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Evaluation of L-band Superconducting Cavity fabricated from Heraeus Nb Plates

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Abstract

PJ (Pechiney Japon) and CERCA (Compagnie pour l'Etude et la Réalisation de Combustibles Atomiques) started a collaboration of R&D of superconducting linear accelerator with KEK (High Energy Accelerator Research Organization) since last April. For the 1st stage, 1) Nb single cell cavities, 2) a Nb 3 cell cavity, and 3) Nb film /Cu cavities were selected as our target as R&D issues. A 3cell cavity and a single cell cavity were fabricated from Heraeus Nb plates, and the tests results will be reported in this meeting.

1. Introduction

CERCA is a French fabricator of cavities and has supplied a lot of superconducting cavities for CERN, CEA, DESY etc. since many years [1-3], and PJ is the representative in Japan. Recently performances of sc cavities have been enormously improved in the world, but on the other hand, the needs for a higher gradient, a higher Q-value and a higher reliability are strongly requested from scientific and industrial fields. For this worldwide reason, we have improved our techniques and abilities by international collaborations. Following this kind collaborations, we started a collaboration with KEK since last April '98. Our target items for this collaboration are shown in Table 1.

Generally speaking, Nb material, production method and surface treatments are significant factors for an excellent cavity performance. In Europe, Heraeus Nb materials and CP (Chemical polishing) have been mainly applied. However KEK has used Tokyodenkai Nb materials and EP (Electropolishing). One of the purpose of this collaboration is to exchange scientific data on Nb material and surface treatments.

Before starting the collaboration program shown in Table 1, PJ participates in an R&D of a L band single cell cavity from Heraeus Nb plates as an educational program of KEK. The single cell

cavity was fabricated at KEK in house and the Nb plates used were supplied from W.C. Heraeus GmbH. Simultaneously, to advance the collaboration program, a 3 cell cavity, which had already produced at CERCA, was sent to KEK after a measurement of cavity performance in French side. These two cavities performances will be reported in this paper.

Table 1 Collaboration KEK and CERCA/PJ for L-band sc cavity

<u>Material</u>	<u>NB of cell</u>	<u>NB of cavity</u>
Nb bulk	1	2
Nb bulk	3	1
Nb film/Cu	1	2

2. A 3 cell cavity fabrication and its performance

1) Cavity production at CERCA

CERCA had fabricated a 3 cell cavity only for an internal R&D purpose at the beginning, i.e., a welding and other fabrication procedures are tested. For example, all parts were welded from out side as shown in the fabrication process (Fig.1). As CERCA had not aimed to see the cavity performance at the beginning, all parts of this cavity came from scrapped

materials during the production at CERCA of TTF(Tesla Test Facility) nine cells cavities for DESY, and which were out of the internal quality inspections at CERCA. The reasons of nonconformity were over cuts, under thickness, surface defects and so on. The Nb materials used were Heraus RRR350 in the specification. As the surface treatment, CP (140 μ m inside and 19 μ m outside) and HPR (High Pressure Rinsing) at 100bars were performed. The drawing of this cavity is shown in Fig. 2.

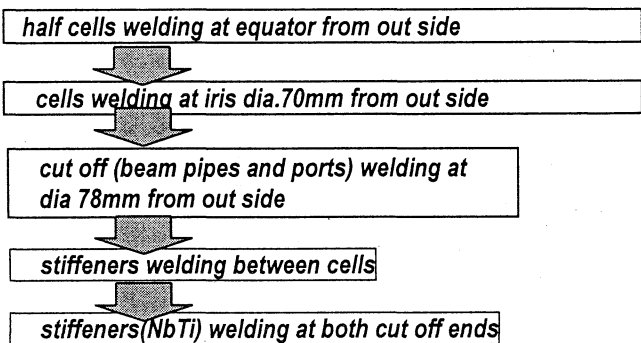


Fig. 1 EBW PROCEDURE FOR 3 CELL CAVITY

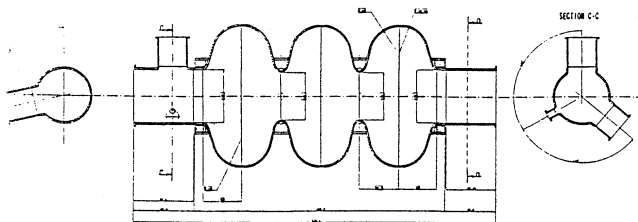


Fig. 2 3 CELL CAVITY DRAWING

2) Test result at French side

This 3 cell cavity was tested at CEA-Saclay SEA prior to sending it KEK. The vertical test result is shown in Fig. 3. Field emitted electrons were observed from 9MV/m and the field was limited at 15MV/m by the RF power limitation. At KEK the inner surface was inspected by an endoscope developed at KEK and some defects

like welding spatters were observed as in Fig. 4. One reason of the Q degradation with field gradient in the Q-Eacc curve probably comes from the defects. For the next step, we will try to remove them by BP (Barrel polishing) and EP, and will see the effect by measuring the cavity performance.

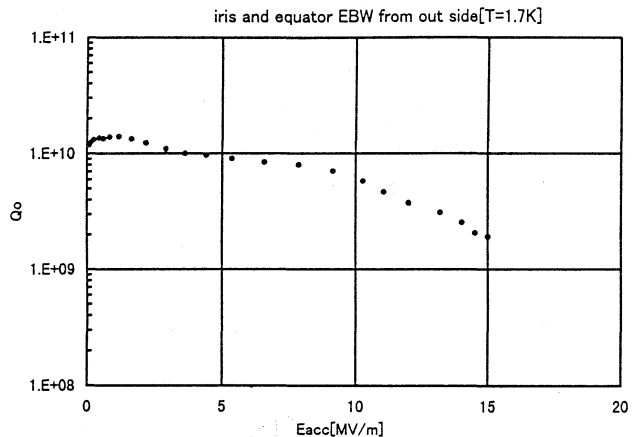


Fig. 3 3 CELL CAVITY TEST RESULT



Equator

Fig. 4 3 CELL CAVITY SURFACE ASPECT AT EQUATOR

3. A single cell cavity fabrication and its performance

KEK has reliably obtained E_{acc} more than 30MV/m by using Tokyodenkai Nb materials. KEK is now testing if Heraeus materials can show the same performance as Tokyodenkai's ones. We omit in this paper the explanation of fabrication process at KEK, because it has introduced many times in a lot of papers[4]. Heraeus Nb materials of RRR300 in the specification were used. The surface

treatments applied on this cavity were the standard BP and EP at KEK [5]. BP 30 μ m, flash CP about 10 μ m, an annealing at 760°C 5hours, EP 50 μ m and HPR were performed, and finished by an ultrapure water rinsing.

1) Single cell cavity performance

Fig. 5 shows the 1st vertical test result measured at KEK. In the 1st measurement (●), a processing level was observed at 19MV/m, which is the same performance in the Tokyodenkai material cavities. This level was easily processed out, then again the second measurement (○) was carried out from the low field. In the second measurement, no X ray was observed at every field. The field gradient reached up to Eacc 33.4MV/m and was limited by quench. This excellent cavity performance is the same as Tokyodenkai material cavities. It is not easy to obtain reliably 30MV/m from Heraeus material cavity in Europe, but many cavities at KEK has reached Eacc over than 30MV/m[5]. From the result of this Heraeus material single cell cavity in this paper, the difficulty in Europe is probably due to the difference between CP and EP, but not because of the materials.

4. Summary

- 1) KEK and PJ/CERCA just started an R&D collaboration of sc cavity. The purpose is to improve the performance of sc cavity by this international collaboration.
- 2) A 3 cell Heraeus Nb material cavity was fabricated at CERCA. Even if this cavity was only for the purpose of welding test, i.e., all EBWs from out side, the cavity performance showed 15MV/m of Eacc.
- 3) A single cell Heraeus Nb cavity was manufactured at KEK. The KEK standard surface treatment (EP) was applied on this cavity, and the cavity performance achieved up to Eacc 33.4MV/m at the 1st measurement. This result shows that the superiority of EP is independent of the materials.

5. Acknowledgement

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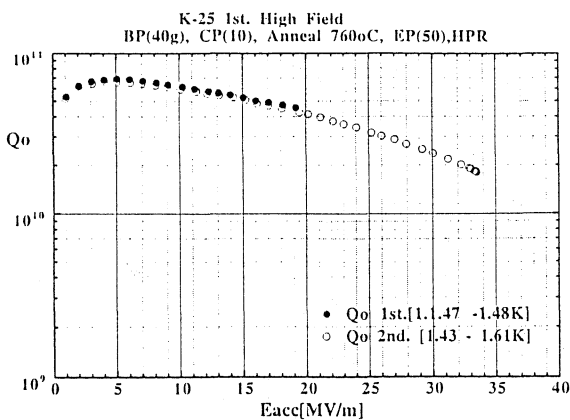


Fig. 5 TEST RESULT

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