

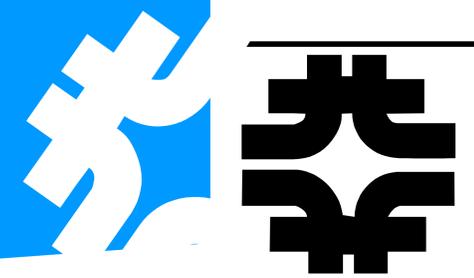


SRF Materials Lab

EP on Small Samples at Fermilab

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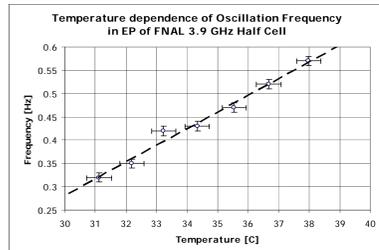
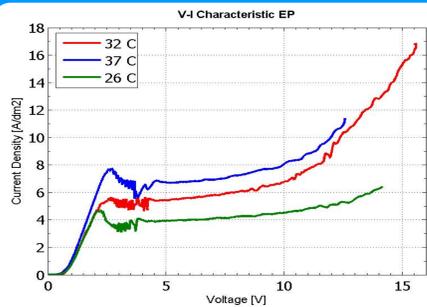
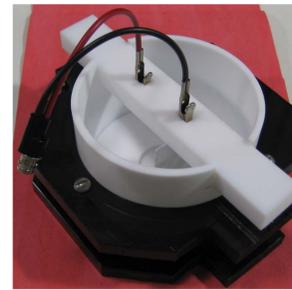
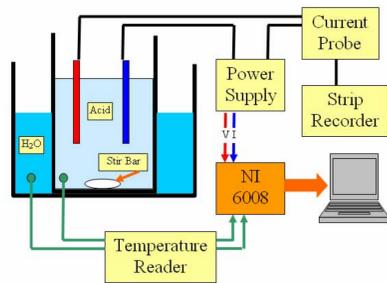
R. Geng, Cornell University, Ithaca, NY, U.S.A.



Small Samples

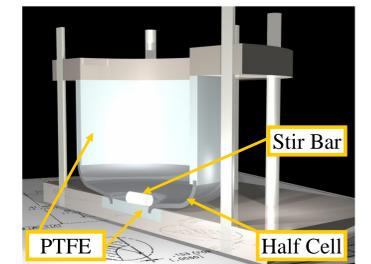
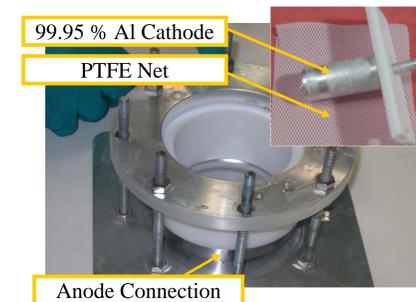
Being the electropolishing process (EP) worldwide considered an essential step in the processing of high gradient SRF cavities, studies on EP of small samples has been started at Fermilab as part of the SRF materials R&D program.

A simple bench top setup has been developed to understand the basic variables affecting the EP. In addition a setup for vertical EP of half cells, based on the Cornell design, has been used and one for dumbbells has been designed and tested. Results and findings are reported.



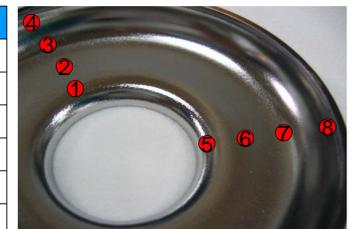
The EP setup for small samples is very simple and allows to have a good control on all fundamental parameters. Voltage drop, current, temperature of acid and temperature of water are monitored using in parallel: a strip chart analog recorder and a USB NI DAQ connected to a laptop. Data are acquired using a NI LabView custom application. The most complicated parameter to quantify is the acid agitation obtained with a magnetic stir bar. Current voltage characteristics as a function of temperature and characterization of the current oscillations have been studied.

Half Cells in Vertical Setup

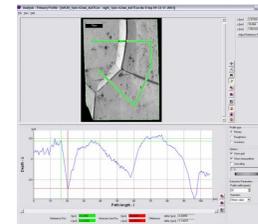
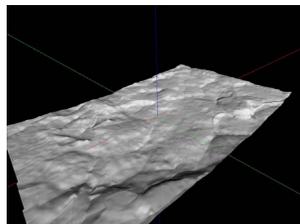


Setup and Model of Half cell vertical EP

Point	Initial [mm]	EP 1 [μm]	EP 2 [μm]
1	2.734	13	15
2	2.739	10	15
3	2.681	5	8
4	2.676	15	15
5	2.726	10	18
6	2.737	10	13
7	2.668	8	18
8	2.655	13	10



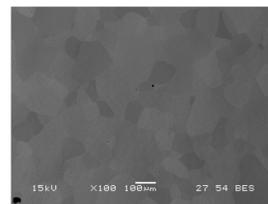
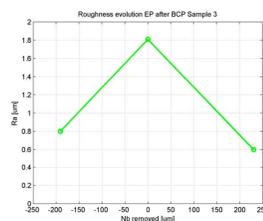
Software based 3D reconstruction and profilometry are used to quantitatively characterize the effect of BCP, EP, and Heat treatments on the surface topography of Nb. Two SEM images of the same area, obtained at different angles, are used for a 3D reconstruction. Profilometry performed on this reconstructed images may allow better resolution with respect to mechanical measurements but the technique needs to be carefully debugged first. Attempts of using a commercial software are presented



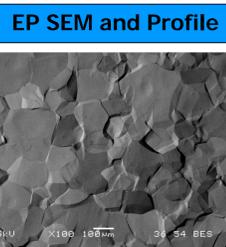
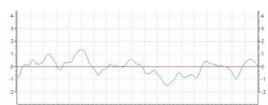
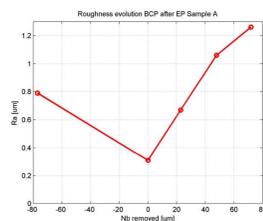
Nb Surface profiles using Alicona MEX

EP on 3.9 GHz half cells has been performed adopting the vertical setup developed at Cornell University. During EP the fixture is placed in a chemical hood inside a secondary container. The secondary container is filled with water and ice to control temperature. Both the temperature of acid and water are monitored. The agitation of the acid is performed via Teflon coated magnetic stir bar. The same DAQ as for small samples is used. The above table shows the localized material removal during EP in different positions of the half cell along two orthogonal radii. These measurements were performed using an ultrasonic thickness measurement instrument.

Sample #	Treatment	R_a (μm)	Etch (μm)
3	BCP	1.8134	191
	1st EP		146
	2nd EP		59
	3rd EP	0.60	26



Sample #	Treatment	R_a (μm)	Etch (μm)
A	RAW	0.79	-
	EP	0.31	77
	HT	0.31	-
	1st BCP	0.67	23
	2nd BCP	1.06	25
	3rd BCP	1.26	25



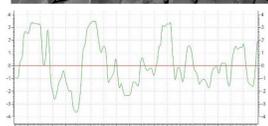
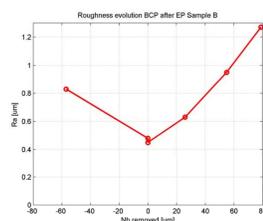
Systematic studies of the surface roughness of small samples has been performed.

A first set of samples have been BCP etched and later EP has been performed in successive steps

A second set of samples have been EP and later BCP etched in successive steps.

The average roughness have been measured using a Taylor Hobson Talysurf Intra device equipped with a 2 μm radius diamond chisel

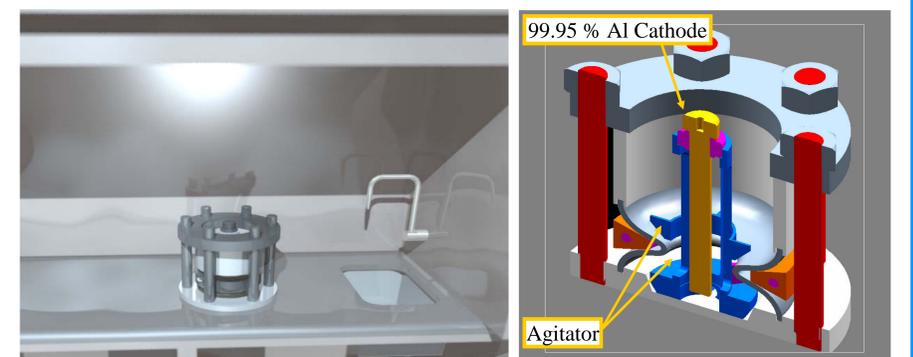
Sample #	Treatment	R_a (μm)	Etch (μm)
B	RAW	0.83	-
	EP	0.48	57
	HT	0.45	-
	1st BCP	0.63	26
	2nd BCP	0.95	29
	3rd BCP	1.27	24



BCP SEM and Profile

Next Steps

A fixture enabling to EP 3.9 GHz dumbbells in vertical position is being tested. The goal of this effort is to fabricate a 3 cells cavity using dumbbells and half cells electro polished before the final welding. Possible solutions for horizontal EP of full 1.3 GHz cavities are being investigated. Alternative acid mixes for EP and BCP will be investigated.



Models of Vertical EP on Dumbbells