



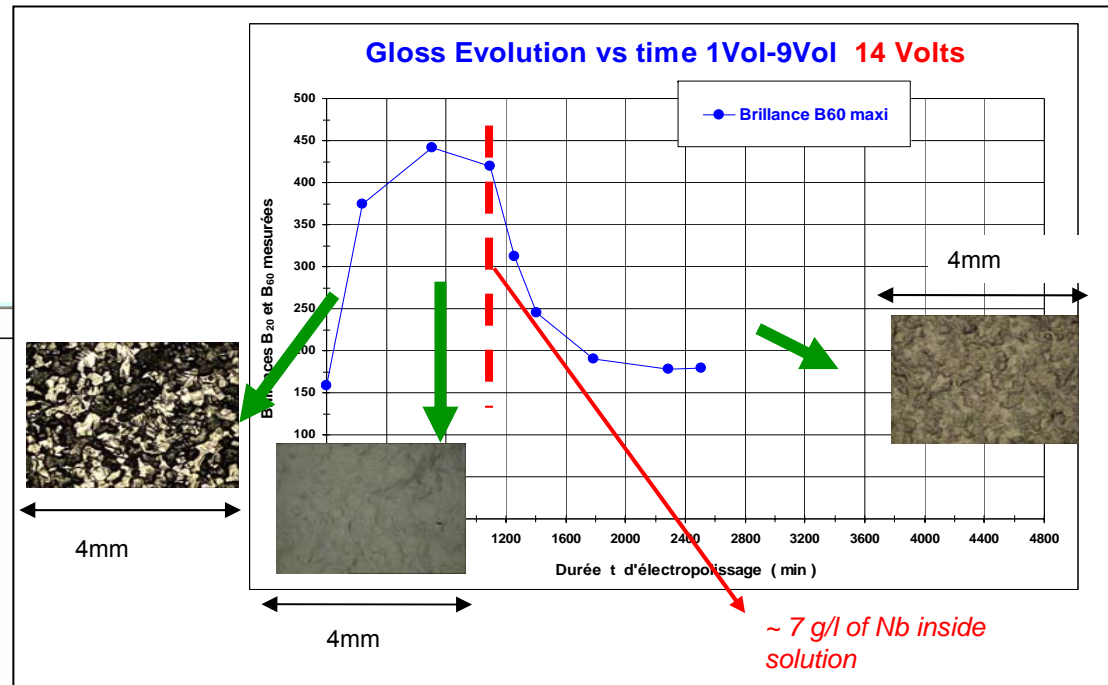
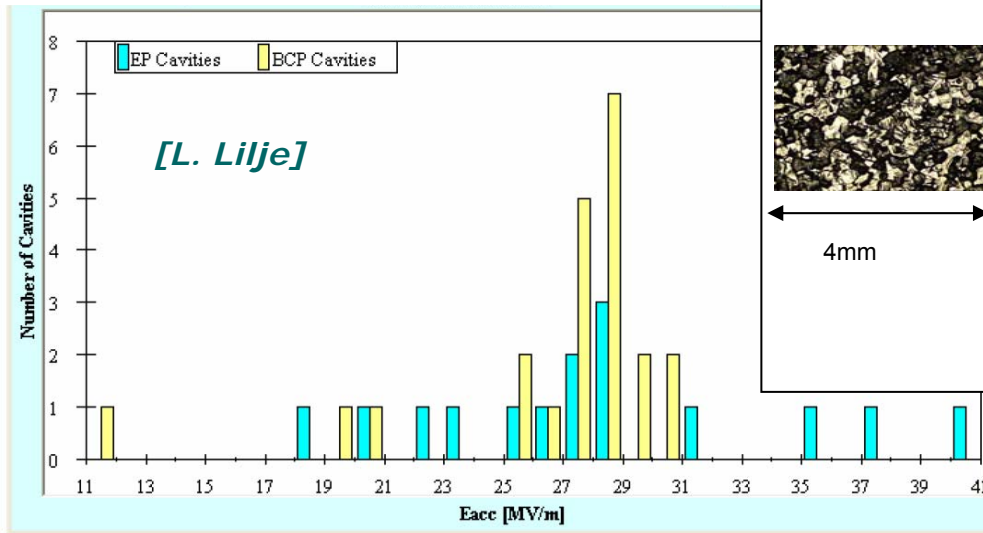
# From R&D to industrial set-up

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- R&D issues
  - Process R&D
    - Mechanism issues
    - Contamination issues
    - Modeling
  - Monocell Set-up
  - Tumbling
- Specifications
- 9 Cell EP R&D facility @ ANL

# EP R&D

- EP gives very high  $E_{acc}$  but large spreading of results
- EP recipe very effective for short etching/ samples
- Contamination issues (S)
- Lifetime issues



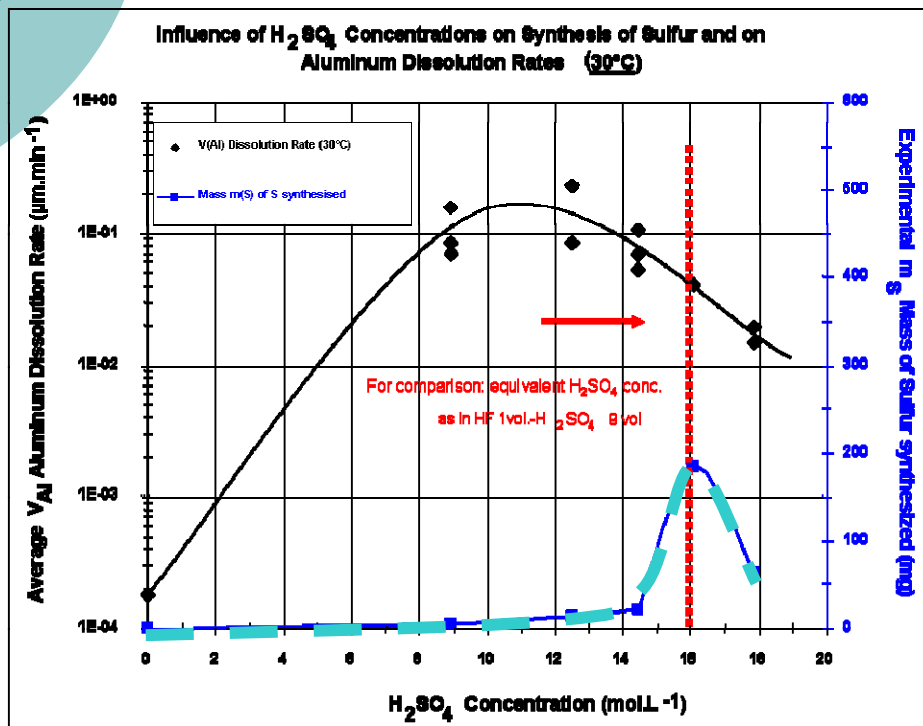
# Mechanism issues

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- => find out the Fluorine role
  - Is it the limiting species ? (porous film => no !)
  - Does it improve Nb<sup>5+</sup> solubility ?
- => find out a way to maintain fluorine content
  - NaF, low temperature...
- => find out a way to monitor F<sup>-</sup>
  - Chromatography (*diluted samples, all ions*)
  - NMR (*samples, no dilution, only F<sup>-</sup> or H<sup>+</sup>*)
  - Abs Spectroscopy UV/Vis (*effective on HF + H<sub>2</sub>SO<sub>4</sub>, but bubbles issues*)
  - Resistivity measurement (*expensive, but effective on HF + H<sub>2</sub>SO<sub>4</sub>, bubbles issues*)
  - ISE (*very inexpensive !, dilution or works only with free F<sup>-</sup>*)
  - ...?

# Sulfur issues

*S forms at low [F-] and high [H<sub>2</sub>SO<sub>4</sub>]  
S is not soluble in H<sub>2</sub>O*

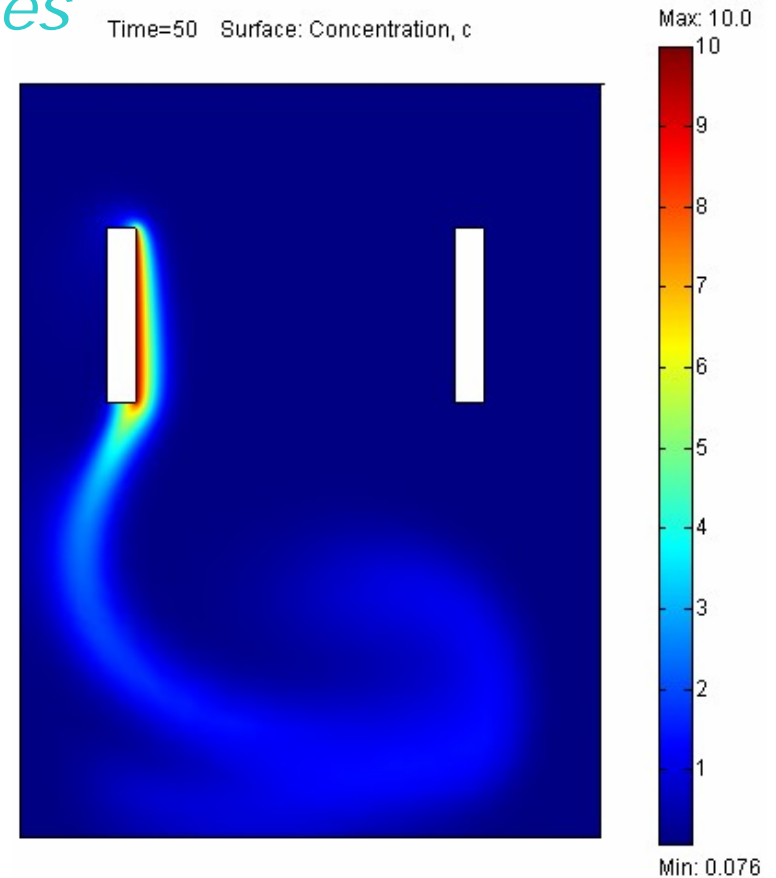


- => Improve rinsing !
  - Ethanol, organic solvents
  - Surfactant solution + US
- Keep [F<sup>-</sup>] high
- Lower [H<sub>2</sub>SO<sub>4</sub>]
  - viscosity/ acidity issues
- Other viscous buffer...

# Modeling issues

*Viscous layer is mandatory for uniform etching inside cavities*

- => find out what conditions favor viscous layer
- => find out what disturbs viscous layer
- => play with parameters like viscosity, composition, EXm reactions
- => getting into more complex situation : geometry, motion, hydrodynamics
- In the end : correlate with experimental facts



[F. Eozenou]

*=> Intuitions !*



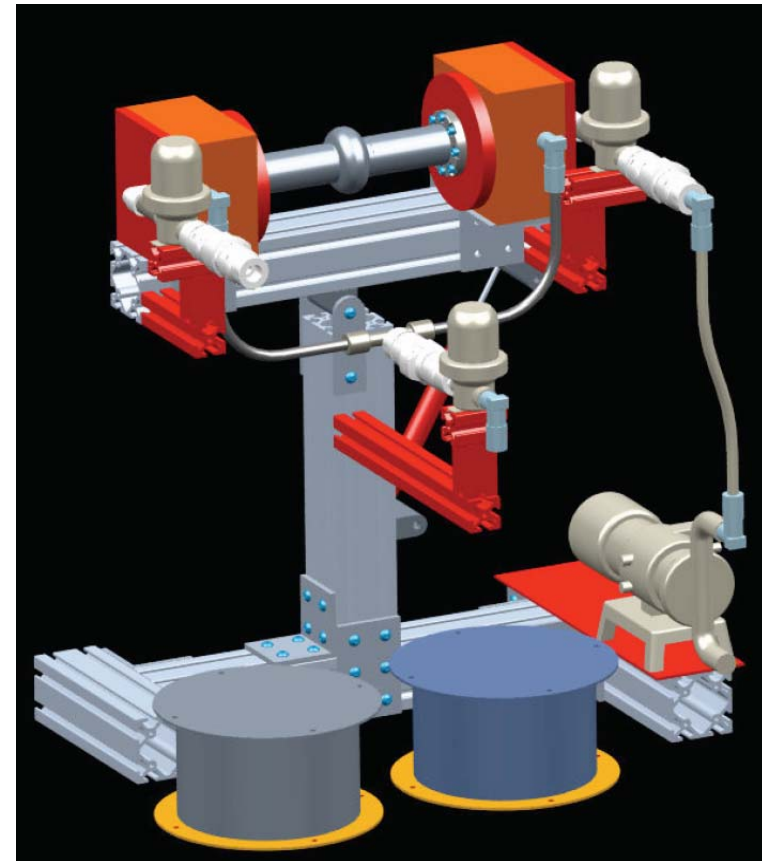
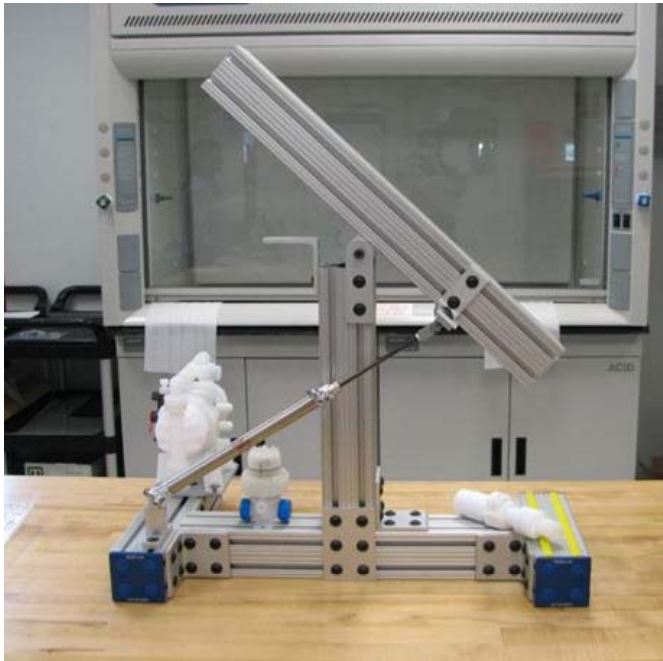
# What can be done quickly on samples

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- Correlate degradation and actual  $[F^-]$  ?
- Variation of  $[Nb^{5+}]/[F^-]$  in EP soln => mechanism limitation
- Add  $F^-$  Salt (NaF)
  - viscosity/plateau
  - lifetime
- Other viscous buffer
- $\neq$  temperatures
- R&D on samples is necessary:
  - low cost.
  - saves a lot of time and money

# EP R&D: monocell facility

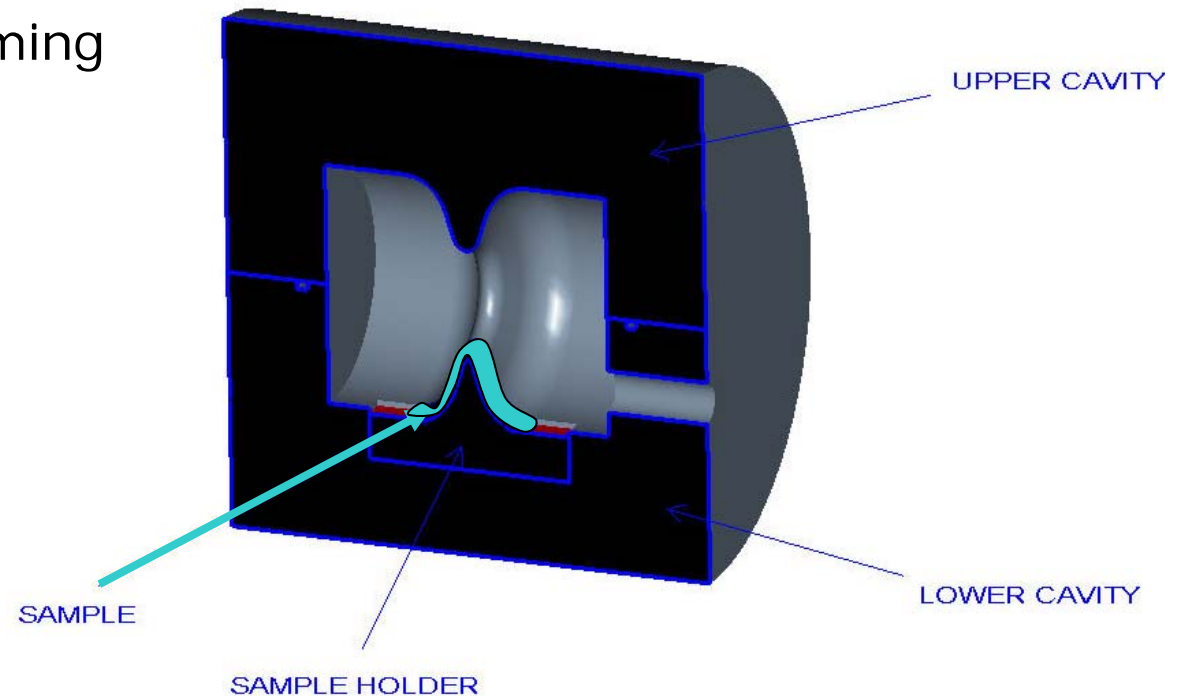
- Small scale cavity set-up (3.9 GHz)
- R&D program with small vol. of acids
  - Intermediate between samples & 9-cells
  - Low cost + Safety
  - High turnover



# Tumbling

C. Cooper, K. Ewald

- Mechanical "pre"-polishing => saves EP etching
- Inexpensive, ± automated
- Issues
  - Iris/equator etching rate
  - H free process
  - Time consuming





# EP Facility : specifications

- Common work (ANL, FNAL, LANL, Cornell...): *M. Kelly, C. Boffo, T. Tajima, P. Bauer, K. Shepard, C. Cooper, H. Padamsee, H. Carter*
- Based on input from SMTF-TTC meetings
- Should evolve with R&D results
- Should be a basis for industrial engineering studies (end of 06/beg.07)
- Companies are now being contacted

Parameter	Unit	Range
Voltage	V	0-20
Current density	mA/cm <sup>2</sup>	30-150
Temperature	° C	25-35
Temperature stability	° C	+/- 1
Acid flow	l /min	0-25
Cavity rotation	Rpm	0 <sup>+</sup> -5
Nb content	g/l	< 10 (<6)
HF content	%	> ? (>1 Mol/l ?)
N <sub>2</sub> flow	scfm l/min	1-3 10-30