

FLUORINE FREE IONIC LIQUID ELECTROPOLISHING OF NIOBIUM CAVITIES

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V. Pastushenko LNL-INFN, 16th International Conference on RF
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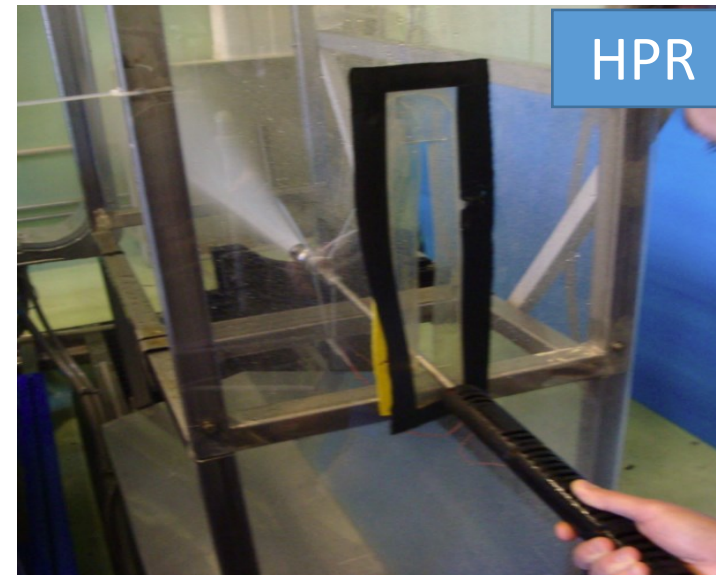
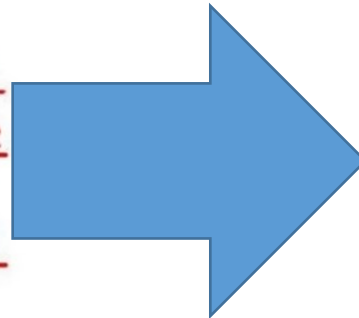
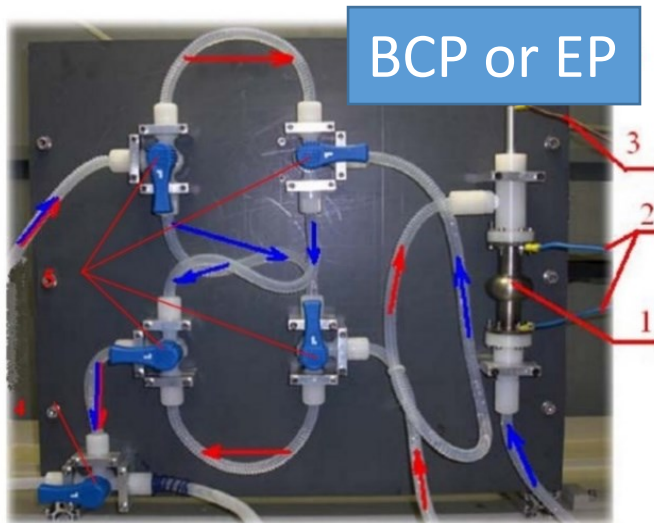
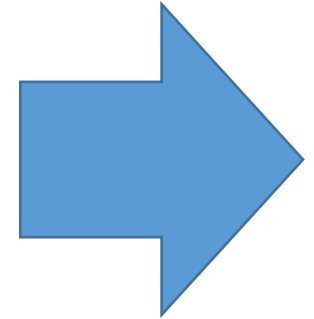
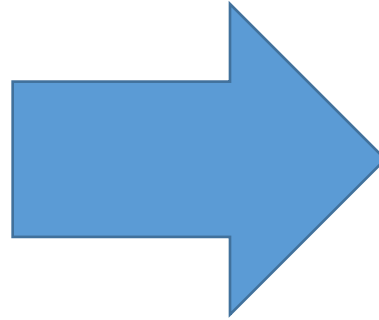
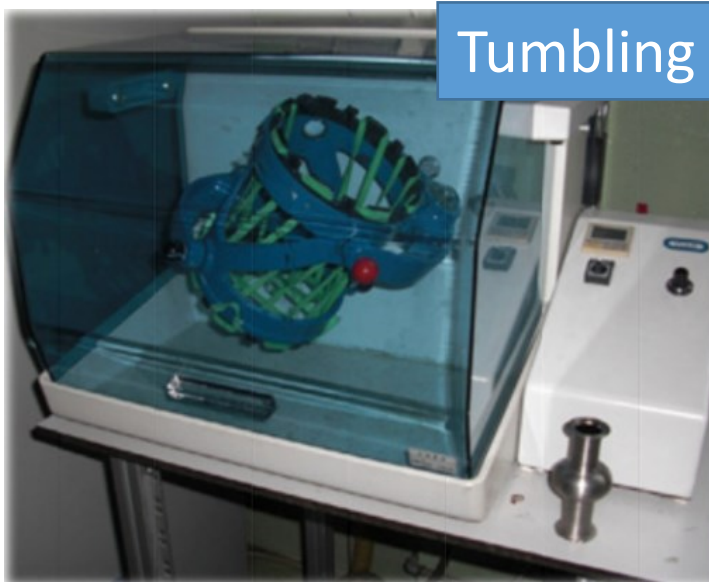
Outline

- Standard surface polishing
- Mechanical polishing of 6 GHz cavity
- New system for tumbling built in LNL
- Electropolishing
- Ionic Liquids – Green Chemistry
- Study the parameters of Electropolishing in Ionic Liquids
- Recent results

Aim:

To find the optimum condition for electropolishing
of niobium in fluorine-free electrolyte

Standard surface polishing techniques



Blue indicator – direct flow, red – indirect.

1 – cavity kit; 2 – anode contacts; 3 – cathode contact; 4 – outgoing valve; 5 – flux regulating valve; 6 – stand.

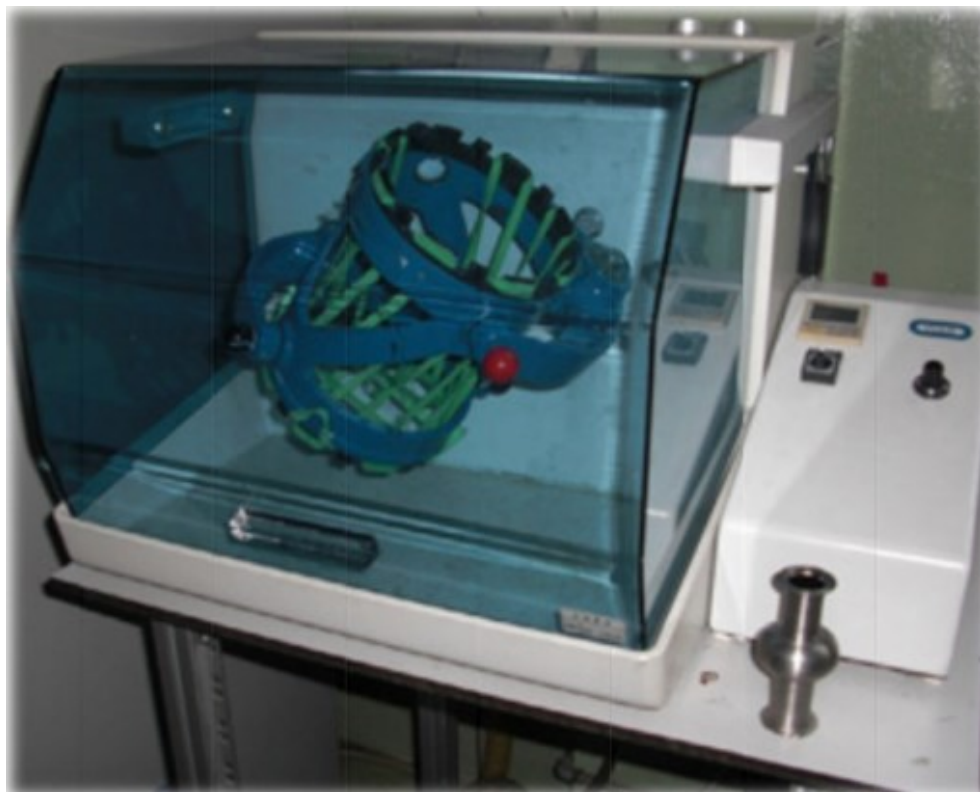
Mechanical surface treatment techniques

for

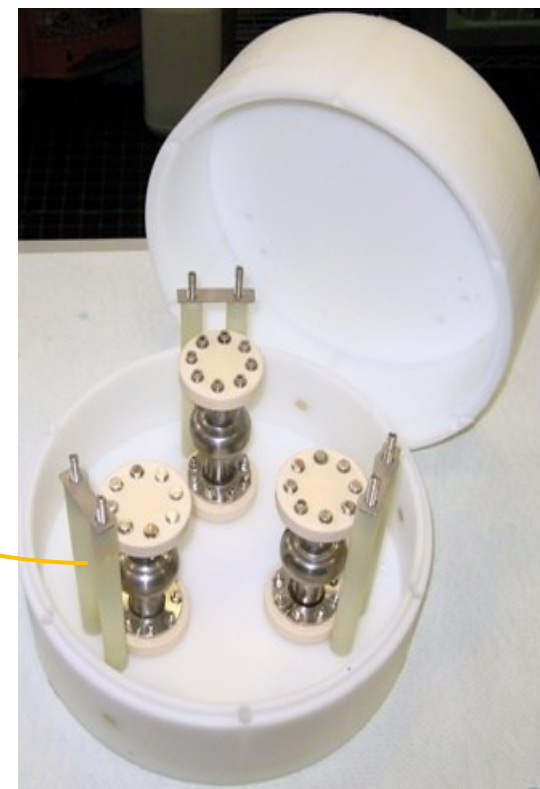
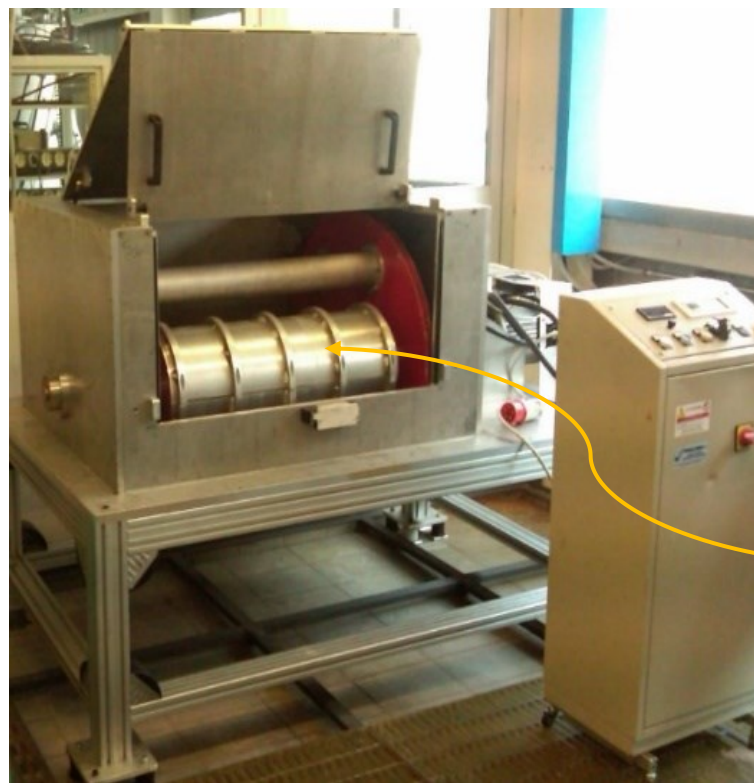
6 GHz cavity

Mechanical polishing approaches (LNL-INFN)

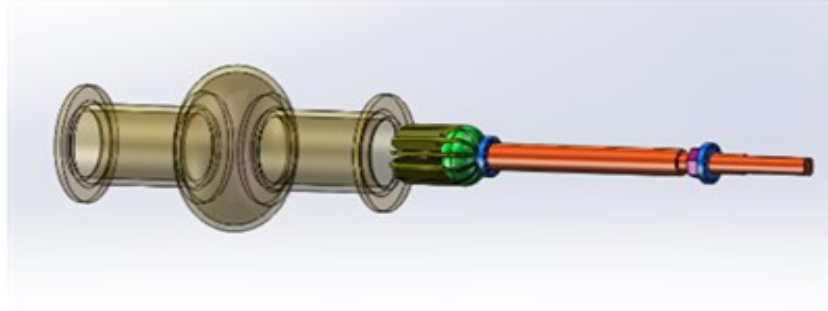
TURBULA® Shaker-Mixer



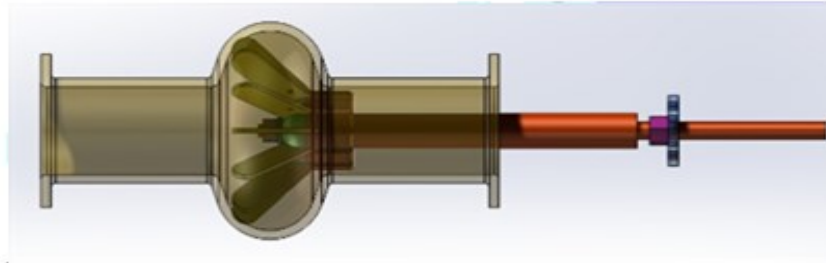
Centrifugal barrel polishing (CBP)



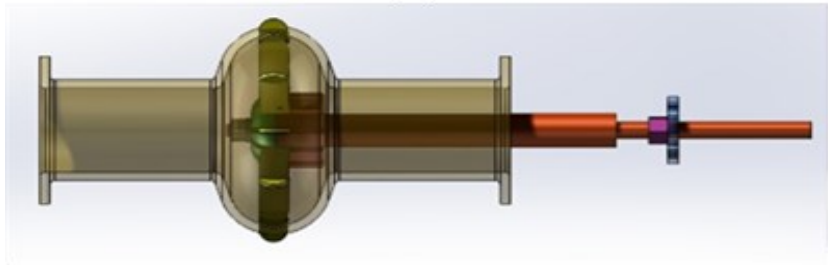
“Flower brush”



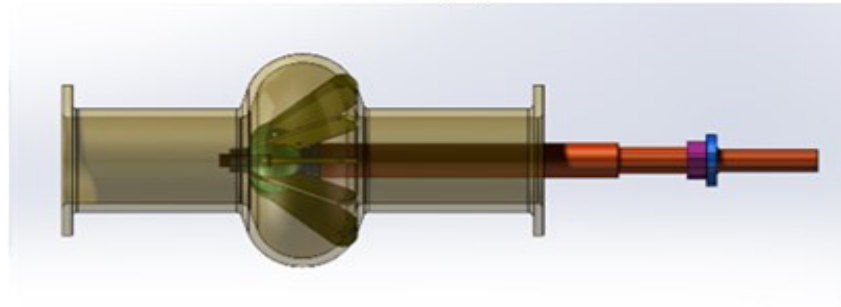
(a)



(b)

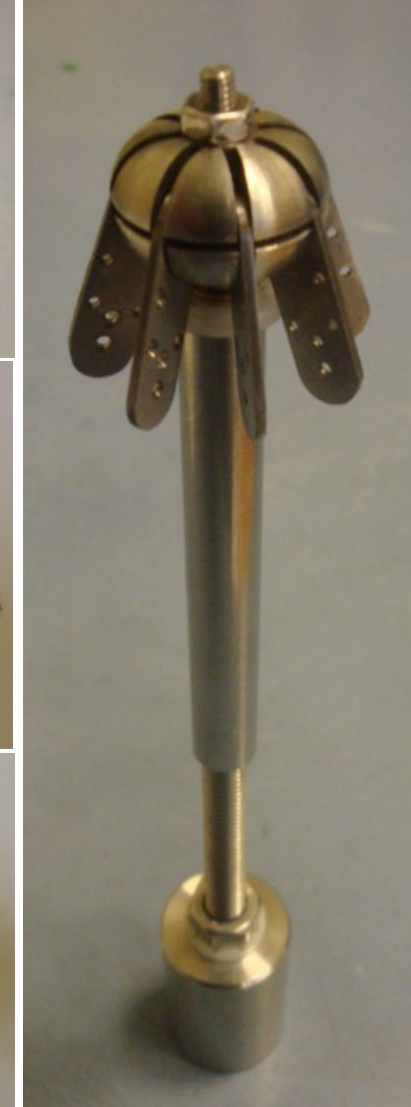


(c)

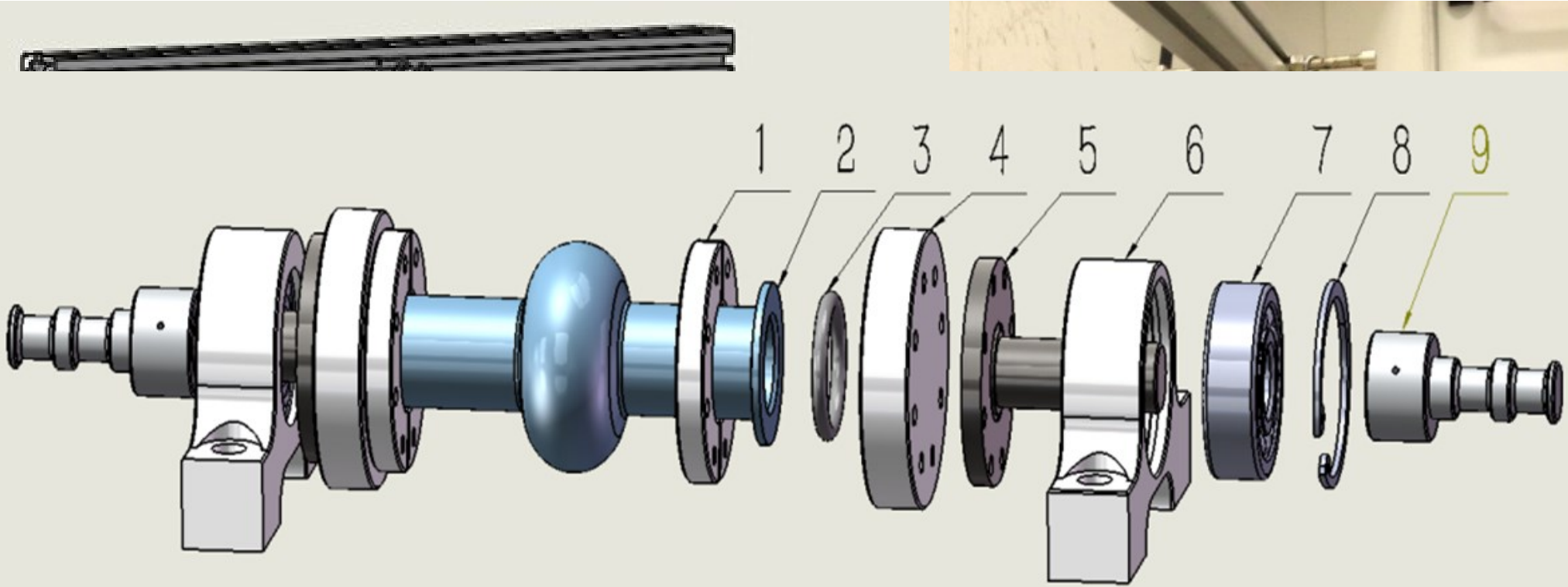


(d)

- The polishing brush on the market was usually used to polish the inner surface of tube, whose diameter equal everywhere.
- We design a customized brush that can go to the center of the cavity.
- The whole “flower” is made in stainless steel, the abrasive material is fixed to the leaves.



Vibrating system - a new mechanical polishing approach



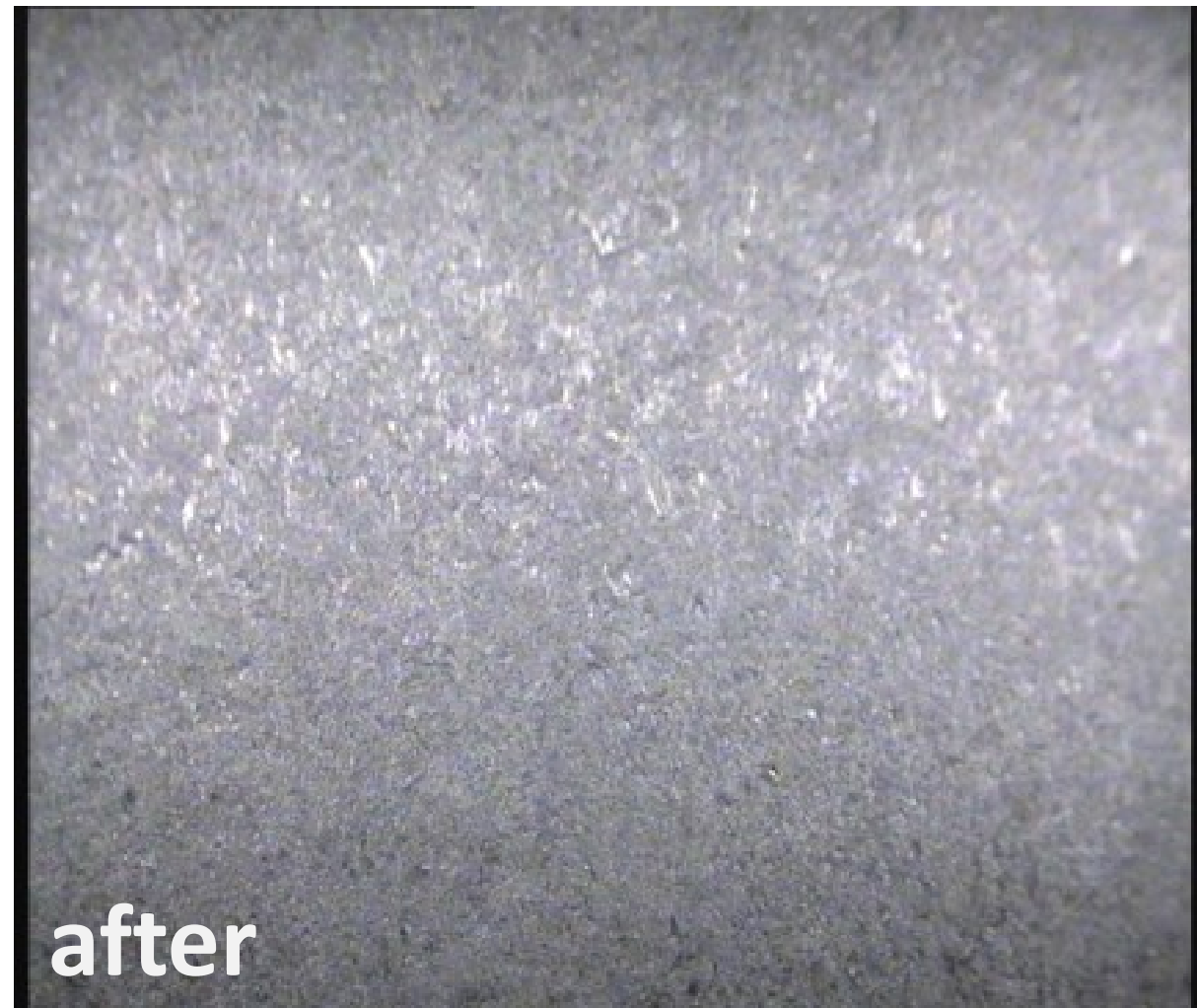
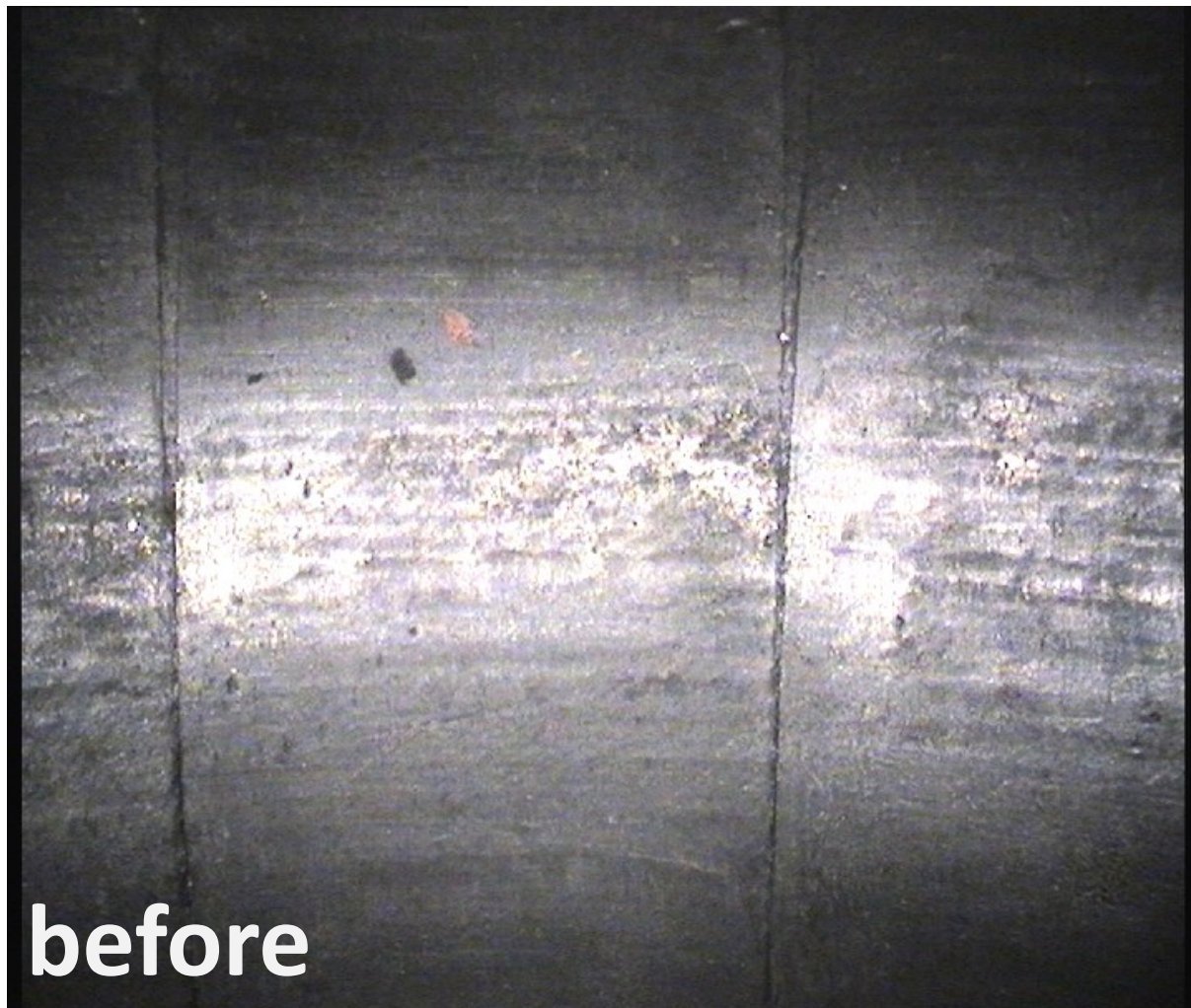
1 - half flange; 2 - 6GHz cavity; 3 - O-ring; 4 - plastic blind flange; 5 - drive axis;
6 - bearing holder; 7 - self-aligning bearing; 8 - snap ring; 9 - belt axis.



rubber shock absorber



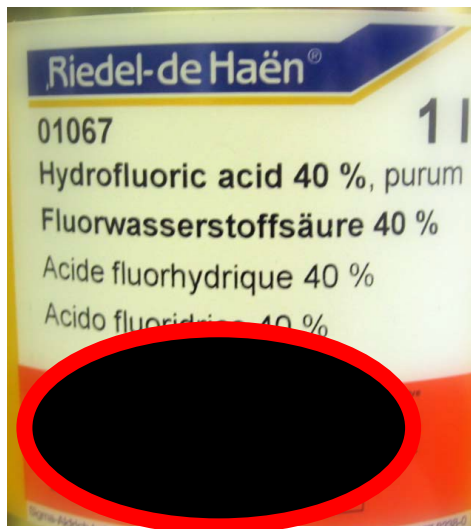
Inner surface of 6 GHz cavity before and after tumbling



Electropolishing

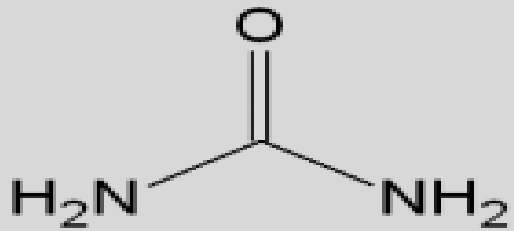
Standard electropolishing of niobium cavities

HF : H₂SO₄ (ratio 1 : 9)

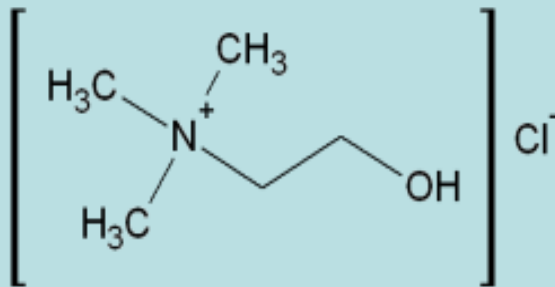


IONIC LIQUID as an Alternative

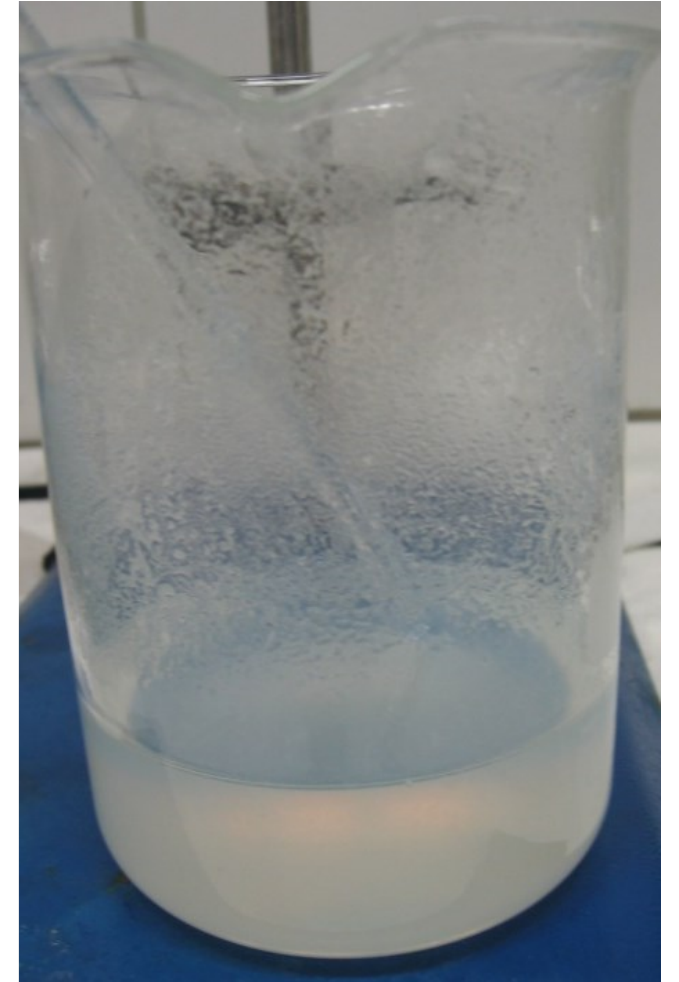
Urea



Choline Chloride

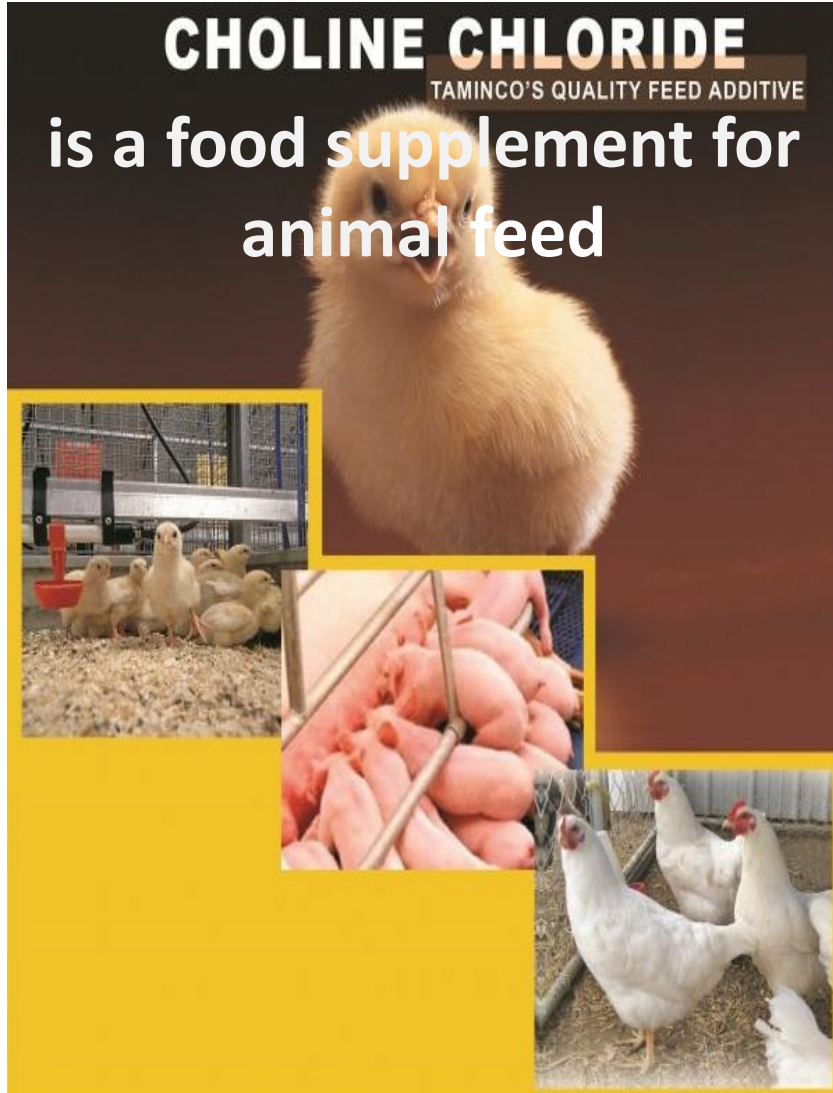


T - 120°C



Green Chemistry

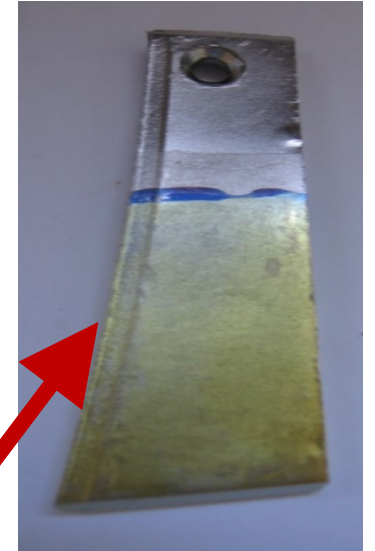
CHOLINE CHLORIDE
TAMINCO'S QUALITY FEED ADDITIVE
is a food supplement for
animal feed



Study the parameter for Electropolishing in Ionic liquids

Ionic liquids based on Choline Chloride

Ratio	Components	Note
1 : 1	Ch Chl : Sulfamic Acid	Not create IL
1 : 1	Ch Chl : Ammonium persulfate	Not create IL
1 : 1	Ch Chl : Malic Acid	no polishing
1 : 2	Ch Chl : Ethylene glycol	pitting



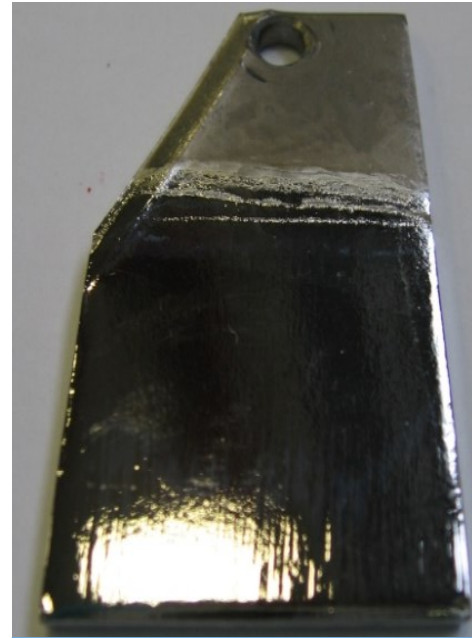
Influence of the additives on the surface state



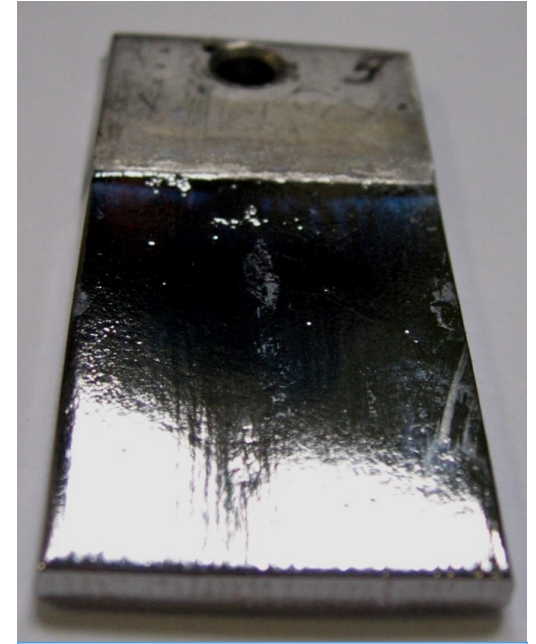
+30 g/l EDTA



**+10 g/l
Polyethylene
glycol**



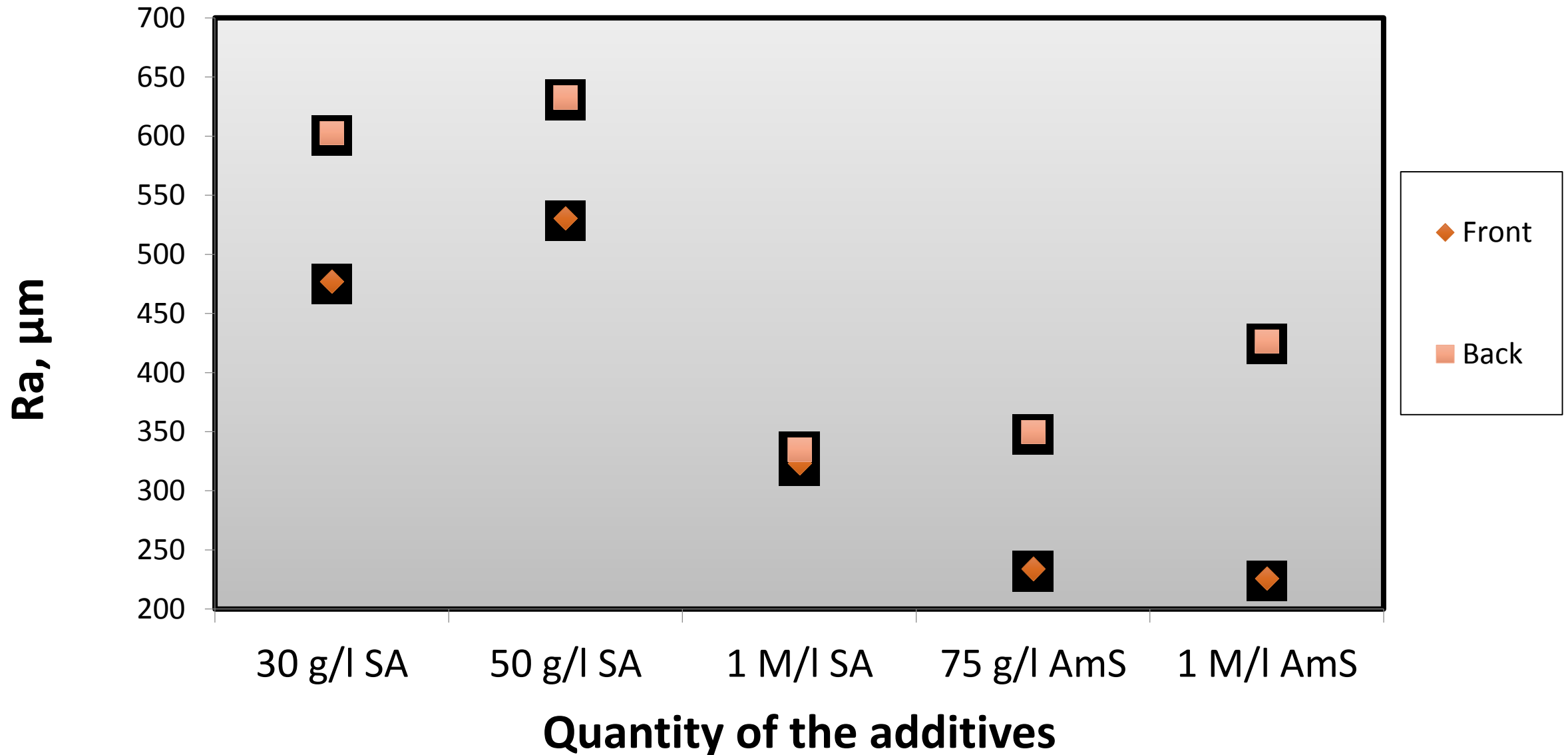
**+114 g/L
Ammonium
Sulfamate**



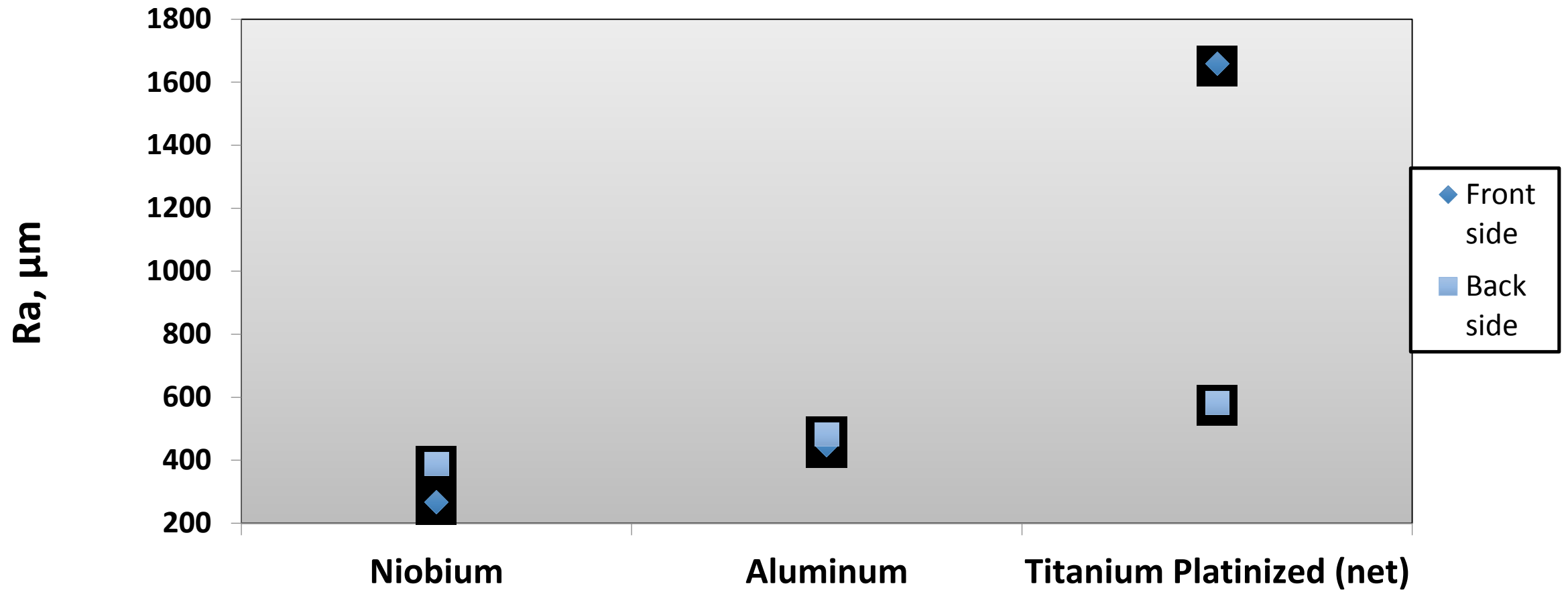
**+50 g/l
Sulphamic Acid**

❖ Solutions are based on electrolyte: Choline Chloride and Urea (1:4) + additive

Dependence of roughness from quantity of additives



Dependence of roughness from material of the cathode



The Best parameters for EP Nb samples

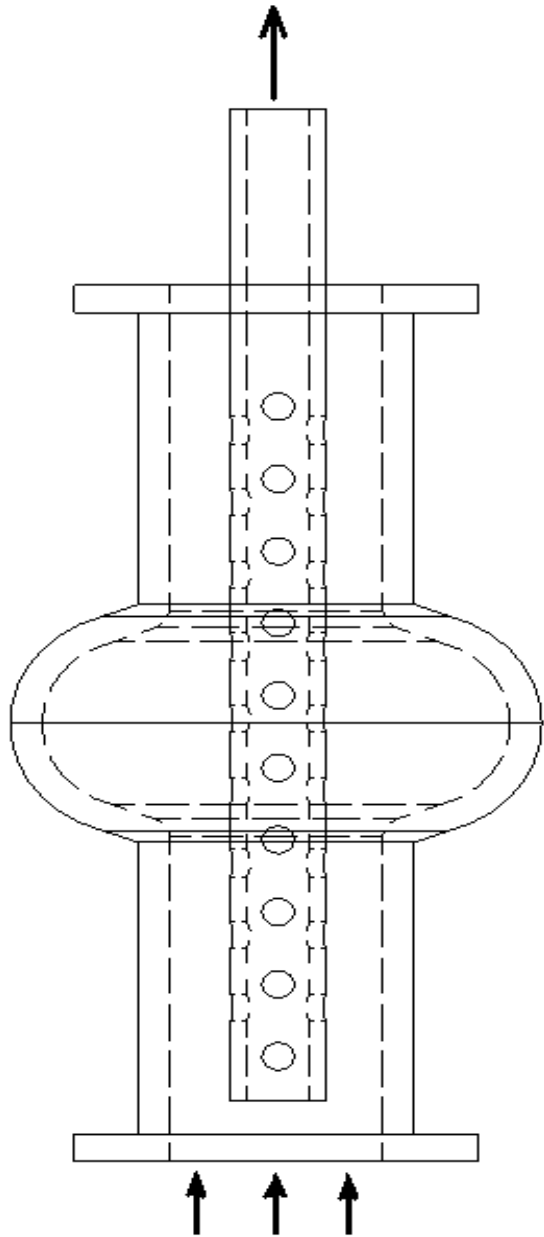
Choline Chloride : Urea	1 : 4
Sulfamic acid, g/l	97
Material cathode	Nb
Temperature, °C	Higher then 120
Current density, A/cm ²	0,3



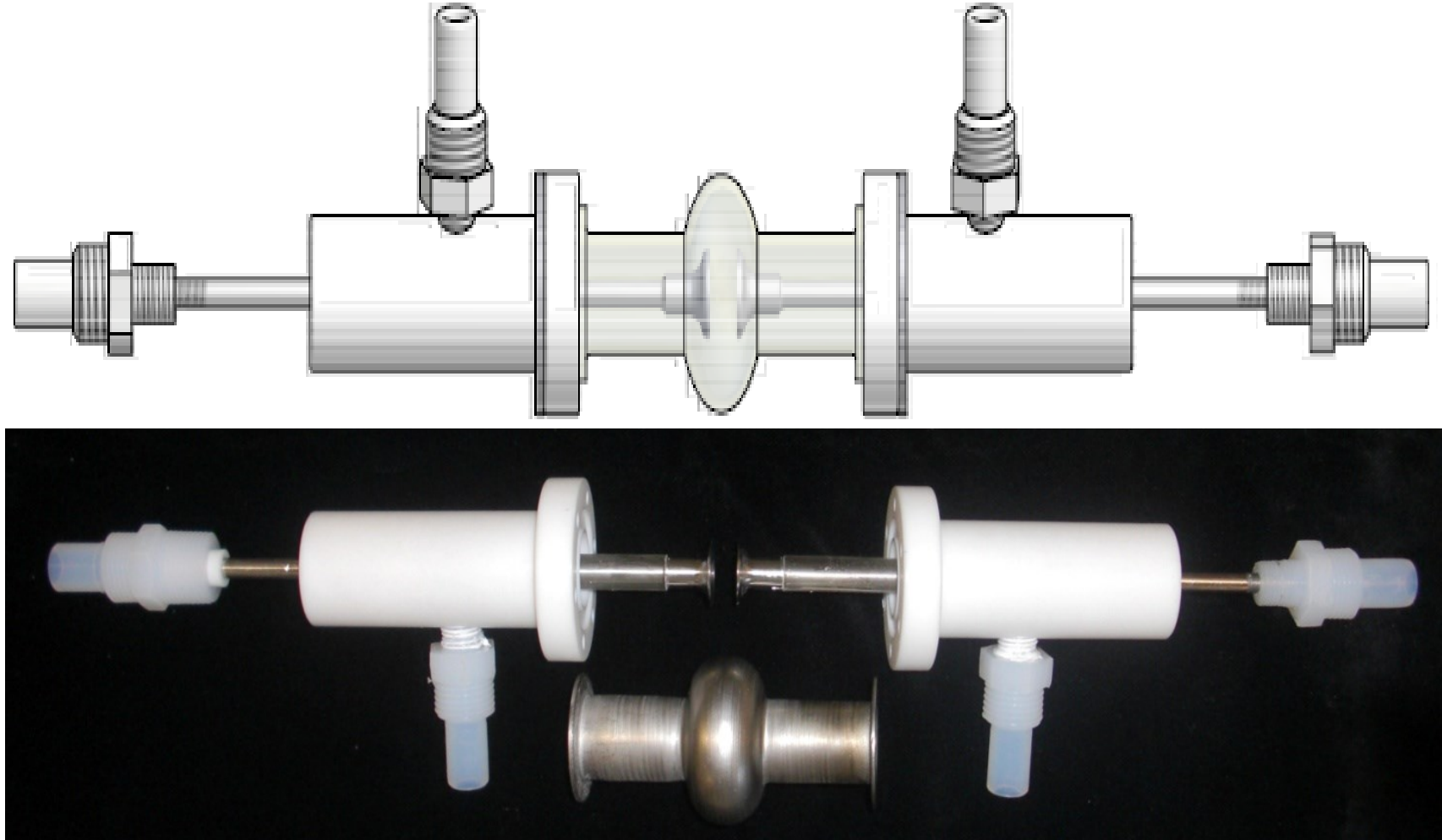
Development of system for Electropolishing in Ionic Liquids

Vertical **vs.** **Horizontal**
Electropolishing **Electropolishing**

Vertical EP: holed cathode



Vertical EP: Two part cathode



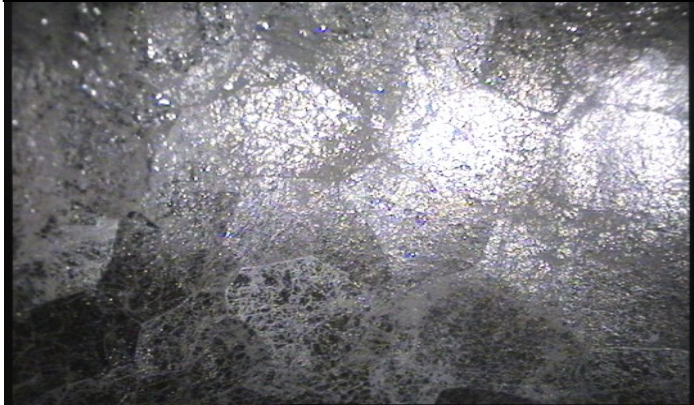
Vertical Electropolishing



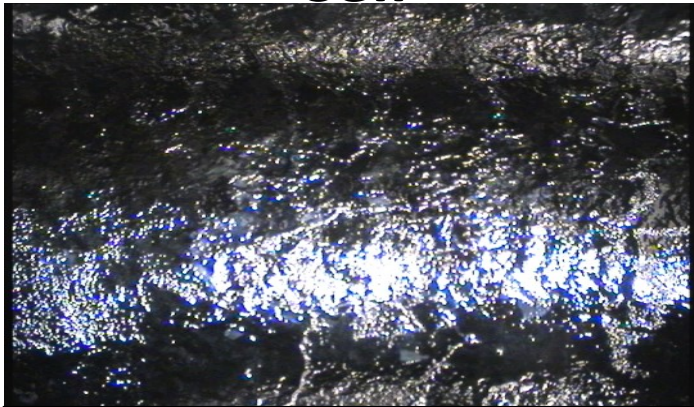
❖ Creating a lot of bubbles during the electropolishing has damaged the surface!

Horizontal Electropolishing

top part



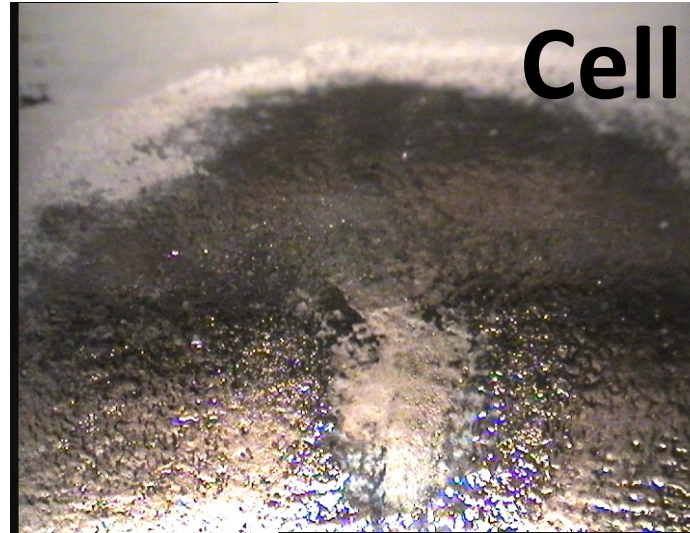
Cell



down part

Cavity, half immersed
in the solution

Cell



Cavity with pumping the
solution inside

top part



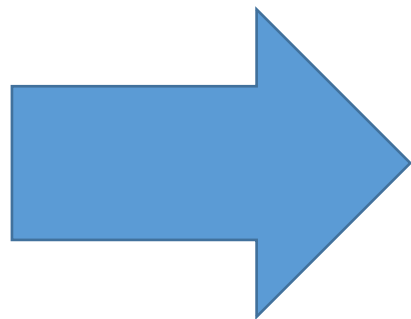
Cell



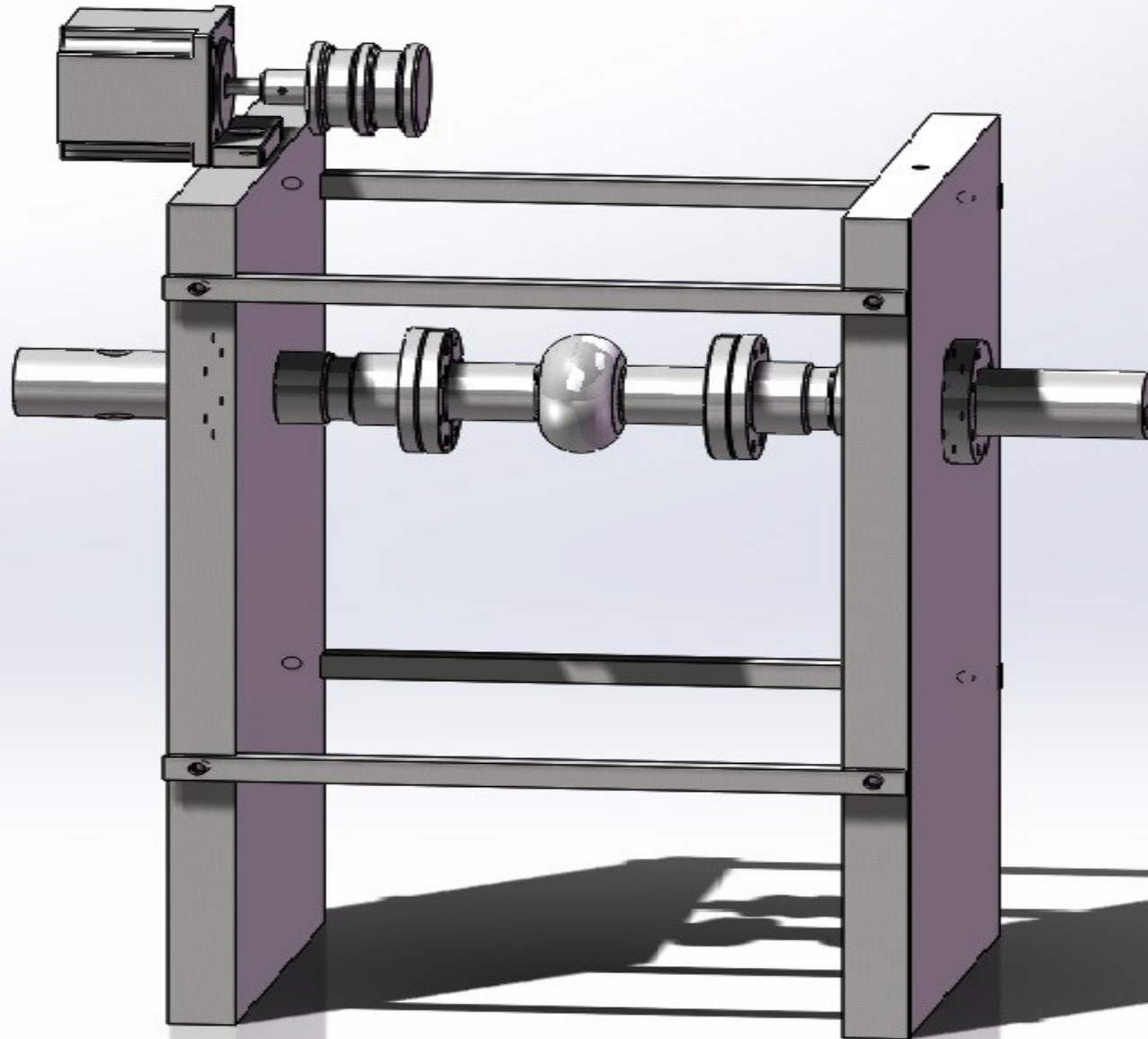
down part

Cavity half immersed
in the solution and rotating

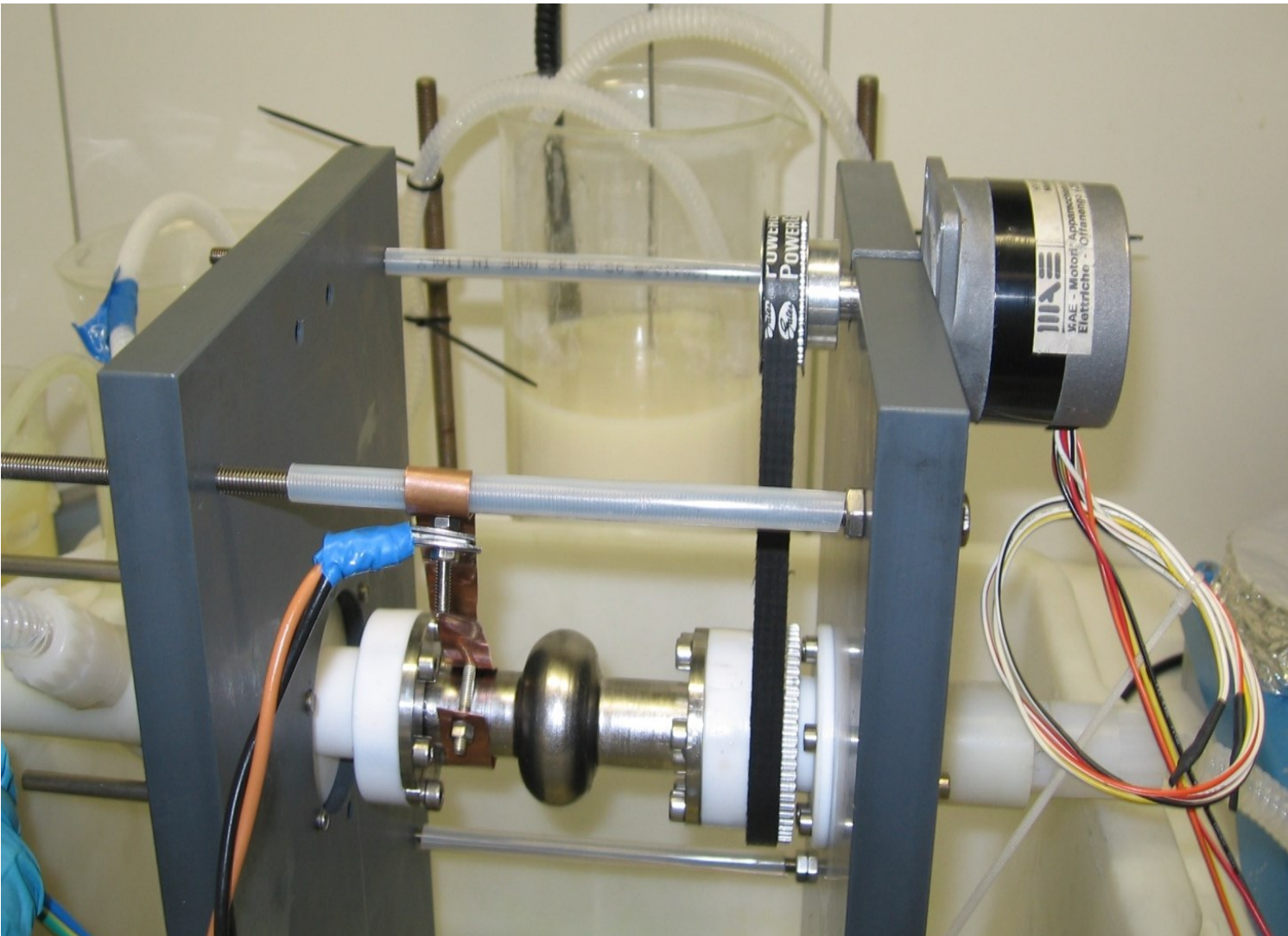
Half cavity before and after treatment

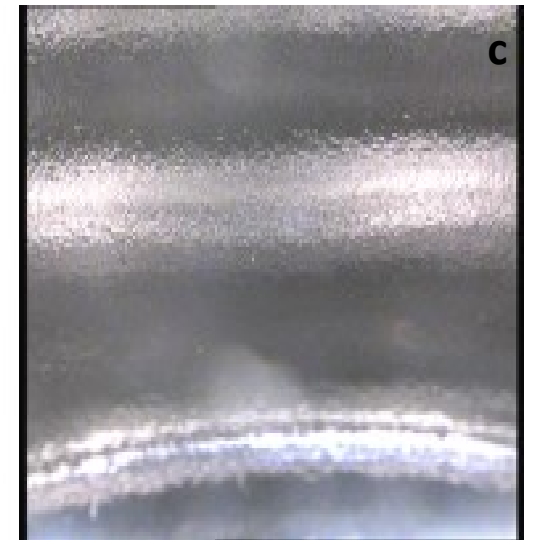
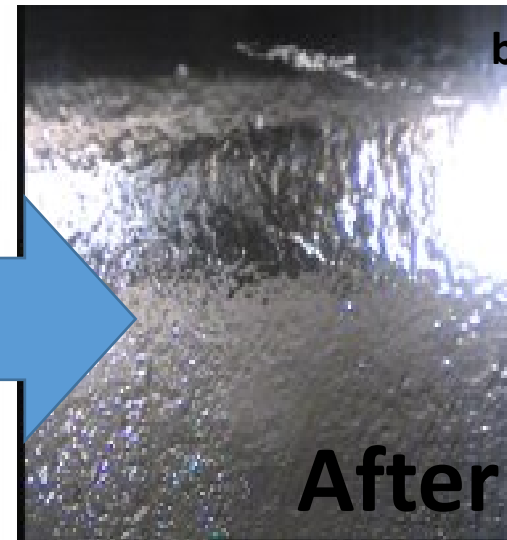
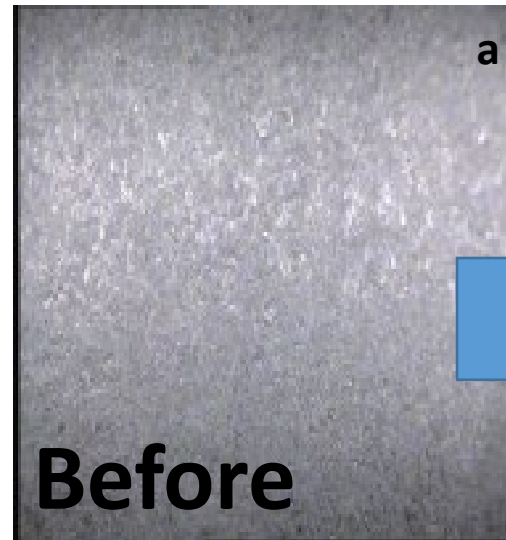
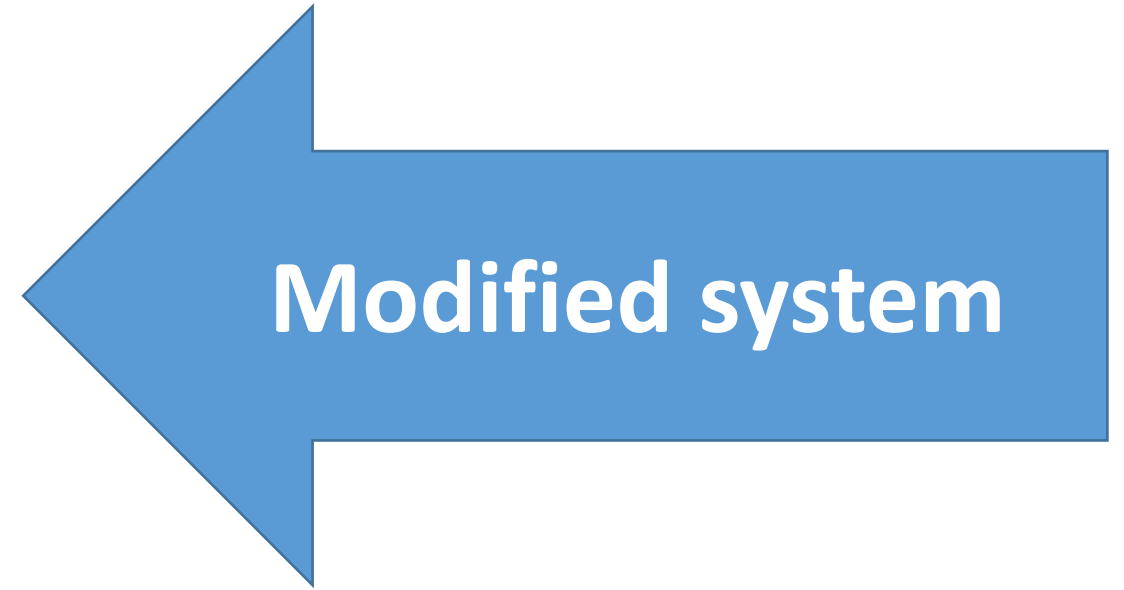
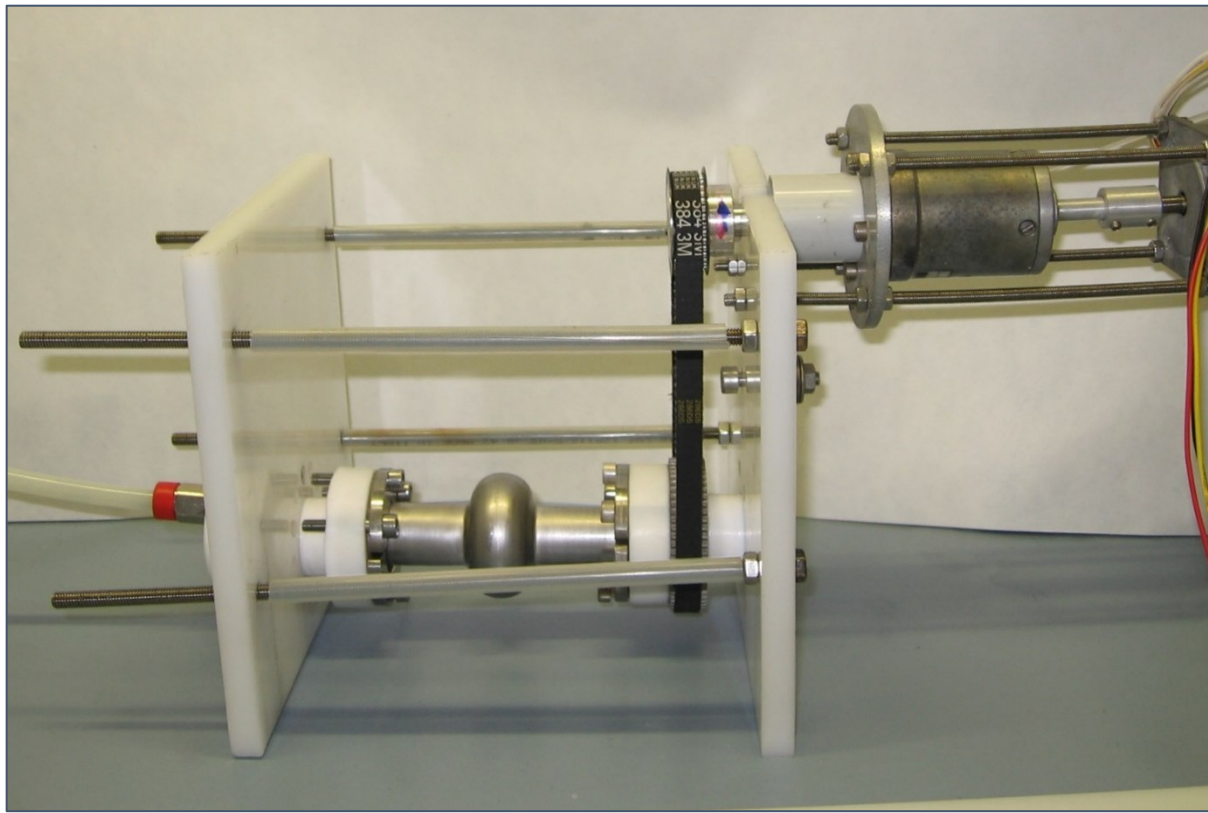


New system for electropolishing 6GHz cavity



Testing the new system





Conclusions

- ✓ We found the competitive solution for the EP, based on compounds commonly used in agriculture
- ✓ We have polished three cavities and measured one
- ✓ We don't have enough statistic for now, so we continue to work...



**Thank you for
attention!**