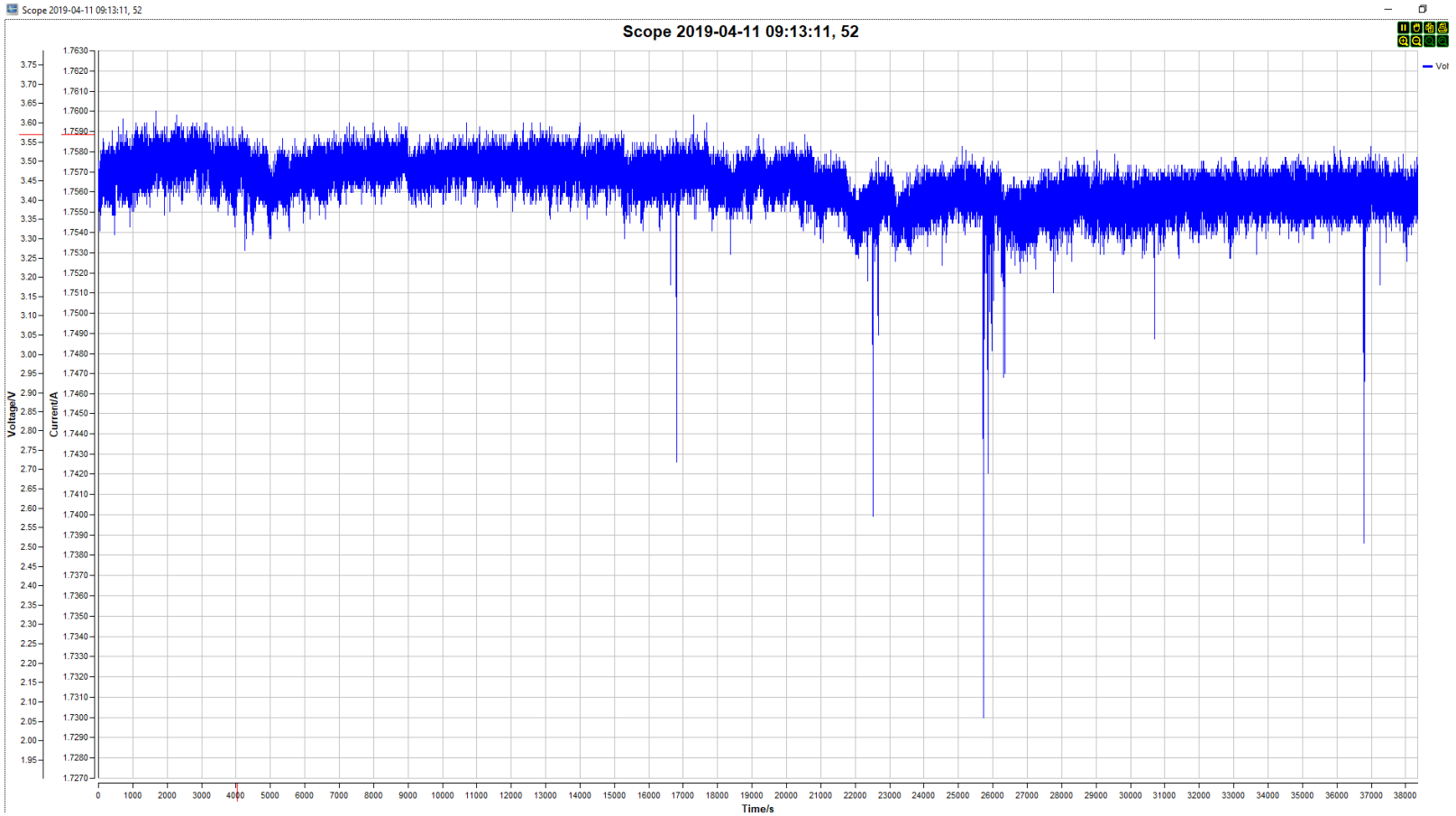











Scope 2019-04-11 09:13:11, 52
Scope 2019-04-11 09:13:11, 52
Vol
Voltage/V
Current/A
Time/s