LABORATORI NAZIONALI DI LEGNARO

FLUORINE FREE IONIC LIQUID ELECTROPOLISHING OF NIOBIUM CAVITIES

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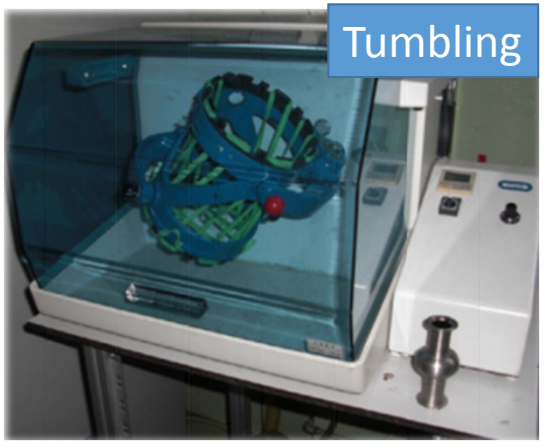
Outline

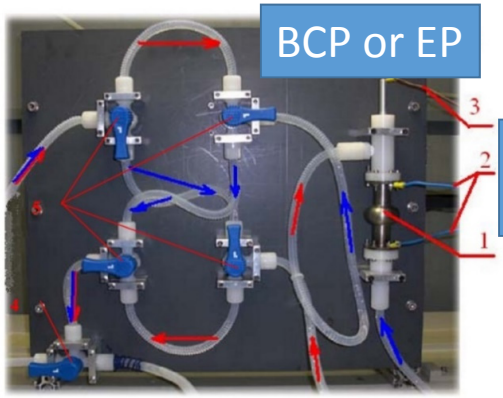
- Standard surface polishing
- Mechanical polishing of 6 GHz cavity
- New system for tumbling built in LNL
- Electropolishing
- Ionic Liquids – Green Chemistry
- Study the parameters of Electropolishing in Ionic Liquids
- Recent results

Aim:

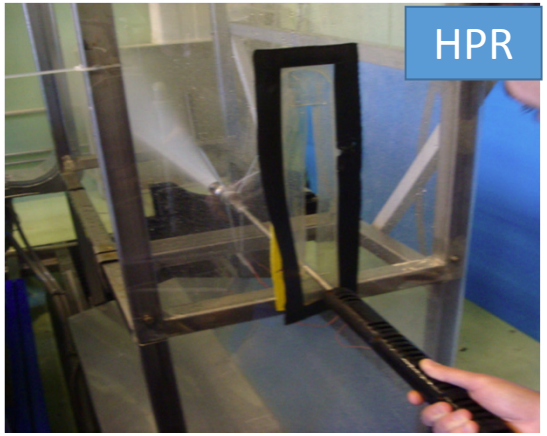
To find the optimum condition for electropolishing of niobium in fluorine-free electrolyte

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.



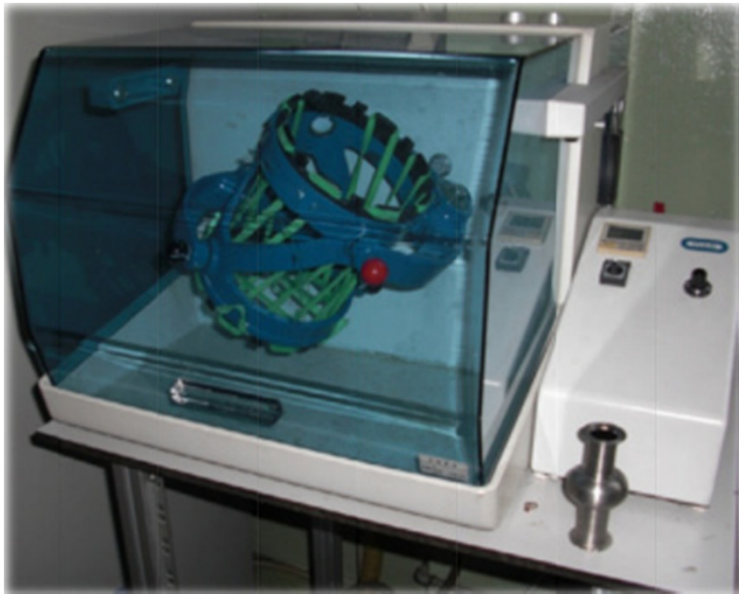
Mechanical surface treatment techniques

for

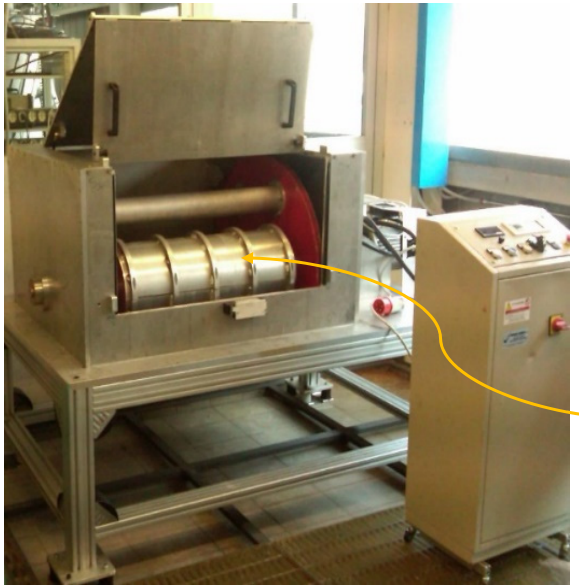
6 GHz cavity

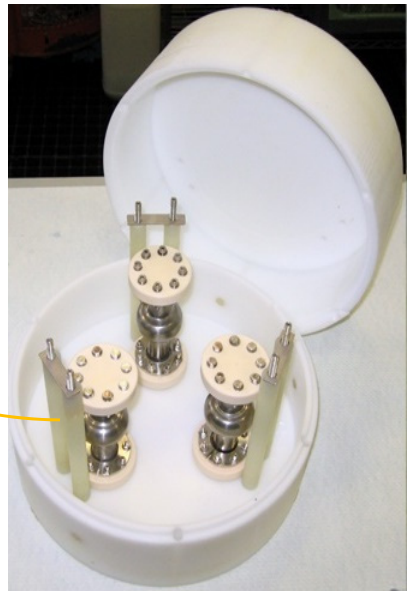
Mechanical polishing approaches
(LNL-INFN)

TURBULA® Shaker-Mixer

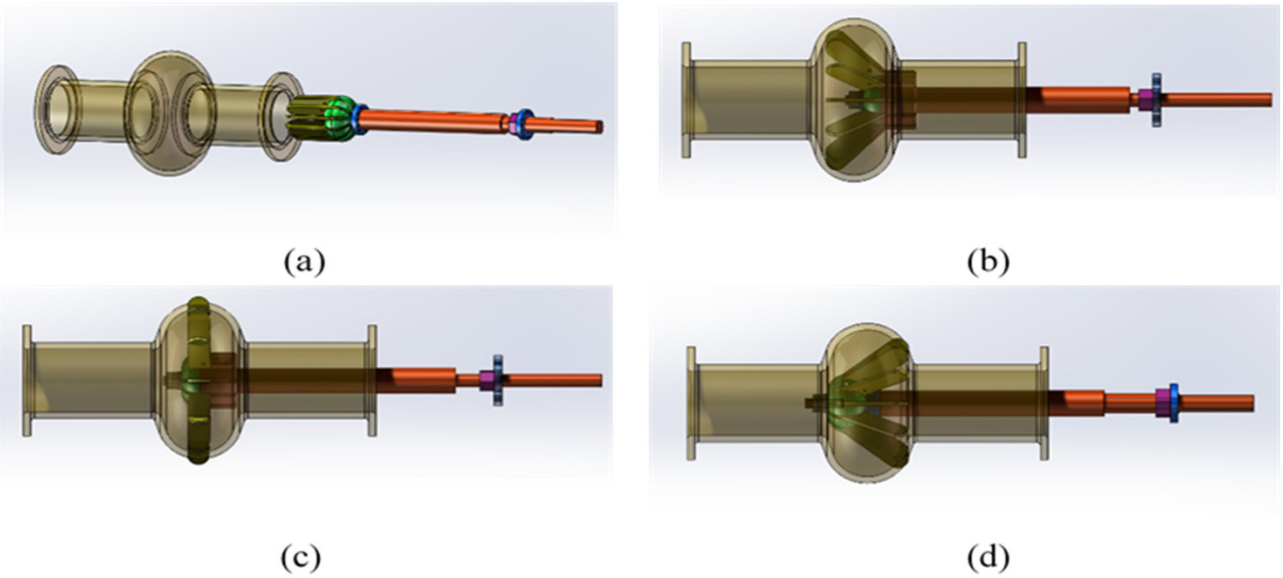


Centrifugal barrel polishing (CBP)



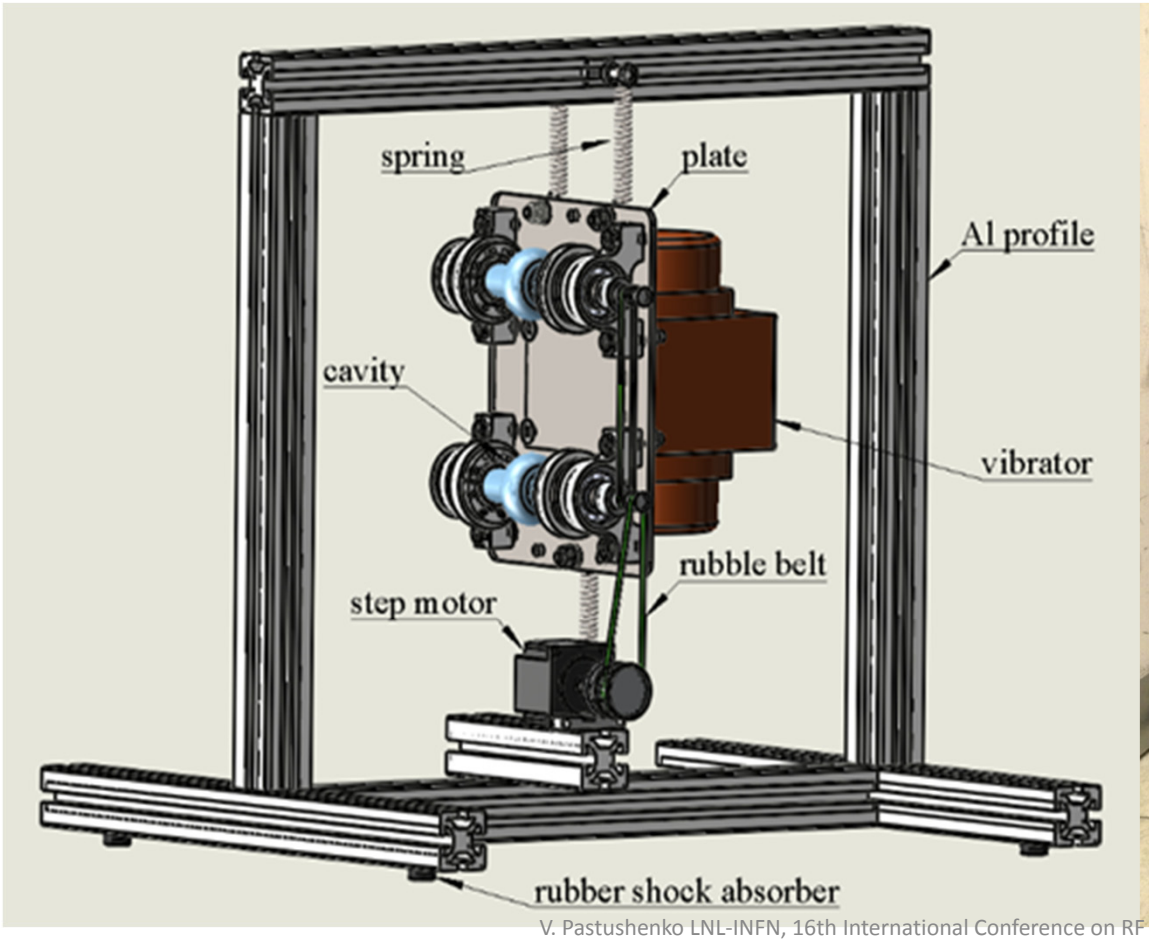


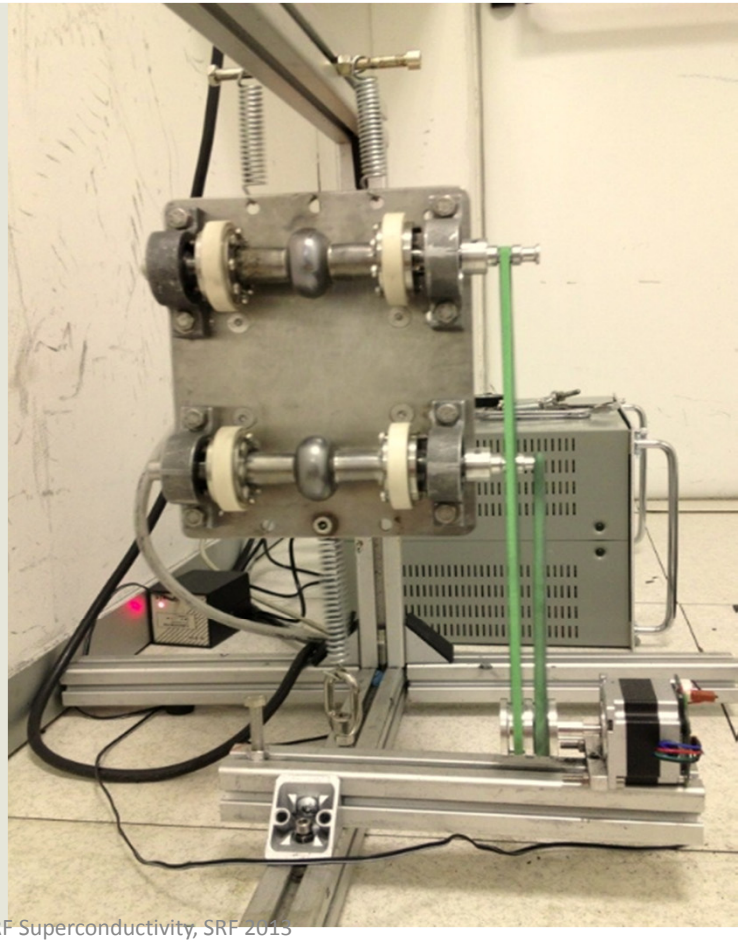
“Flower brush”



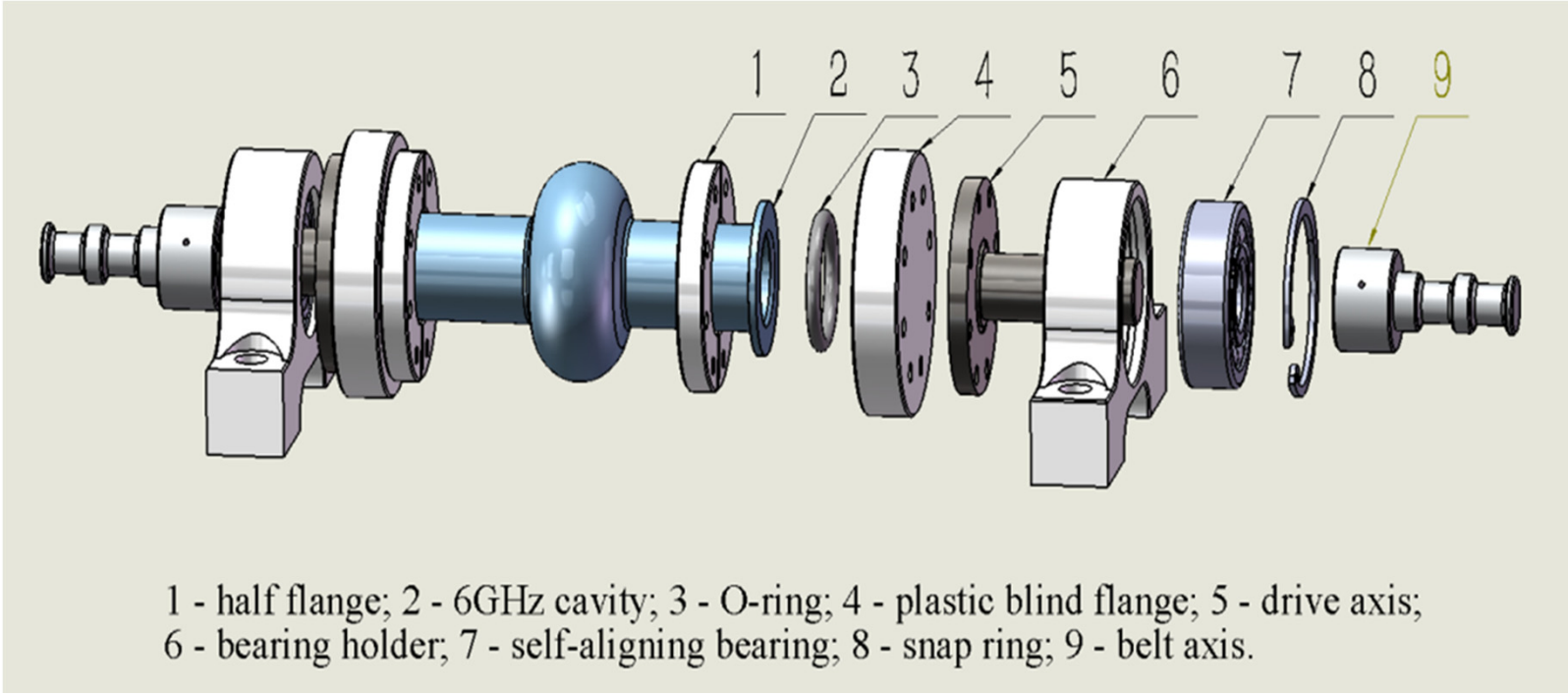
- The polishing brush on the market was usually used to polish the inner surface of tube, whose diameter equal everywhere.
- We design a customized brush that can go to the center of the cavity.
- The whole “flower” is made in stainless steel, the abrasive material is fixed to the leaves.

Vibrating system - a new mechanical polishing approach



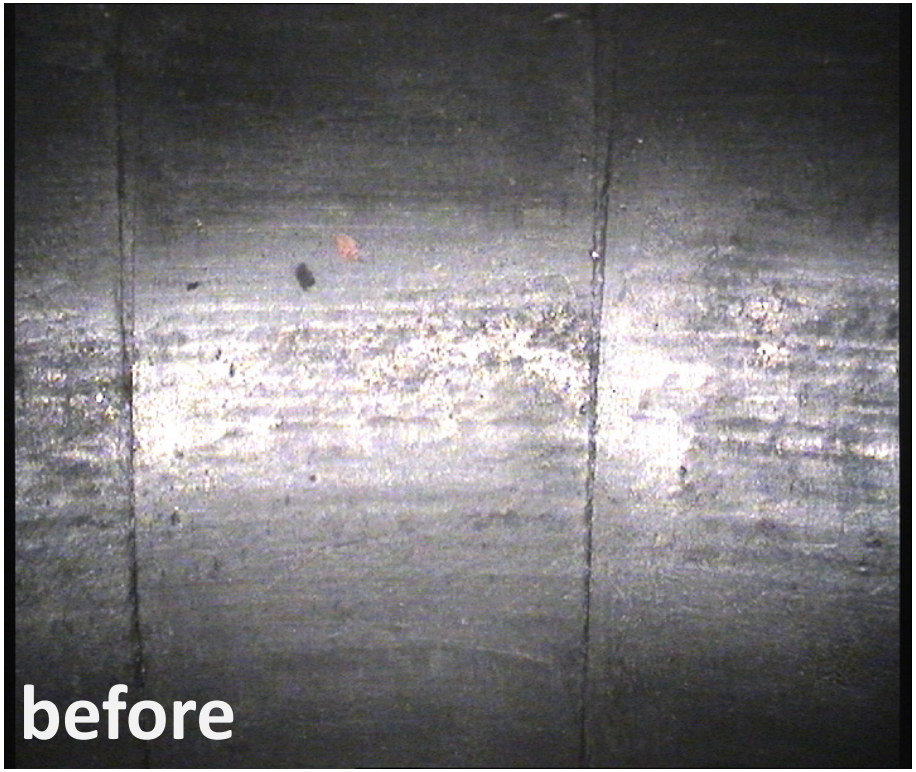


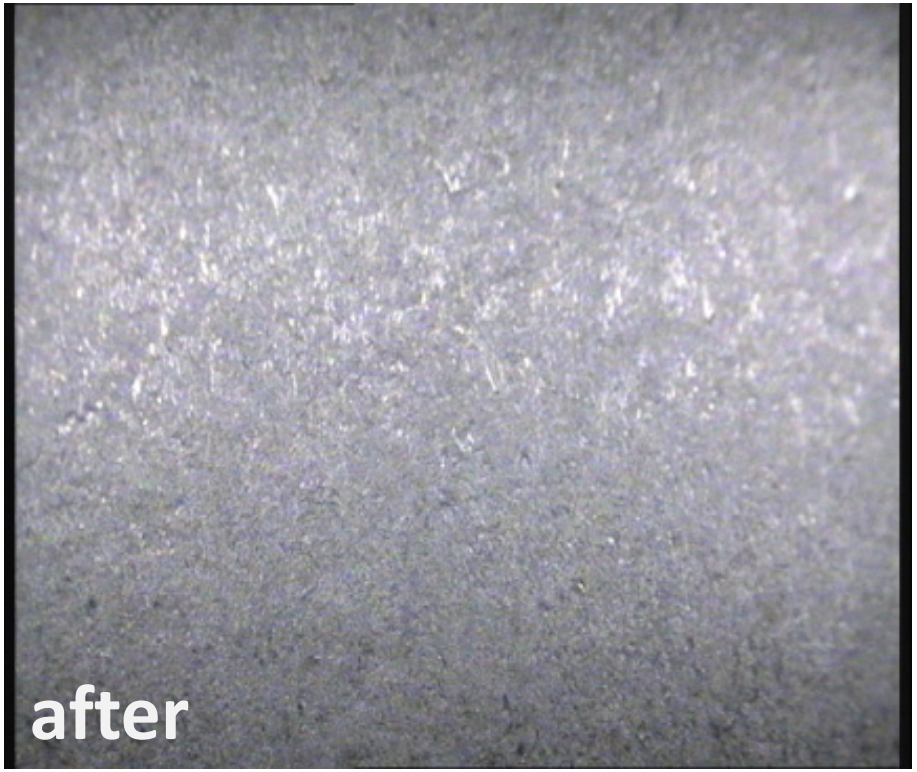
Vibrating system - a new mechanical polishing approach



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.

Inner surface of 6 GHz cavity before and after tumbling

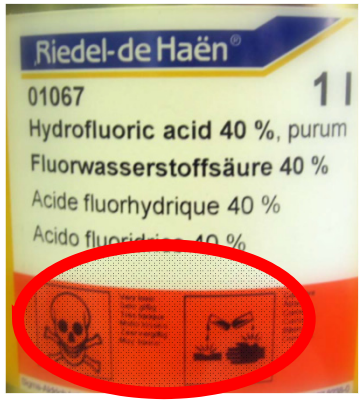


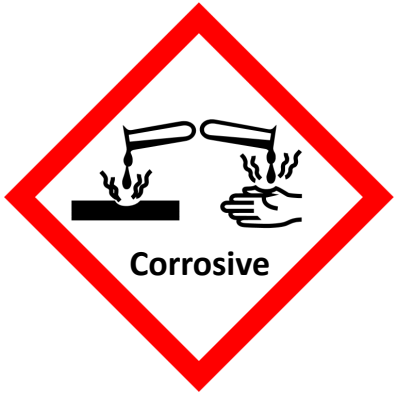


Electropolishing

Standard electropolishing of niobium cavities

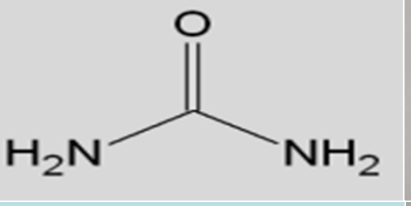
HF : H_2SO_4 (ratio 1 : 9)



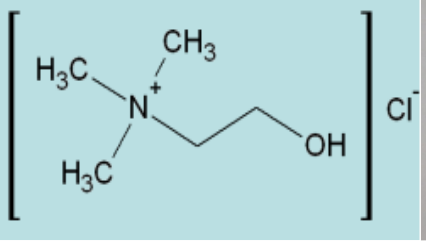


IONIC LIQUID as an Alternative

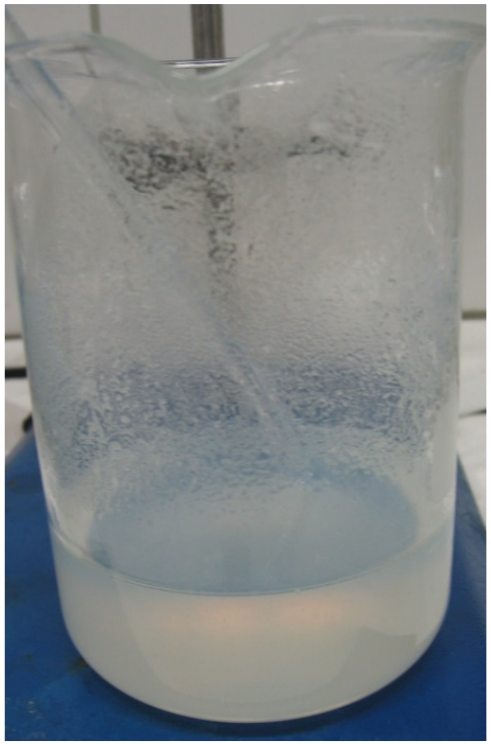
Urea



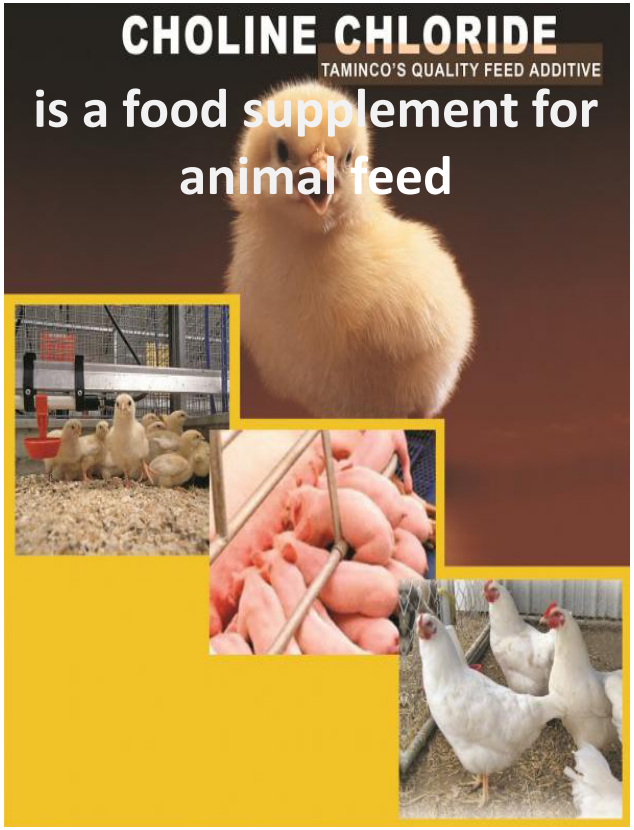
Choline Chloride

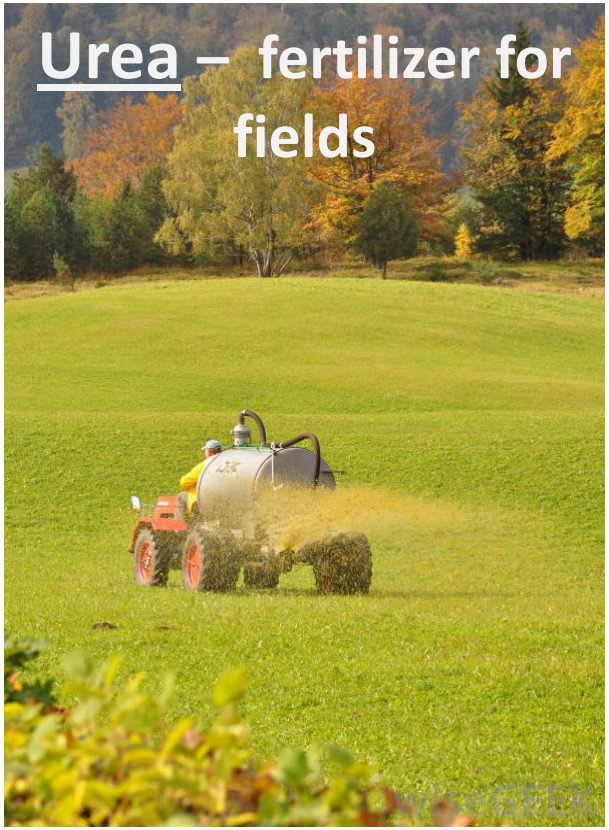


T - 120°C



Green Chemistry

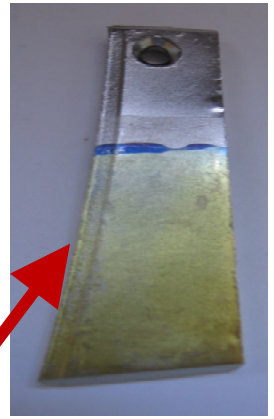




Study the parameter for Electropolishing in Ionic liquids

Ionic liquids based on Choline Chloride

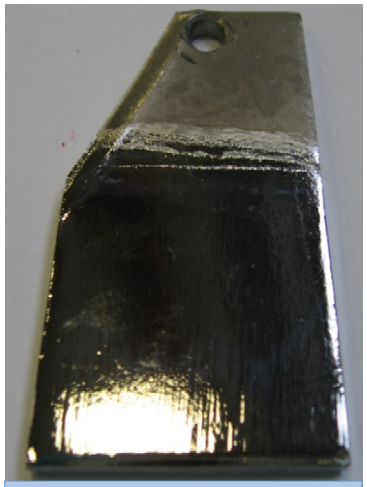
Ratio	Components	Note
1 : 1	Ch Chl : Sulfamic Acid	Not create IL
1 : 1	Ch Chl : Ammonium persulfate	Not create IL
1 : 1	Ch Chl : Malic Acid	no polishing
1 : 2	Ch Chl : Ethylene glycol	pitting



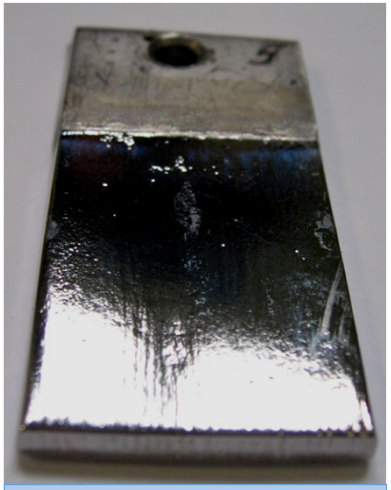
Influence of the additives on the surface state

+30 g/l EDTA

+10 g/l Polyethylene glycol



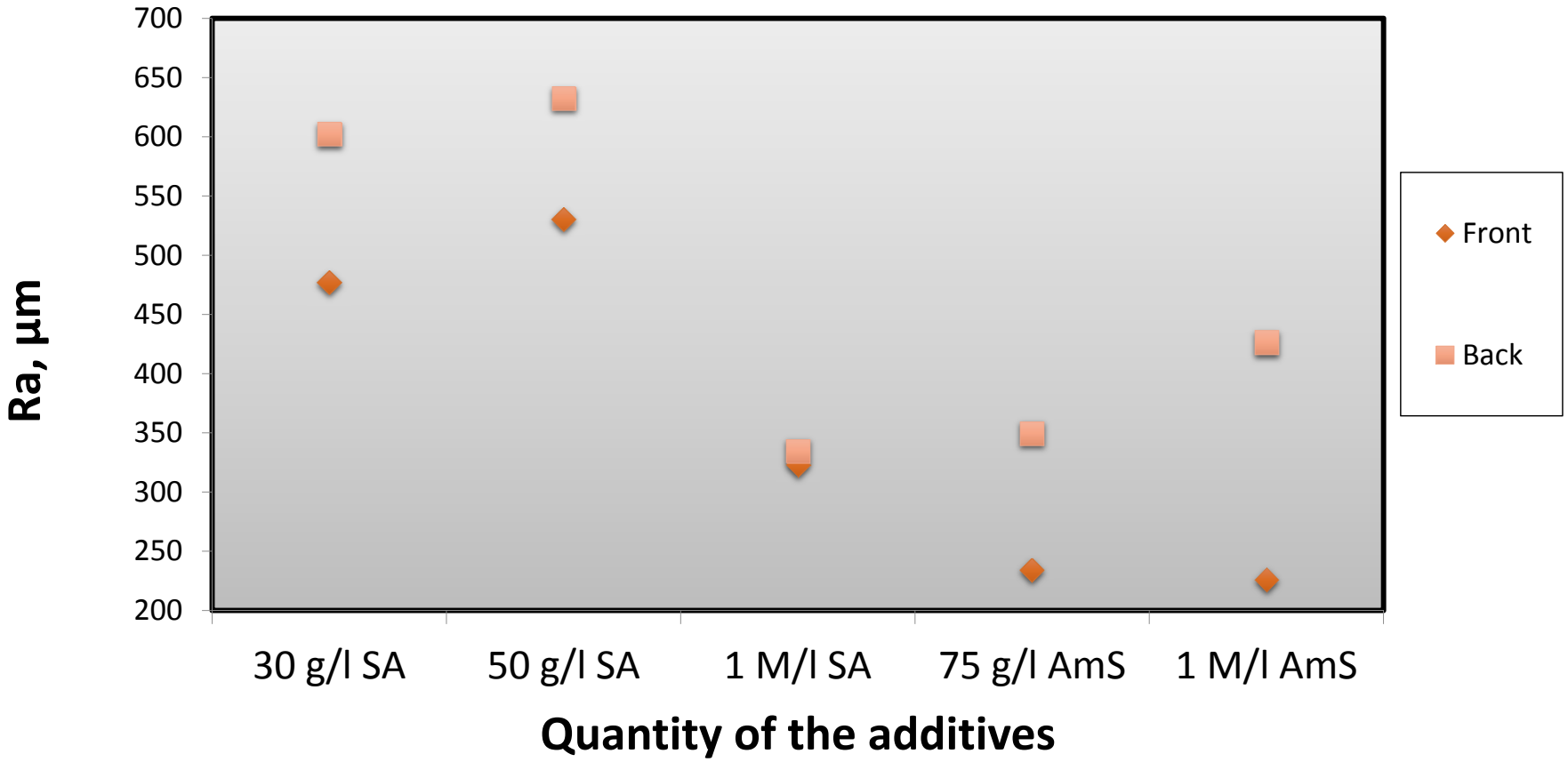
+114 g/L Ammonium Sulfamate



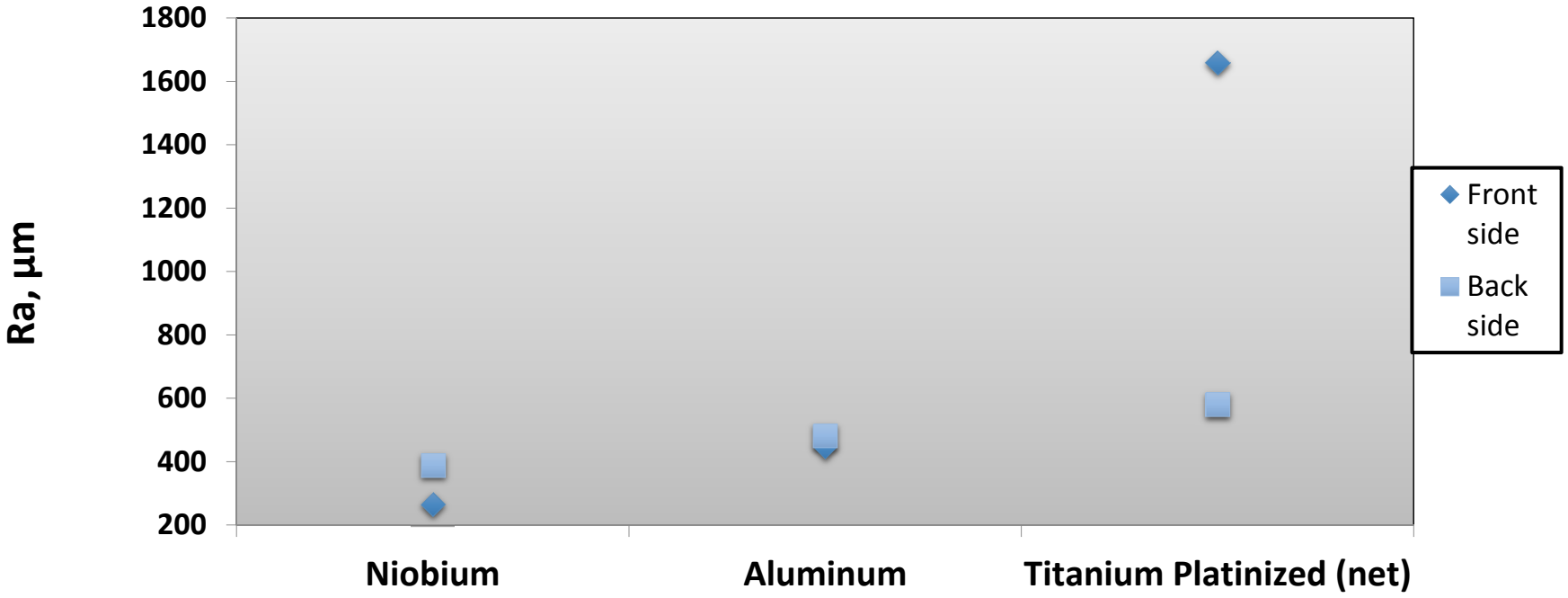
+50 g/l Sulphamic Acid

- **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

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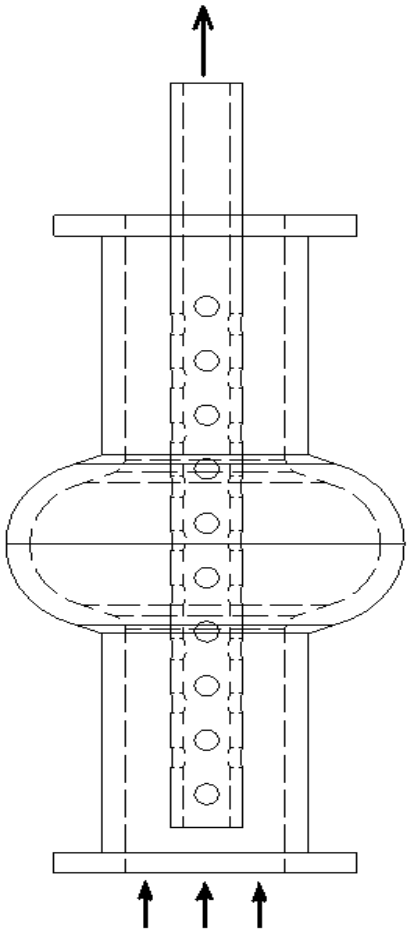
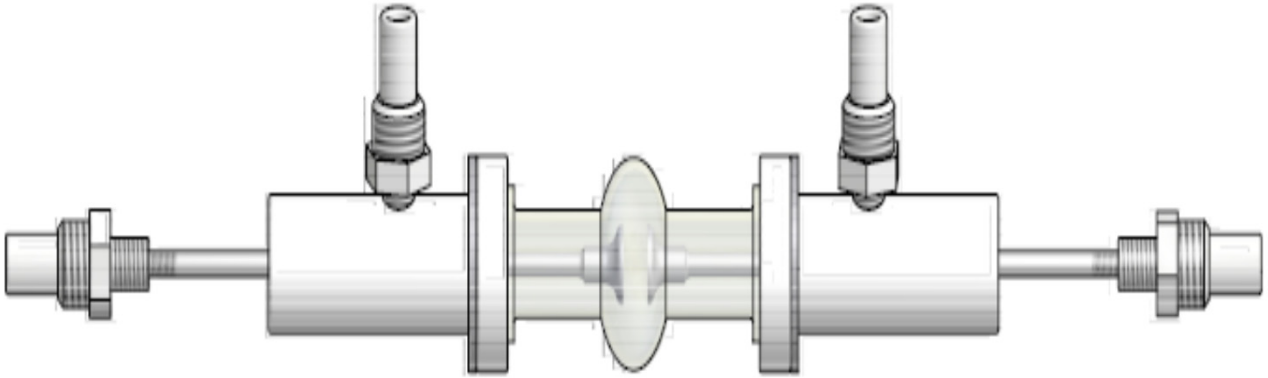
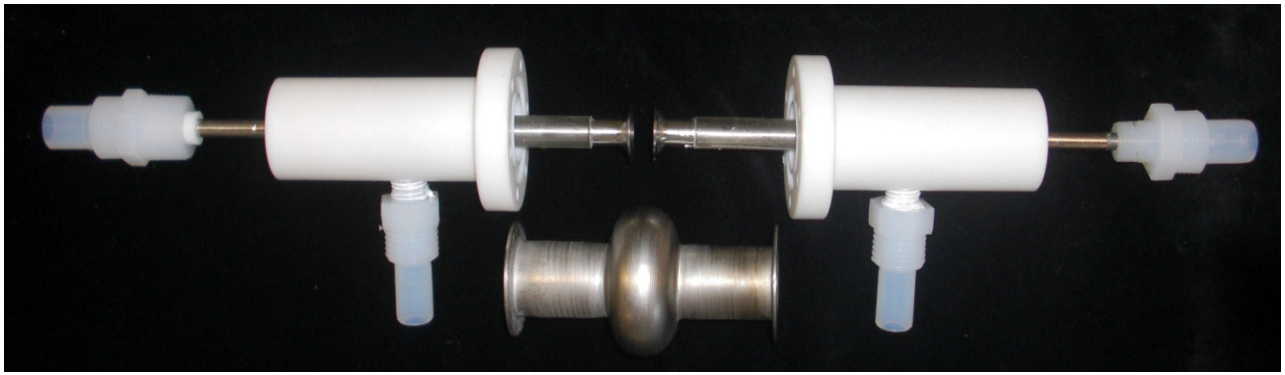
Vertical Electropolishing vs. Horizontal Electropolishing

Vertical EP: holed cathode

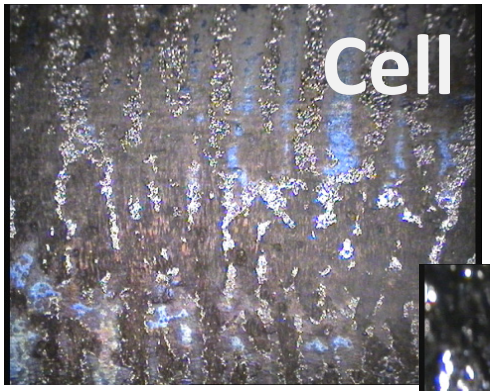


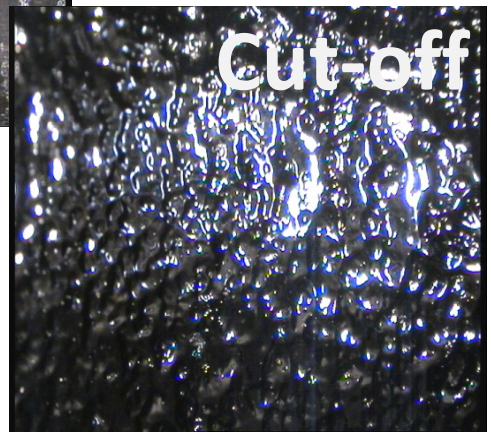
Vertical EP: Two part cathode





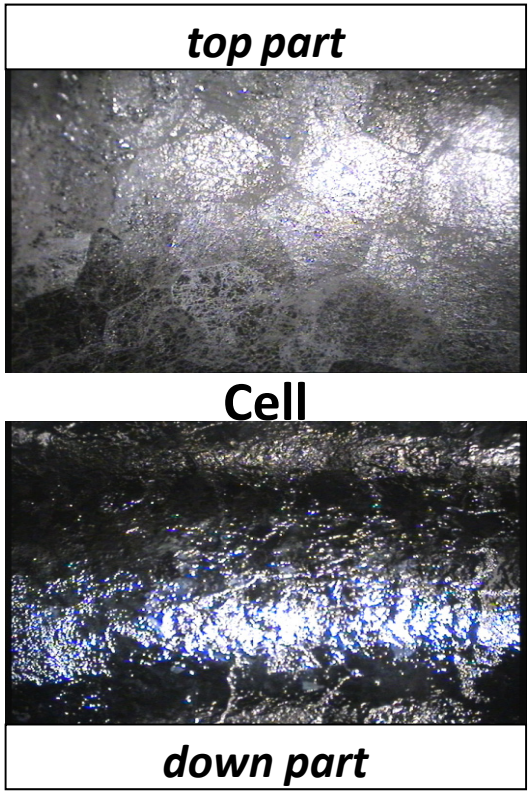
Vertical Electropolishing





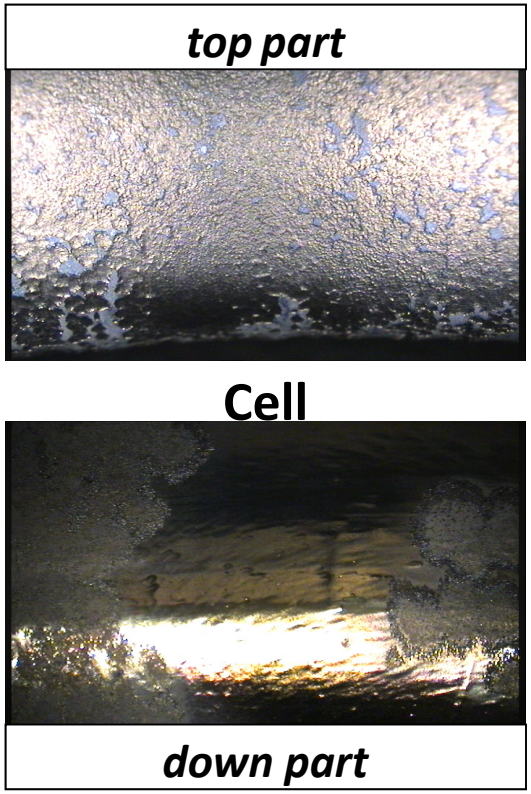
- Creating a lot of bubbles during the electropolishing has damaged the surface!

Horizontal Electropolishing



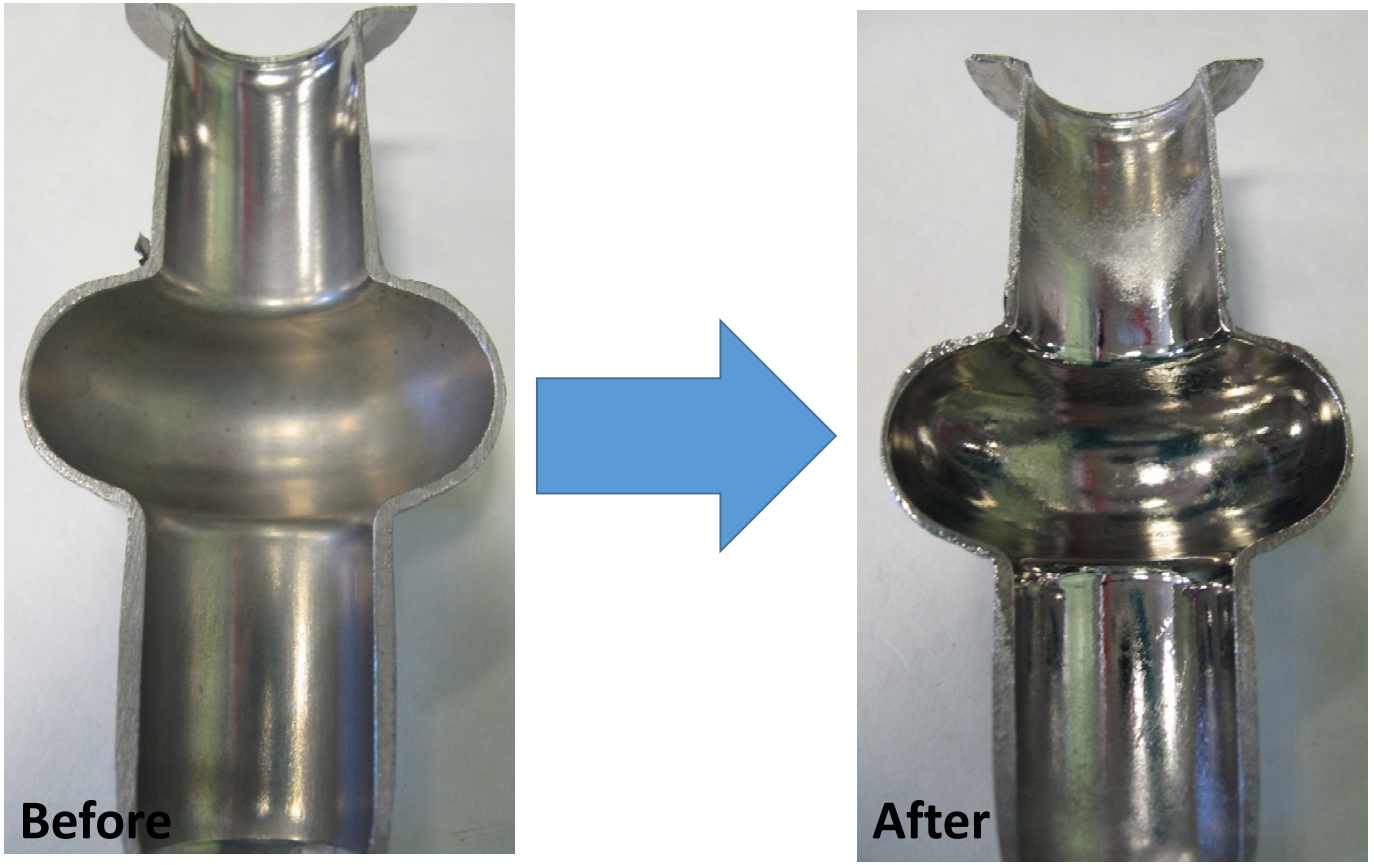
Cavity, half immersed
in the solution

Cavity with pumping the
solution inside



Cavity half immersed
in the solution and rotating

Half cavity before and after treatment



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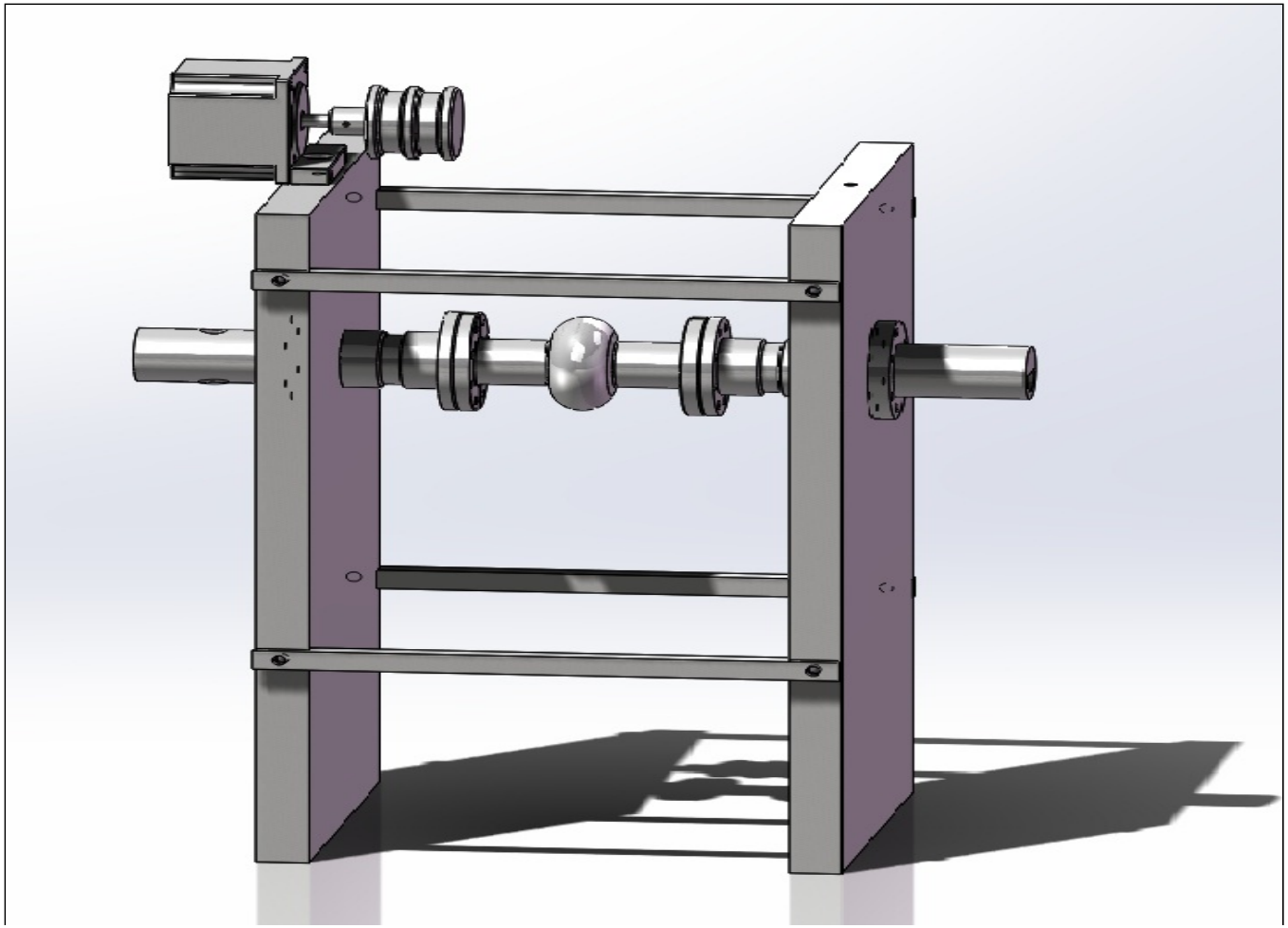
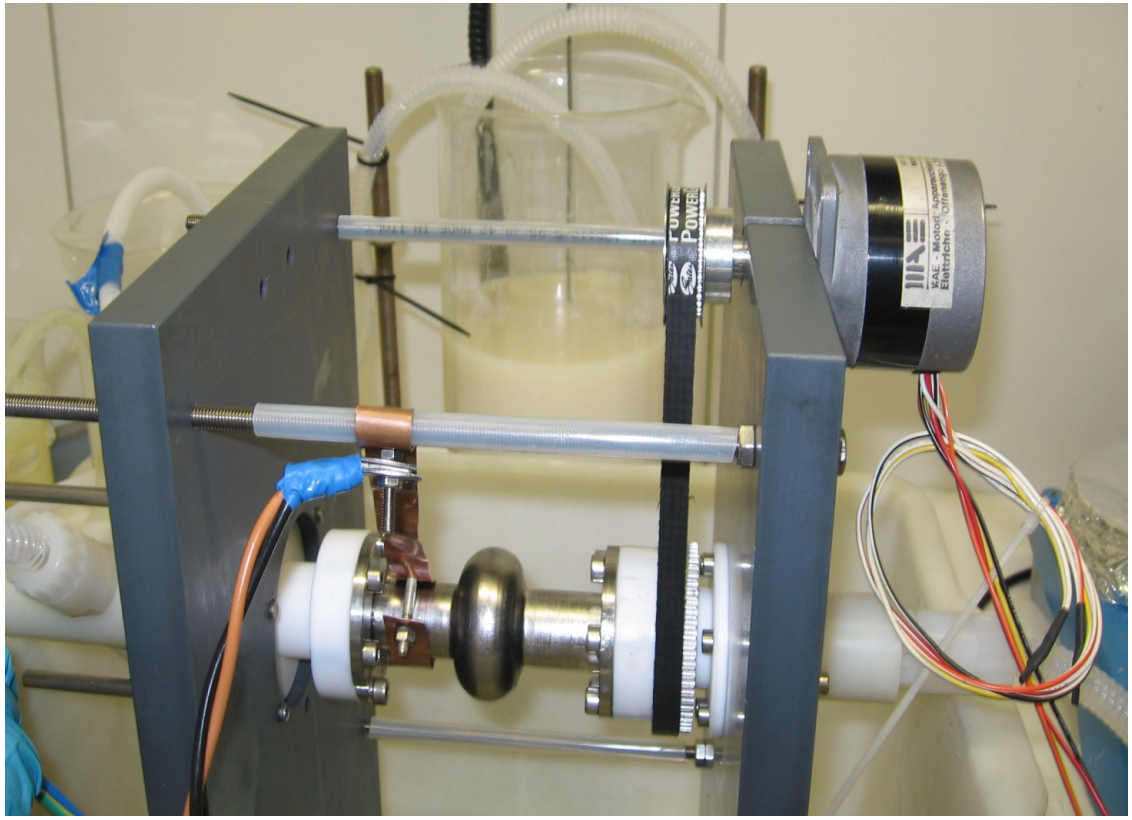
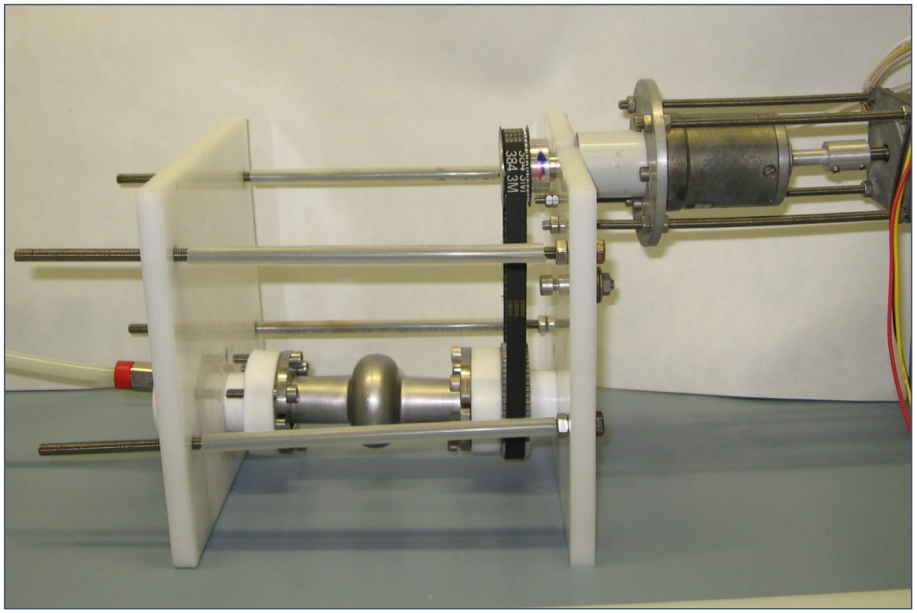
New system for electropolishing 6GHz cavity



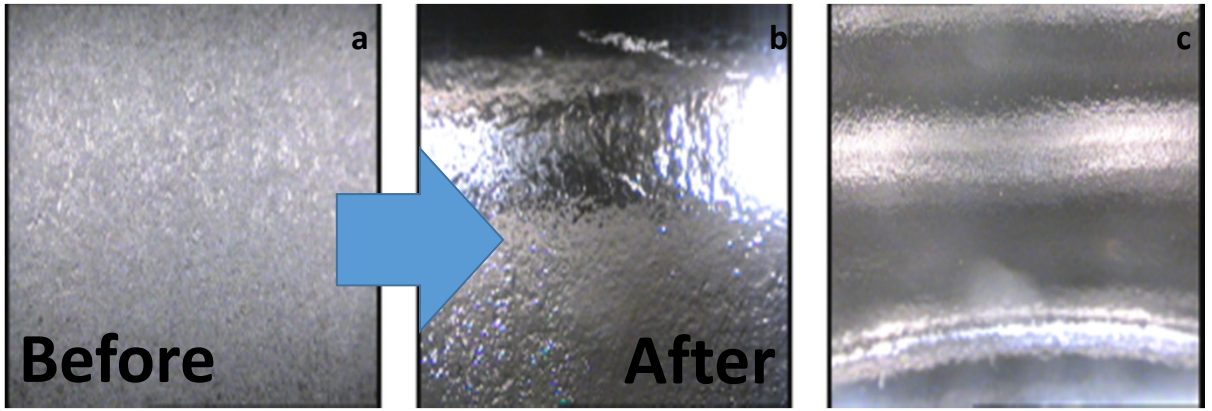
Testing the new system





Modified system

Result



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…

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Thank you for attention!