ISBN: 978-3-95450-191-5 doi:10.18429/JACoW-SRF2017-TUPB086

STUDY ON LOCAL CHEMICAL TREATMENT FOR RECOVERY FROM SURFACE OXIDATION BY HPR PROCESS ON SRF CAVITIES*

H. Guo†, P.R. Xiong, Z.X. Shi, Z.M. You, Y.K. Song, W.M. Yue, A.D. Wu, Y.M. Li, T. Tan, Y. He, S.H. Zhang, Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, China

Abstract

High pressure rinsing (HPR) with ultra-pure water (UPW) is the last step which is commonly used for SRF cavities cleaning. The serious surface damage will be caused due to the failure of the distance control between the nozzle and cavity surface or the breakdown of the wand rotation. The surface of taper HWR cavities which are used for CIADS project was damaged in HPR process. Two methods were used for surface recovery and the result will be presented in this paper.

INTRODUCTION

High pressure rinsing (HPR) is widely used as the final cleaning step in superconducting cavities post process. It could remove the residual acid and particles inside the cavity. An oxidation layer on niobium surface will be formed if the water jetted by high pressure impact on one spot and the distance between nozzle and niobium surface is very close [1]. A new HPR system is designed in IMP, which is used for HWR015 cavity cleaning. This kind of cavity is used for CIADS project [2]. Recently, the surface of HWR015 cavities was oxidized by this new HPR system. In this paper, we would show two methods which are used for surface recovery.

HPR SYSTEM

The new automated HPR system consisting of cavity fixture, a wand and nozzle has been designed and installed at IMP (see Fig. 1). It has 5 axles. The cavities can be moved and rotated, which make sure all ports of cavity can be cleaned without disassembly. The nozzle of HPR system have three fan jets, two side and one top (see Fig. 2).

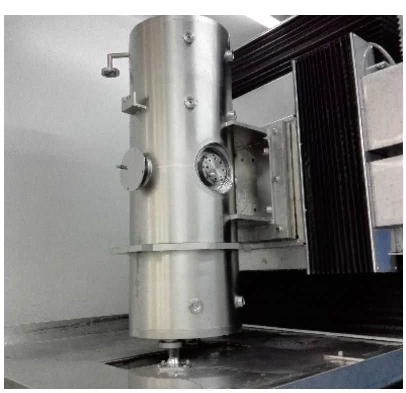

Figure 1: Automated HPR system.

* Work supported by the National Natural Science Foundation of China (91426303) and special fund on equipment from CAS.
† email address: guohao@impcas.ac.cn

Figure 2: The nozzle of HPR system.

SURFACE OXIDATION

During the HPR process of HWR015, the distance between nozzle and surface of inner conductor is too close (less than 50mm). The water sprayed from top jet impacted the surface for a long time. Then a bluish violet spot appeared on the centre of the surface (see Fig. 3). This spot is oxide layer caused by long time HPR, and it is certified by Tyagi and Sertore. [1,3,4] There were 4 cavities have oxide layer, and it is prepared for crymodule immediately. So a method should be found to solve this problem as soon as possible.

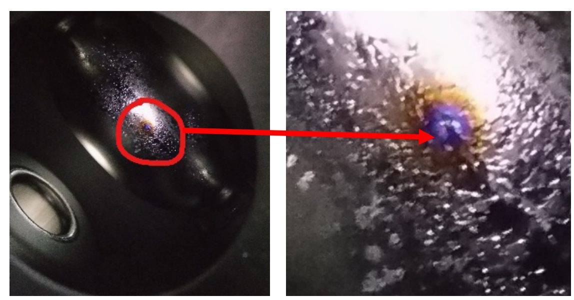

Figure 3: Bluish violet spot on the surface of inner conductor.

SURFACE RECOVRY

Local chemical treatment is the fastest method. It is use acid to etching the oxidized spot and remove the oxide layer. In order to test the result before and after local chemical treatment. Samples experiment have been done first.

Samples Experiment

At beginning, we prepared two samples of niobium which were impacted by HPR for 180 second. The surface of samples is oxidized obviously. (see Fig. 4 a and c). Two acids have been prepared for recovery experiments. The first acid is HF (40 wt%), the other one is BCP acid (HF: HNO_3 : H_3PO_4=1:1:2). The parameter of experiment see Table 1. After acid etching, the oxide layer disappeared obviously. Thus we can use these methods on cavities.

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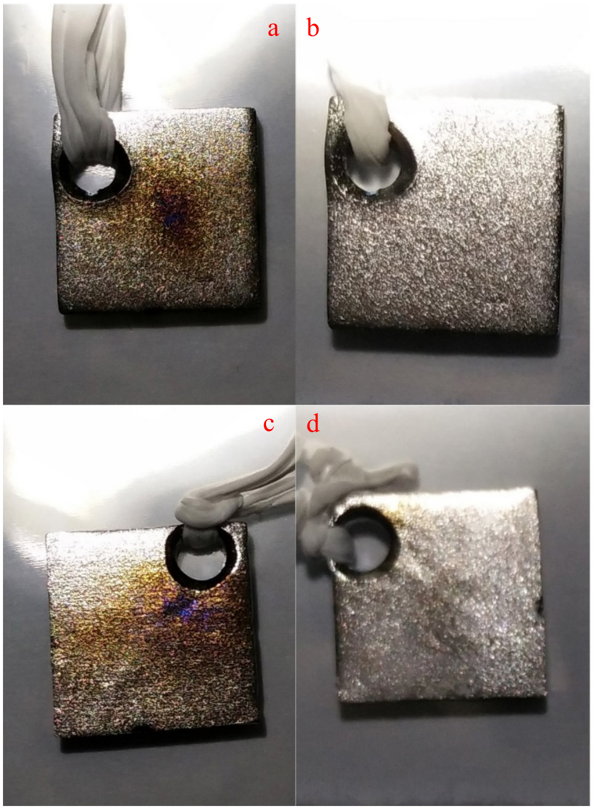

Figure 4: Two niobium samples oxidized by HPR and after chemical treatment (a and c are oxidized by HPR, b is etched by HF, d is etched by BCP acid).

Table 1: Parameter of Sample Experiments

Sample	a,b	c,d
HPR time	180s	180s
Acid	HF (40 wt%)	HF: HNO_3 : H_3PO_4=1:1:2
Etching time	60s	90s

Experimental Preparation

In order to protect the surface of cavity from scratching, a special tool has been made. As shown in Fig. 5, the tool is fixed by iron wire which is long enough to enter into cavity and touch the surface of inner conductor. There is PVC tube coverd the wire. At the top of the PVC tube, the non-woven fabric has been pressed into tube which is used for acid dipping.

Figure 5: Aspecial tool for surface recovery.

Surface Recovery

After the acid preparation and tool preparation, the surface of inner conductor has been recovered in cleanroom. As shown in Fig. 6. A is the picture before etching, b is the picture after BCP acid etching. Compared with a and b shown the oxide layer is removed, but the acid left an etching mark (a cycle around the etching area.). c is the picture before etching, d is the picture after HF etching. Compared with c and d, it can be shown the oxide layer is removed thoroughly. In addition, it has no marks left on the surface after etching.

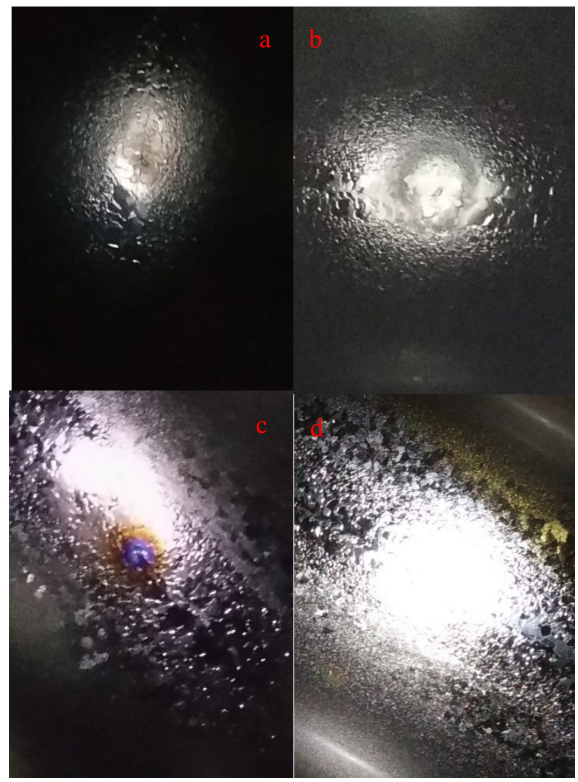

Figure 6: Surface recovery of the cavities inner conductor.

Table 2: Cavities with Surface Recovered

Cavity number	acid	Epk(MV/m)
CM3-1	none	28.45
CM3-2	BCP acid	18.28
CM3-3	HF (40 wt%)	19.67
CM3-4	HF (40 wt%)	24.24
CM3-5	none	35.4

DISCUSSIONS

We have three cavities failed in HPR process and they all did surface recovery process (shown in Table 2). These cavities have been assembled into the first crymodule of HWR015 cavity in IMP, and operated online. During the condition time, these cavities still have MP and FE. It is hard to say whether it is caused by HPR oxidization. Because these cavities also have a vacuum leak, venting,

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disassembly and reassembly process, which could also cause contamination.

CONCLUSION

According to photos shown, the HF is the best choice to remove oxide layer, and the BCP acid would leave an etching mark on the surface. The cavity recovered by BCP acid has a bed performance compared with cavities recovered by HF. In the further the amount of oxide should be test, and the performance drop off by surface oxide layer of cavities should be verified during vertical test.

ACKNOWLEDGEMENT

The authors express their special thanks to Dr. R.L. Geng and Dr. R.A. Rimmer for their suggestions about the method of cavities recovery.

REFERENCES

[1] E. Cavaliere, *et al.*, “High pressure rinsing parameters measurements” in *Proc. SRF’05*, New York, USA, July 2005, paper THP10, pp. 475-477.

[2] Y. He, *et al.*, “SRF Cavities for ADS project in China”, in Proc. SRF’13, Paris, France, Sep. 2013, paper THIOD01, pp. 868-872.

[3] P.V. Tyagi, *et al.*, “Study of HPR created oxide layer at Nb surface”, in *Proc. LINAC’12*, Tel-Avlv, Israel, Sep. 2012, paper MOPB069, pp. 336-338.

[4] D. Sertore, *et al.*, “High pressure rinsing water jet characterization”, in *Proc. EPAC’06*, Edinburgh, Scotland, 2006, paper MOPCH169, pp. 460-462.