STUDY OF BUFFERED ELECTROPOLISHING PARAMETERS ON NIOBIUM SHEET

Song Jin, Xiangyang Lu, Lin Lin, Kui Zhao
Institute of Heavy Ion Physics, Peking University, No.201 Chengfu Road, Beijing, 100871, China

INTRODUCTION

Surface condition plays a critical role on superconducting radio frequency (SRF) cavity performance. Since SRF cavity was born, researches on niobium surface treatment have not stopped to improve their performance. In recent years, with the buffered chemical polishing and then electropolishing gradually becoming chief means for SRF cavity treatment, the performances of multi-cell cavities have great improvement. Cavities could reach a reproducible accelerating field of about 30 MV/m. However, the accelerating field still cannot reach the request (35MV/m) of ILC. On the other hand, polishing rate of traditional EP was another problem. It was only about 0.38μm/min. With the long treatment period and very expensive equipment, the technology of EP made the cost of SRF cavities added greatly. Thus, a method for SRF cavity treatment called buffered electropolishing (BEP) was firstly proposed by Thomas Jefferson National Accelerator Facility (Jefferson Lab).

As part of cooperation with Jefferson Lab and the study on the fabrication of multi-cell niobium cavity, the research on BEP was also carried on at Peking University. The electrolyte of BEP was consisted of hydrofluoric, sulphuric and lactic acids. Niobium samples were used in the first stage of study. The goal was to evaluate the influence of parameters to this process, as well as the technological problems involved in it. In this paper, effects of parameters on I-V characteristic, polishing rate and smoothness of surface were described. With optimization, the maximum of polishing rate 4.66μm/min and repetitive 2.5μm/min was got in our experiment. Meanwile, with over a 200×200μm area measurement by high resolution 3D profilometer at Jefferson Lab, the surface RMS roughness of BEP treated samples could repetitively reach around 50 nanometres. All of above shows this new technology had a great potential to become a new niobium treatment technology.

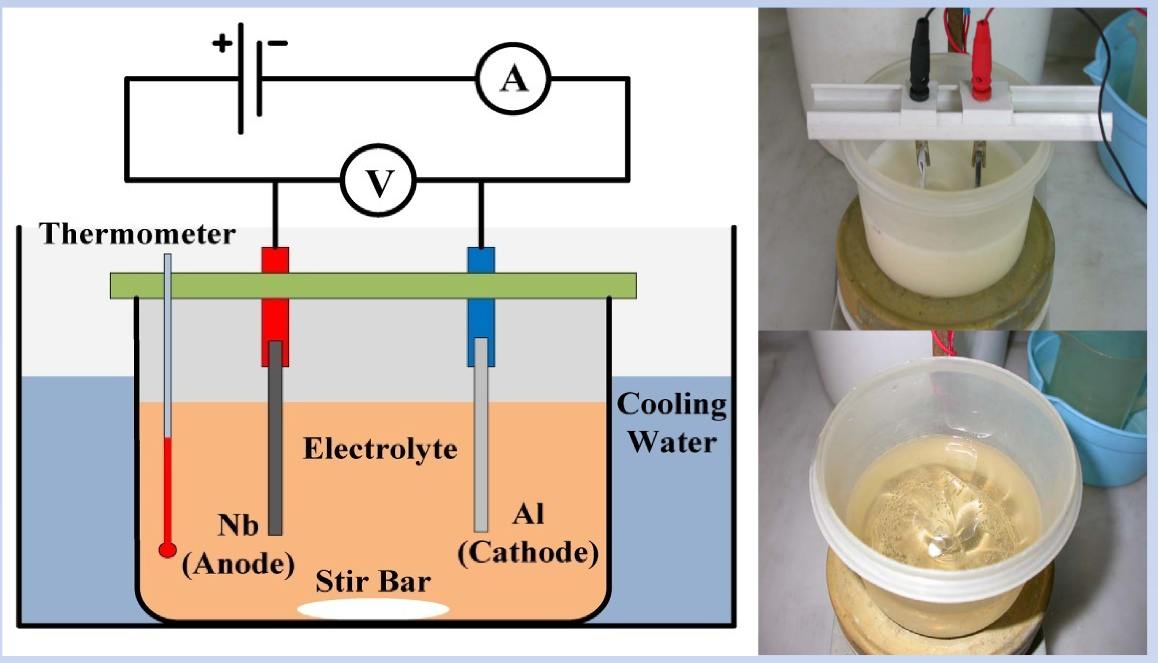

Fig.1 Schematic installation of BEP for niobium samples and the BEP electrolyte

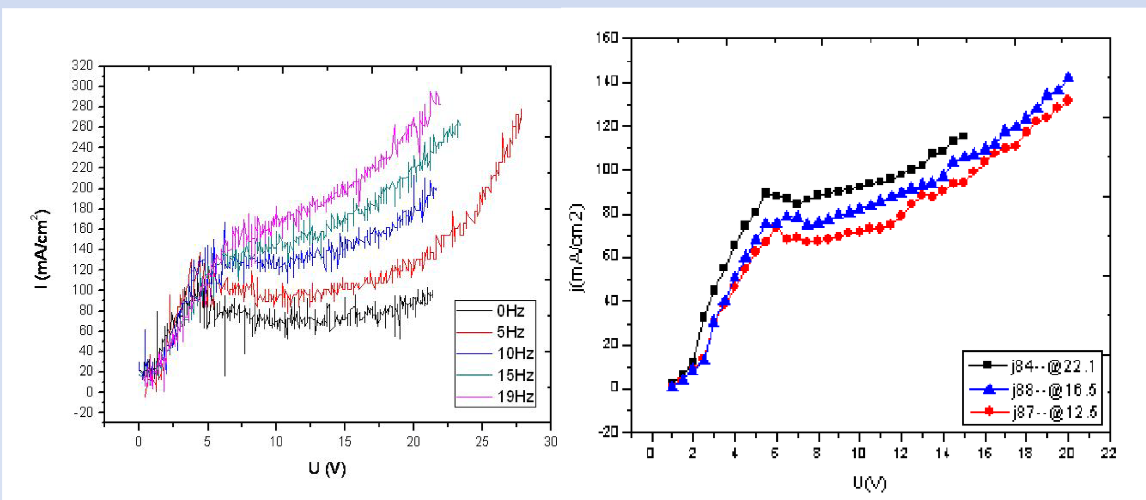

Fig. 2 I-V characteristic of BEP for niobium samples.
Left: Development of I-V curve with different rotational speed of the stirring bar
Right: Development of I-V curve with different temperature

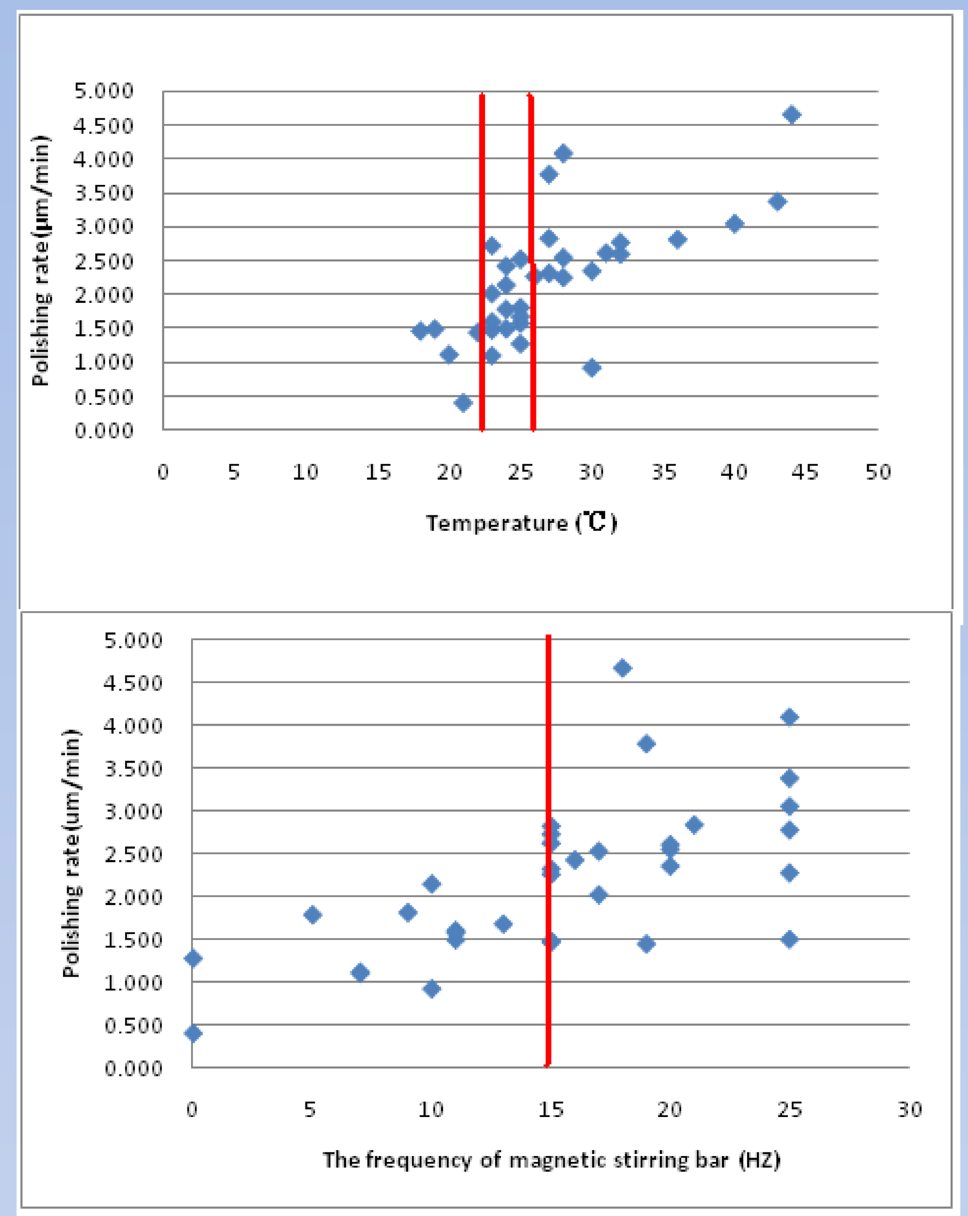

Fig.3 The effects of parameters on polishing rate

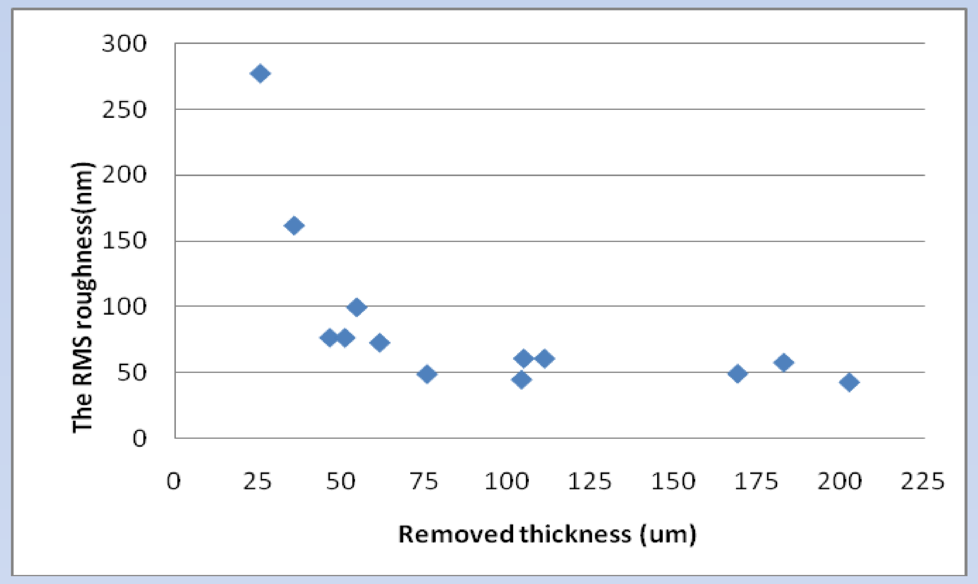

Fig.4 The effects of parameters on surface RMS roughness

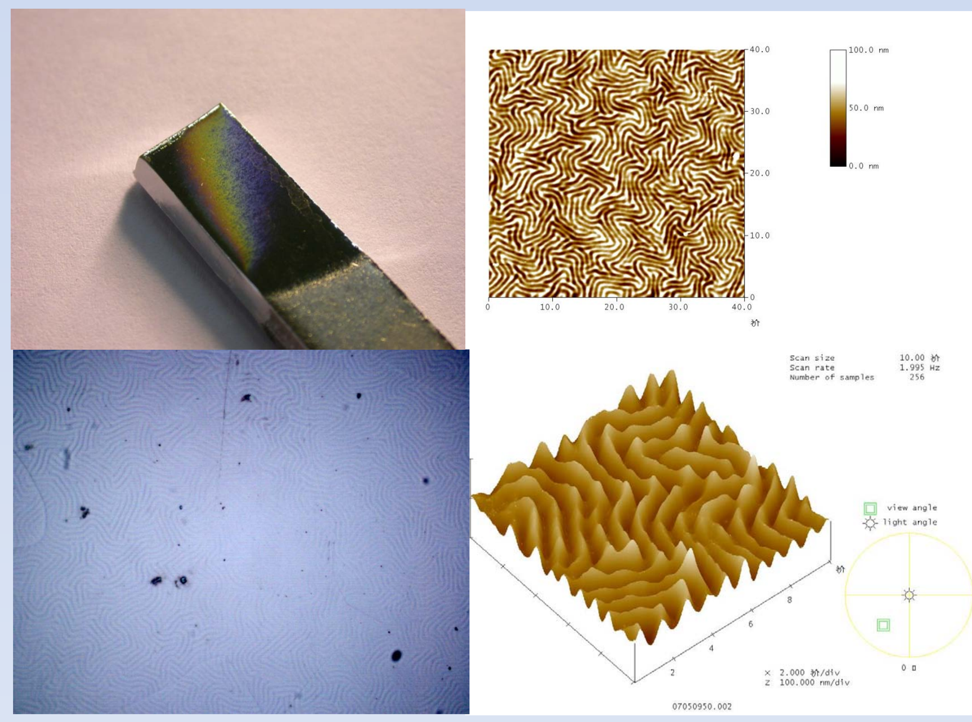

Fig.5 The phenomenon of “rainbow” in high stirring rate of electrolyte

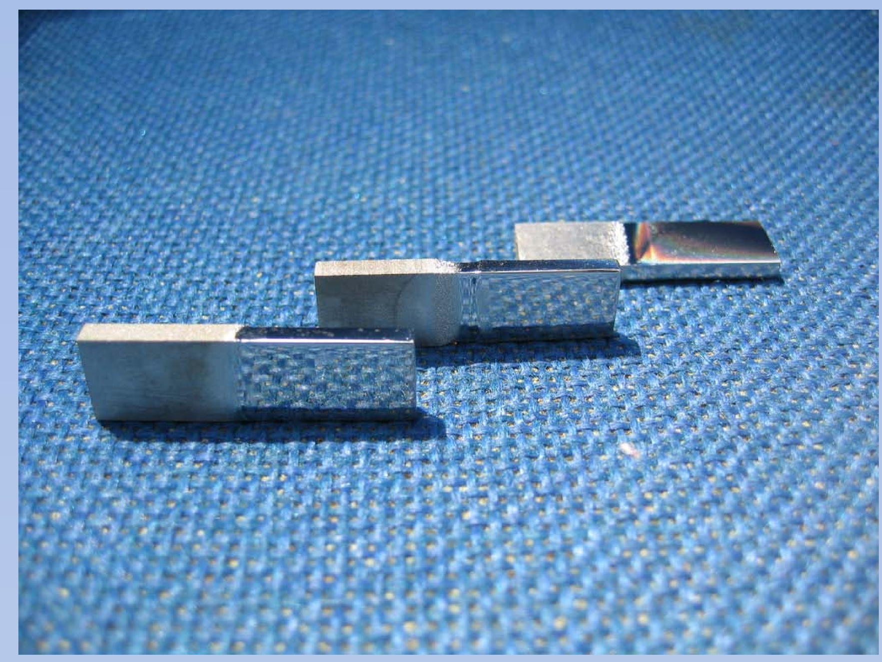

Fig.6 The picture of BEP treated samples

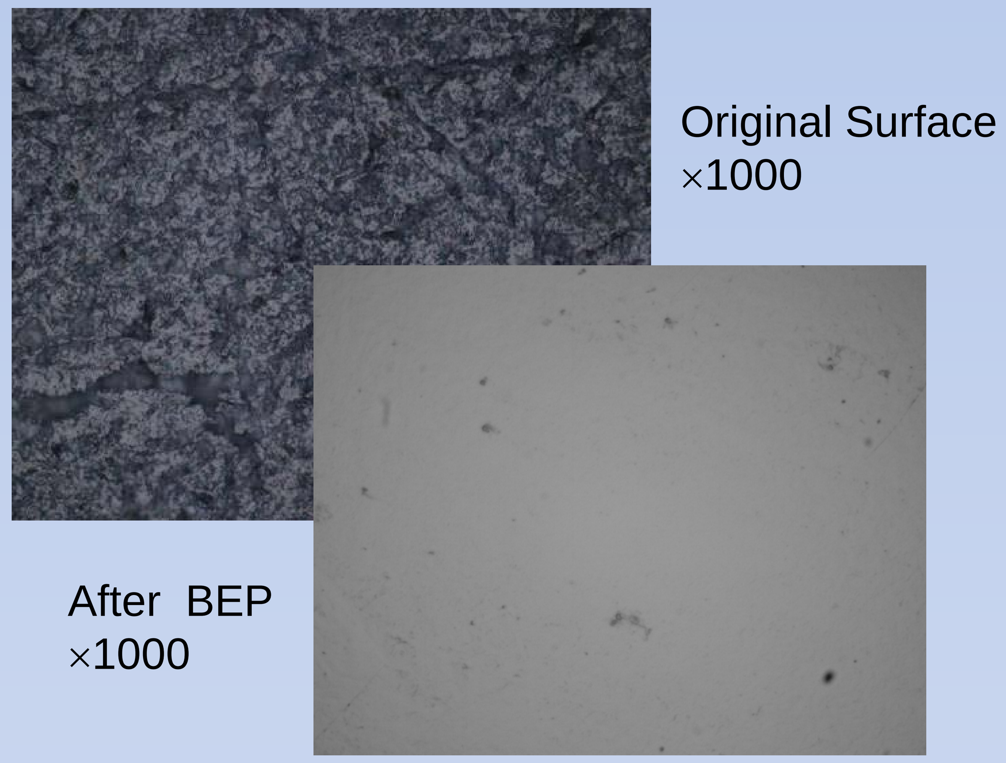

Fig.7 The picture of niobium sample before and after BEP by MOM

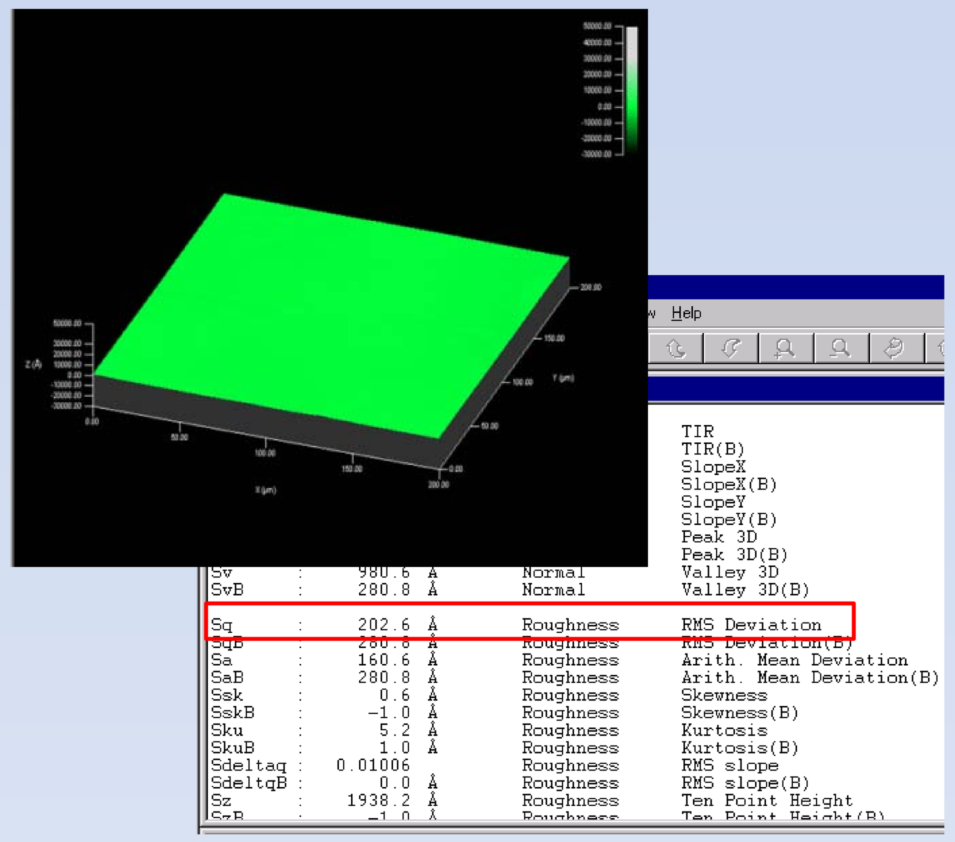

Fig.8 The picture scanned by high resolution 3D profilometer on the BEP treated sample over a 200×200μm area at Jefferson Lab.
RMS roughness was about 21nm

Fig.9 Picture of vertical EP set-up and the demountable cavity

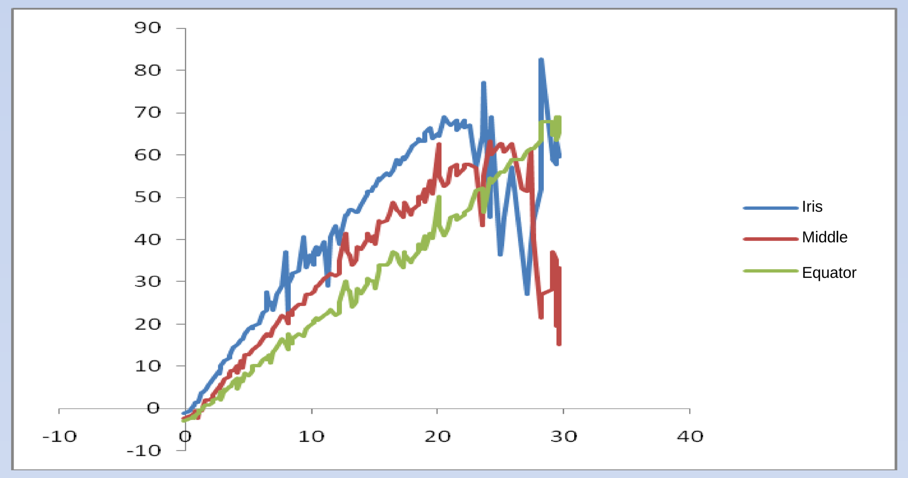

Fig.10 I-V curves of the three samples in demountable cavity

Fig.11 The picture of demountable cavity after BEP

E-mail : jsong@pku.edu.cn

ACKNOWLEDGEMENT: We would like to acknowledge Dr. Andy. T. Wu from Jefferson Lab for measurement of sample roughness and the demountable cavity.