PREPARATIONS AND VT RESULTS OF ERL7-CELL AT CORNELL

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Abstract

We have fabricated ERL 7-cell cavities in–house for Cornell ERL project. So far four un-stiffened 7-cells were fabricated and finished vertical tests (VT). One stiffened 7-cell was just finished fabrication; two other stiffened cavities are under fabrication. Surface preparations are based on BCP. Specification values of our 7-cell is 16.2MV/m with Qo of 2.0e10 at 1.8K. In this paper, we will describe details of surface preparations and VT results.

INTRODUCTION

R&D programs on Cornell ERL project have been continued. ERL7-1, the 1st ERL 7-cell cavity, had already finished vertical test, and then installed to one cavity horizontal test cryomodule (HTC). Details of HTC tests are described in reference [1]. Next six ERL 7-cell cavities, ERL7-2 to 7-7, will be installed to a full mail linac cryomodule which is also currently under fabrication. We have finished fabrication and vertical test of ERL 7-2 to 7-4, results will be described in this paper. ERL7-1 to 7-4 are unstiffened 7-cell cavities. ERL 7-5 to 7-7 have stiffener rings. The 1st stiffened 7-cell, ERL7-5, has been completed and under surface preparations. Figure 1 shows unstiffened and stiffened 7-cell cavities.

CAVITY DIMENSIONS AS FABRICATED

Prior to surface processes, we measured cavity dimensions, frequency, and flatness as fabricated. Results are summarized in Table 1. Frequencies are lower than design and cavity lengths are longer than design values. We had found some RF measurement errors on dumbbells during fabrication. We have fixed the issues, so next three stiffened 7-cell cavities could have more correct frequency and length against design values. More details of cavity fabrications are described in reference [2]. We have inspected cavity inner surface with optical inspection system as fabricated and post bulk BCP, no special features or defects are found on electron beam welding seams.

Table1: Frequency and dimension meas. as fabricated

Cavity	Frequency	Flatness	Cavity length
Design	1298.985 [MHz]	[%]	1160.00 [mm]
ERL7-1	1298.623	88	No data
ERL7-2	1298.521	93	1161.54
ERL7-3	1298.460	91	1161.54
ERL7-4	1298.499	91	1160.67

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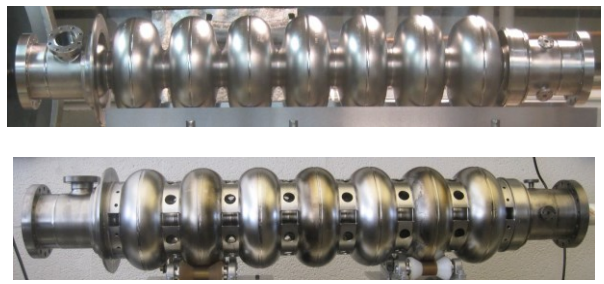

Figure 1: un-stiffened (top) and stiffened (bottom) Cornell ERL 7-cell cavity

SURFACE PREPARATIONS

Buffered Chemical Polishing

Table 2 shows our surface preparations for ERL 7-cell cavities. We have decided to use buffered chemical polishing (BCP) as baseline chemistry to make surface preparations as possible as simple. We did test BCP with the target removal of 80 microns. After etching, removal was measured by ultrasonic thickness gauge. The average of actual removal from top cell to bottom cell was 80±10 microns, figure 2 shows the results. We also measured frequency shift by BCP removal, it was very consistent with simulation values of 10.4 kHz/micron. We confirmed that BCP removal is uniform.

Degassing and Bake in Vacuum Furnace

Large vacuum furnace was installed to Cornell's SRF facility. Hydrogen degasing and low temperature baking are processed in this furnace. The 1st 7-cell cavity, ERL7-1, was degassed at Jlab before installing furnace to Cornell. We have done systematic study to decide degassing parameters [3]. Low temperature baking at 120

Table2: surface preparations of Cornell ERL 7-cell

Process	Parameters
Bulk BCP	140 micron, followed by USC and HPR.
Degassing	650degC, 4days.
Tuning	Frequency and flatness tuning.
Light BCP	10micron, followed by USC and HPR.
Baking	120degC, 48hrs.
HF rinse	10min., followed by USC and HPR.
VT	Meas. at 2K, 1.8K, and 1.6K, w/ T-map.

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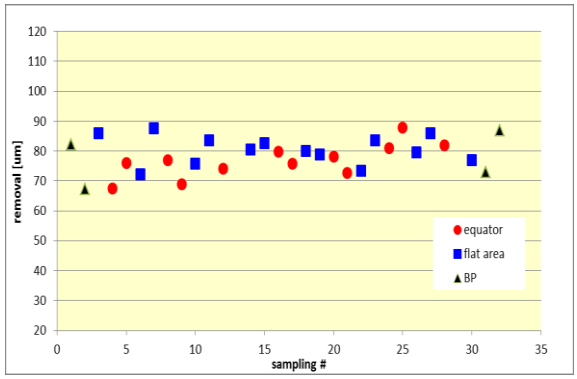

Figure 2: BCP removal.

degC in furnace helps to bake cavity uniformly, and make it easy to do HF rinse after baking.

HF Rinse

We apply HF rinse as final chemistry after low temperature bake with expecting of Qo improvement [4]. Our single cell R&D on HF rinse shows some cavity's Qo was improved, but we need more R&D and statistics.

VERTICAL TEST RESULTS

After surface preparations and final assembly, cavity was pumped down slowly with mass flow control system, confirmed leak tightness, and then installed to vertical test insert. Cavity was measured at 2K, 1.8K, and 1.6K with multi-cell T-map system to monitor temperature rising during RF tests [5]. Figure 3 shows images of 3D dimension check, tuning table, optical inspection system, BCP stand, RF surface after BCP, vacuum furnace, T-map boards, test pit, and 7-cell on vertical test insert with T-map system. Figure 4, 5, 6, and 7 show VT results of each 7-cell, in those figures, blue (■), red (●), and light blue (♦) dots show results at 2 K, 1.8 K, and 1.6 K respectively.

ERL7-1

Figure 4 shows VT results of ERL7-1. Cavity achieved maximum gradient of 25 MV/m at 1.8 K; Qo at highest gradient was 1.35e10. Gradient was limited by quench, but no detectable radiation. ERL7-1 had some different in surface preparations with other three 7-cell cavities. Degassing was done at Jlab with parameter of 650 degC x 10 hrs. NO HF rinse before vertical test. ERL7-1 had been installed horizontal test cryomodule (HTC) after vertical test [1].

ERL7-2

Figure 5 shows VT results of ERL7-2. Cavity achieved maximum gradient of 21 MV/m at 1.8 K; Qo at highest gradient was 1.47e10, administrative limit, no detectable radiation up to highest field. Cavity was kept 100 K over night after 1st VT and done 2nd VT, no hydrogen Q-disease was observed.

ERL7-3

Figure 6 shows 2nd VT results of ERL7-3. 1st VT was limited by strong field emission induced by quench. In order to cure field emission, we re-processed ERL7-3 again with light BCP (10 microns), 120 degC baking, and HF rinse. Field emission was successfully eliminated by additional processes, ERL7-3 achieved maximum gradient of 19.2 MV/m at 1.8 K; Qo at highest gradient was 2.59e10, administrative limit.

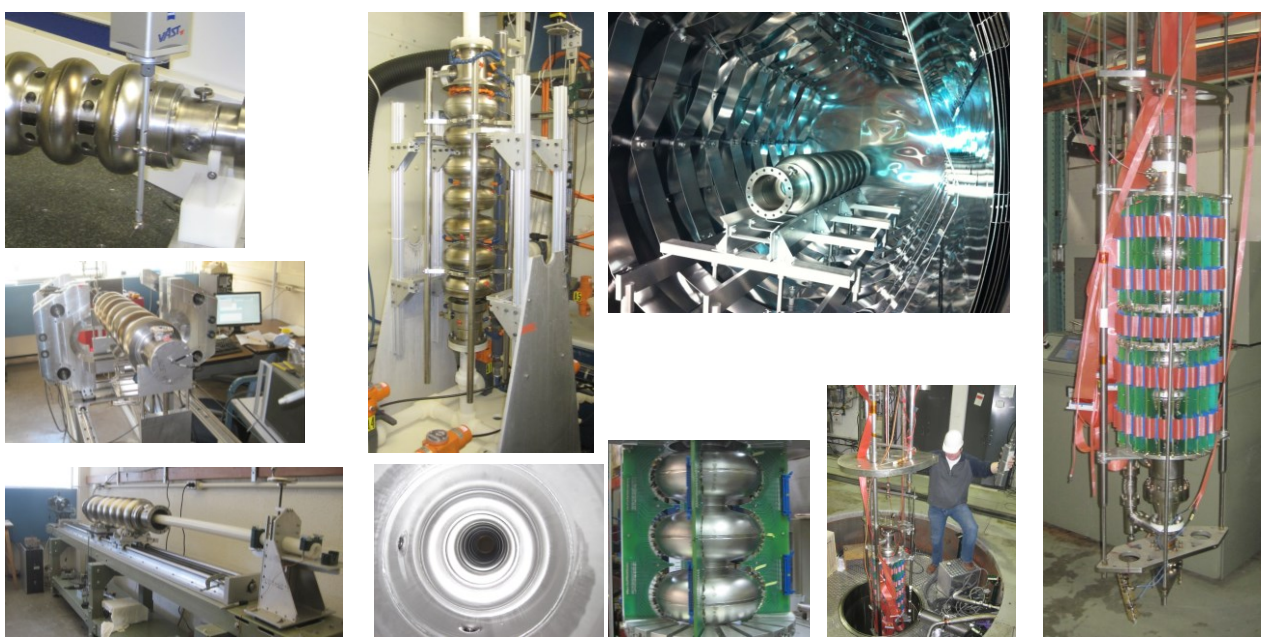
Figure 3: Images of surface preparations on Cornell ERL 7-cell cavity.

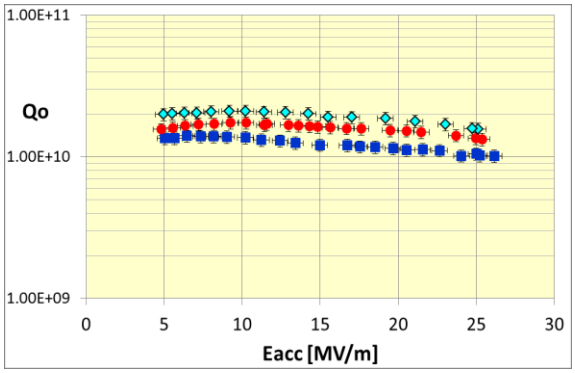

Figure 4: VT results of ERL7-1.

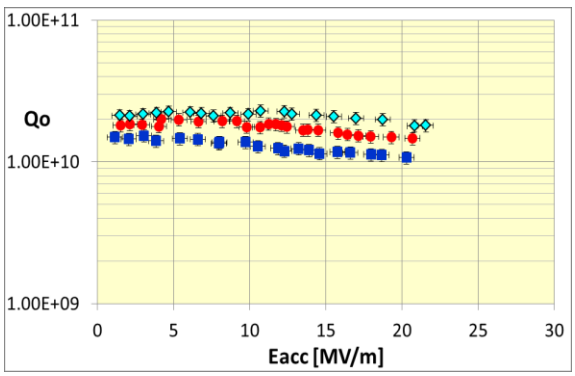

Figure 5: VT results of ERL7-2.

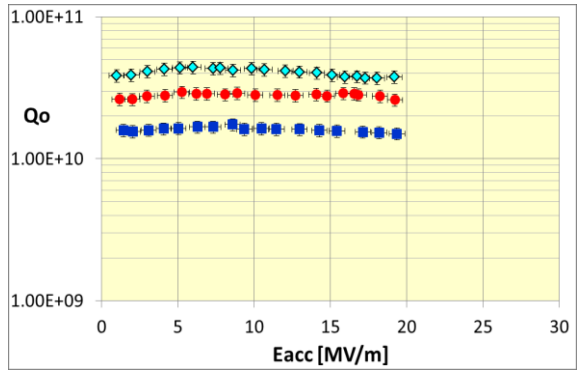

Figure 6: VT results of ERL7-3.

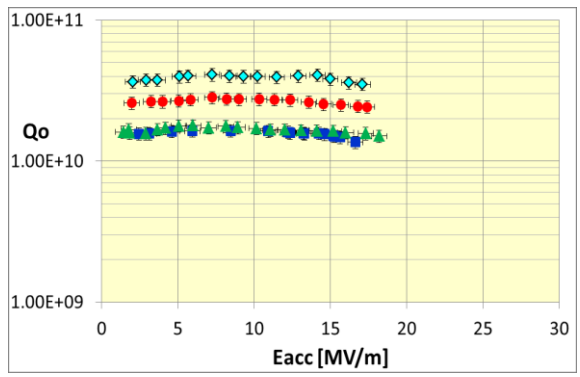

Figure 7: VT results of ERL7-4.

ERL7-4

Figure 7 shows VT results of ERL7-4. Green (▲) dots shows 1st power rise at 2K, and blue (■) dots shows 2nd power rise after quench at 18MV/m. Cavity achieved maximum gradient of 17.4 MV/m at 1.8 K; Qo at highest gradient was 2.43e10, administrative limit.

SUMMARY

ERL 7-cell cavities fabricated and processed at Cornell have successfully achieved required gradient of 16.2 MV/m. Figure 8 summarized 1.8 K measurements of ERL 7-cells. Qo of ERL7-1 and 7-2 are lower than other 7-cells, but ERL7-1 had achieved much higher Qo than specs in HTC after thermal cycles and additional chemistry included HF rinse. The reason ERL7-2 processed with HF rinse shows lower Qo is under investigation. We have also successfully demonstrated that BCP is capable of achieving our target specification values. The yield of four 7-cell cavities is high enough, only ERL7-3 needed 2nd process and test because of FE. HF rinse applied on ERL 7-2 and 3, after 120C bake seems to work well for Qo improvement. Next three stiffened 7-cell cavities will be processed by same procedures with unstiffened 7-cells. We will have more statistics on our 7-cell preparations and VTs. In addition, the results of ERL7-1 in HTC show the slow cool down with small temperature gradient of cavity could help to improve Qo. We will apply slow cool down procedure on VT of ERL 7-5 and other single cell cavities to demonstrate higher Qo in VT pit.

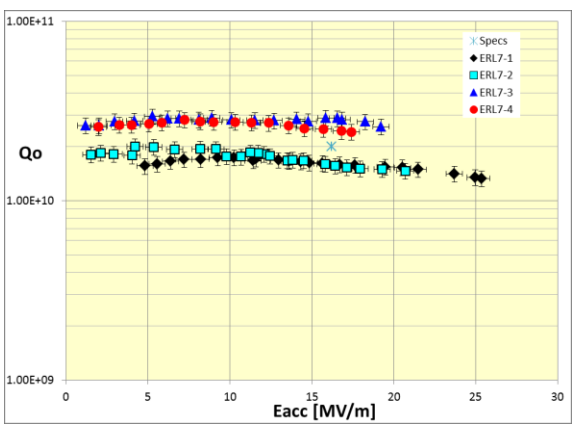

Figure 8: Summary of VT results at 1.8K.

REFERENCES

[1] N. Valles et al., in these proceedings, MOP071.
[2] R. Eichhorn et al., in these proceedings, THP007.
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