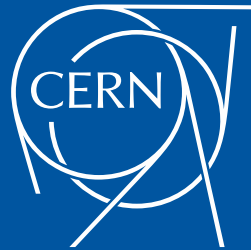


# Electropolishing

(applied to Copper, Niobium, Titanium...)



[www.cern.ch](http://www.cern.ch)

L. Ferreira  
TE-VSC-SCC

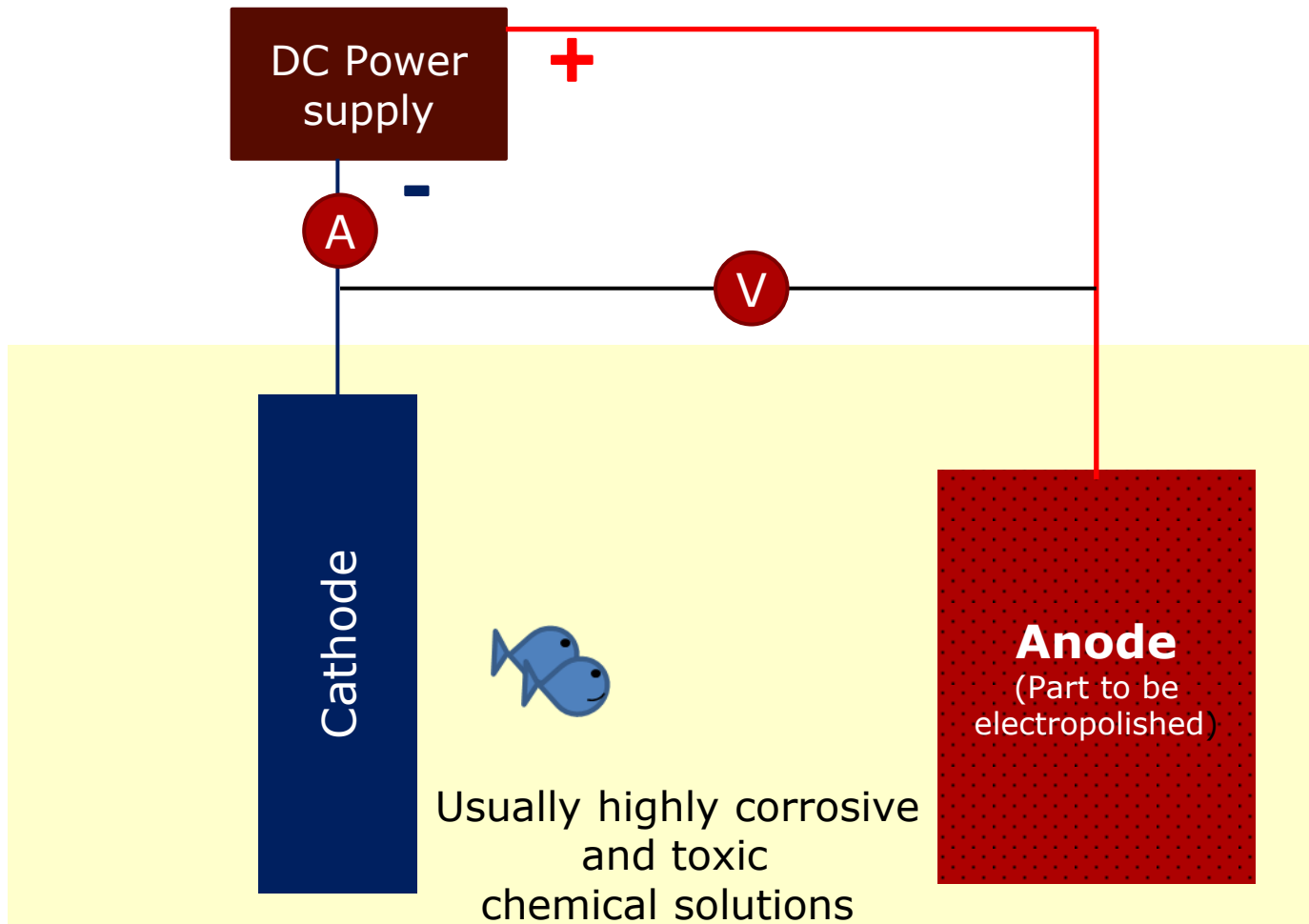
# OUTLINE

- What is electropolishing
- How it works
- Advantages/disadvantages
- Common uses

It's an electrochemical treatment that removes material from metal objects surface. In order to be defined as electropolishing, the working parameters must be so that it allows to smoothen, polish, deburr and clean metal surfaces.

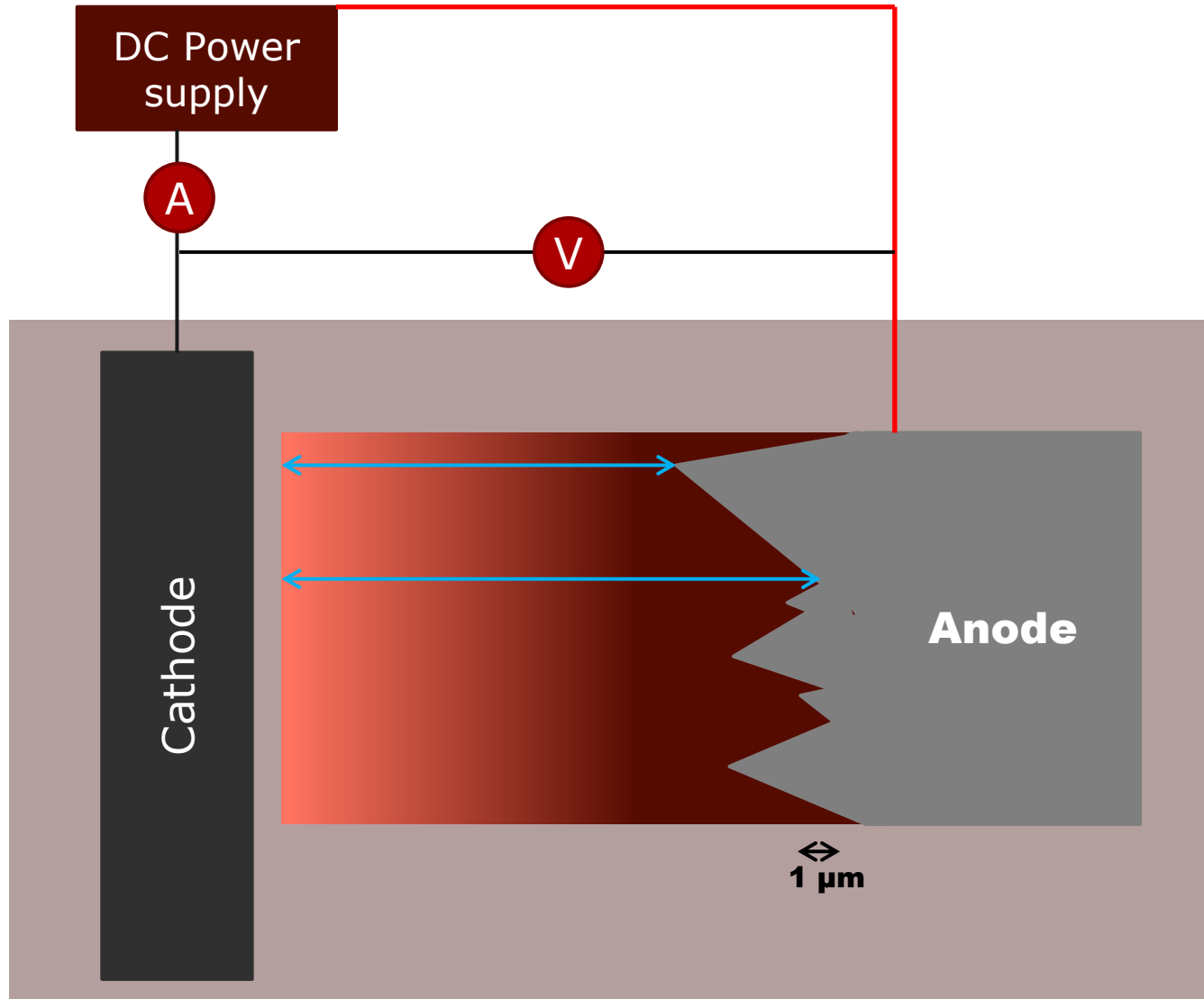
History's first reference to electropolishing seems to have occurred in 1910 when Germany issued a patent for the finishing of silver in a cyanide solution ( Spitalsky, Germ. Pat. Nr. 225873).

The metal is immersed in an electrolyte and subjected to direct current. The metal part to be treated is made anodic and under certain conditions, a controlled dissolution of the metal is achieved.



How it works

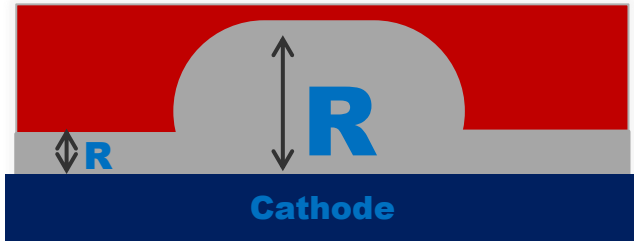
If we go to the  $\mu\text{m}$  level



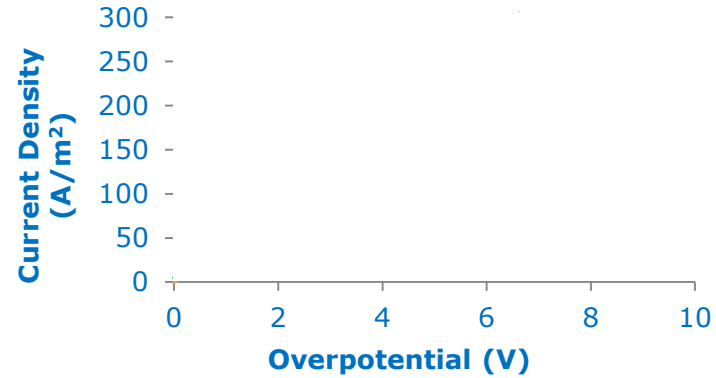
How it works

# Quite straightforward?

## Primary current distribution



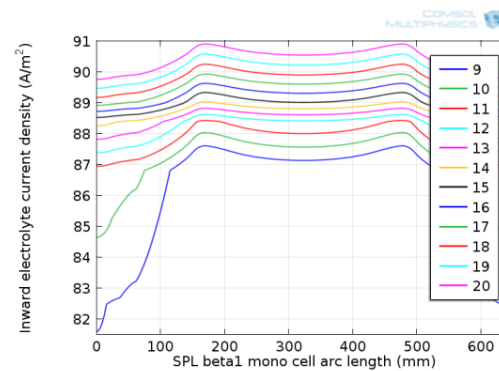
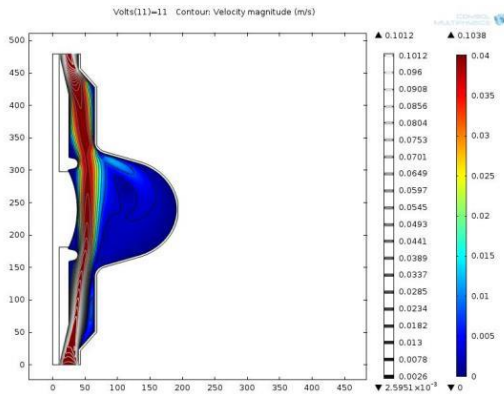
## Secondary current distribution



$$j = f(\eta(\text{Overpotential}))$$

$$j = f(T, Q_v, S_c/S_a, \text{bath composition})$$

For complex shapes and accurate thickness removal, process simulation becomes very helpful.



HOW it WORKS

# It works for all metals?

In literature/patents, it's possible to find processes for:

- Aluminium;
  - Beryllium;
  - Bismuth;
  - Cadmium
  - Cobalt;
  - Copper;
  - Gold;
  - Indium;
  - Iron (Stainless Steel);
  - Lead;
  - Molybdenum;
  - Nickel;
  - Niobium;
  - Silver;
  - Tantalum;
  - Titanium (CERN formulation);
  - Tin;
  - Zinc;
- Suitable for large surfaces
  - Ra within the nm scale
  - Works at room temperature

How it works

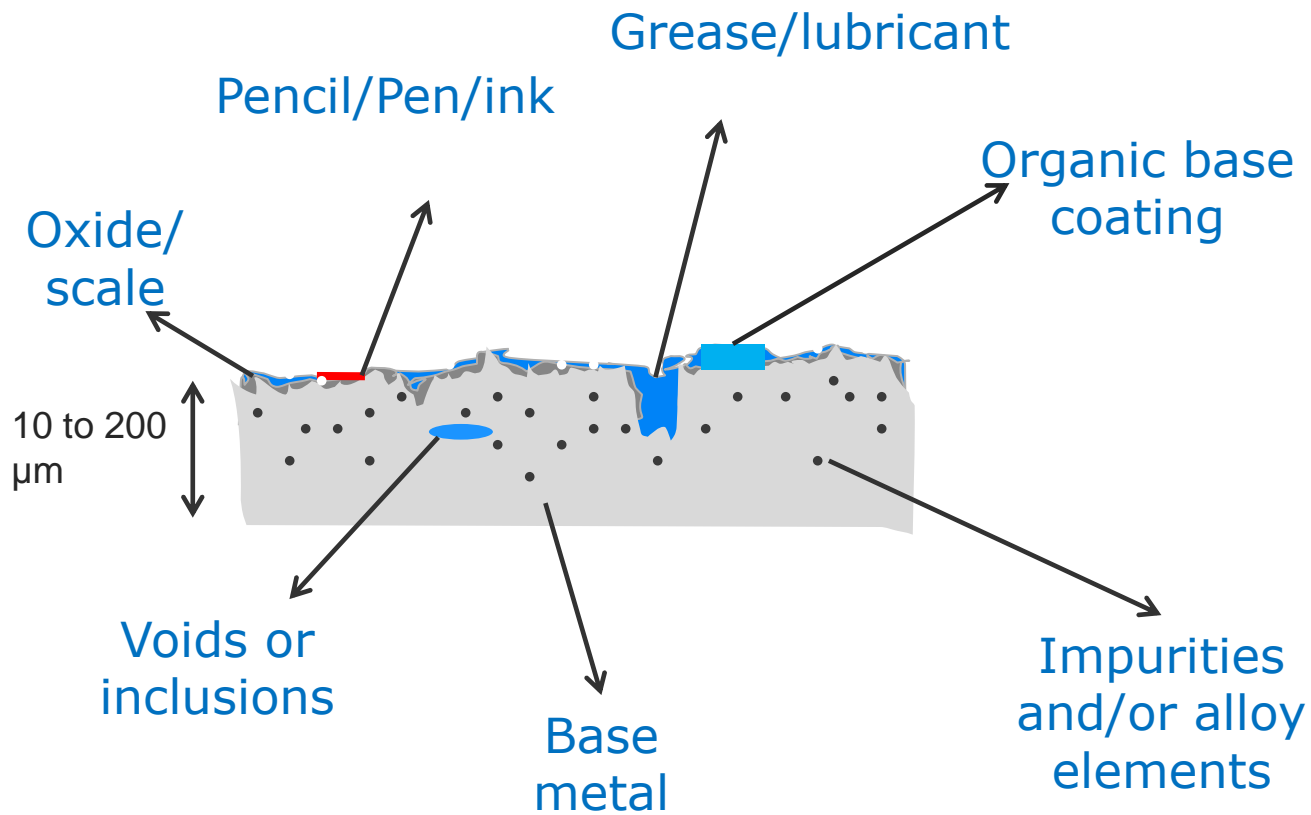
## Electropolishing / Mechanical based polishing

- No contact: Stress relief
- Superior corrosion resistance (less stress, equipotential surface)
- Clean surfaces (no recontamination)
- No direction lines
- Low-resistance, contaminants free welding surface
- Suitable for complex shapes

Advantages



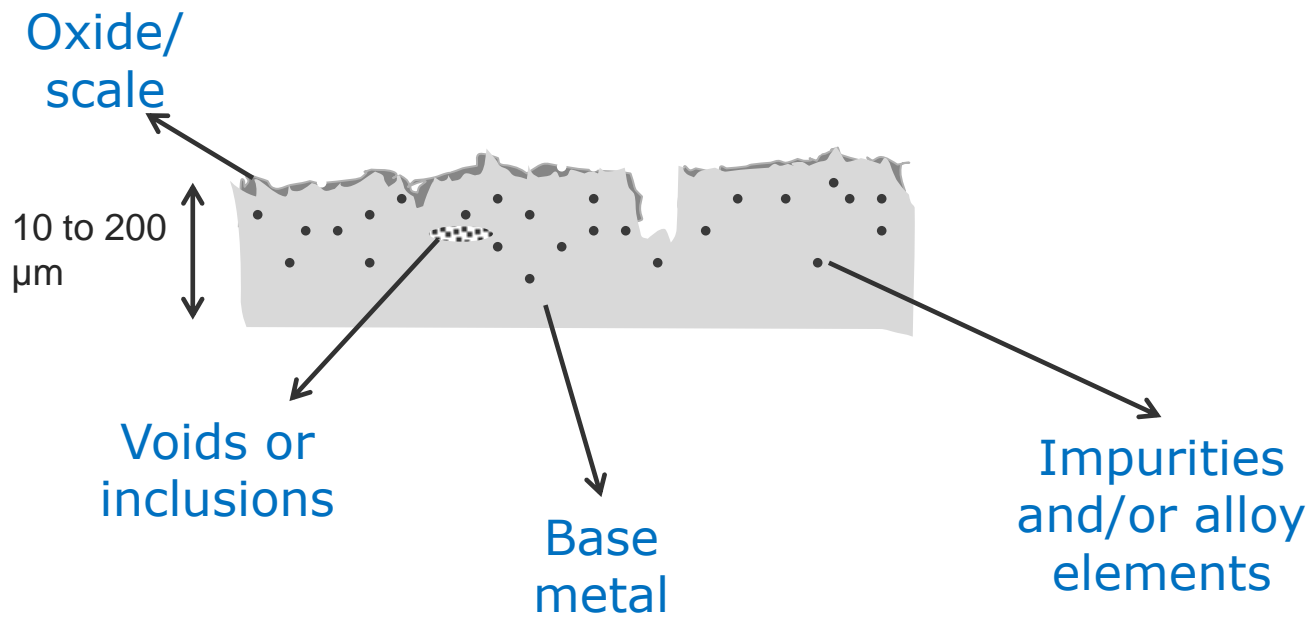
# Clean surfaces: How clean is clean?



Advantages

# Clean surfaces: How clean is clean?

After chemical degreasing (detergent/solvent)



Advantages

# Electropolishing / Mechanical based polishing

- Final roughness is function of initial surface finishing and removed thickness
- Usually highly corrosive and/or toxic solutions
  - Handling;
  - Process equipment;
  - Installation to process extracted fumes;
  - Installation to process waste water.

Disadvantages

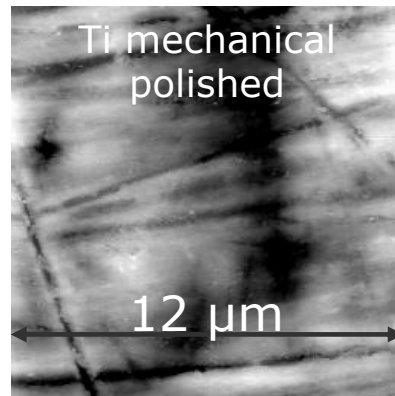
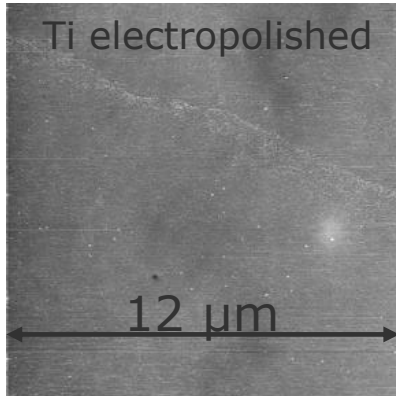
# At CERN

Copper and Niobium components:  
Radio Frequency structures

Goal:

- surface cleaning (200  $\mu\text{m}$  thick)
- smooth surface (high fields)

Titanium and alloys components:  
High Voltage electrodes



Applications

## ...Elsewhere

- Heavy industry:
  - Deburring;
  - Oxides removing;
- Textile industry:
  - Deburring;
  - Smooth surface;
  - Oxides removal.
- Semiconductor:
  - Clean surfaces;
  - Flat surfaces;
  - Easy to clean.
- Pharmaceutical and food processing:
  - Clean surfaces;
  - Easy to clean;
  - Lower bacteria yield.
- Chemical Industry:
  - Clean and Smooth surfaces;
  - Improved passivation;
  - Improved corrosion resistance.

# Thank you!

# Questions?