DEVELOPMENT OF THE L-BAND SUPERCONDUCTING CAVITIES AT MHI

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ABSTRACT

Since 1990, L-band niobium superconducting cavities have been developed with collaboration between MHI and KEK. The test result of the single-cell cavity with a waveguide is presented. The maximum accelerating gradient of 27MV/m was attained with no field emission.

1. Introduction

Notice is taken of the electron-positron collision type linear accelerator as the next-generation accelerator for high energy physics. For this accelerator the X-band or C-band normal-conducting or L-band superconducting cavity is considered to be a leading candidate, and is being studied in laboratories of various countries. Since 1990, L-band superconducting acceleration cavities have been developed with collaboration between MHI and KEK(High Energy Accelerator Research Organization).

Our target in these 3 years is to achieve the gradient higher than 25MV/m in a single cell cavity with a wave guide input port. By replacing cells including iris parts, which has a defect limiting the achievable gradient to 12 MV/m, the gradient of 27MV/m has been achieved.
As illustrated in Fig.1, the EBW defect was found by Temperature mapping and conferred by inspection.

2. Specifications of Single-Cell Cavity with Input Port

The single-cell cavity with an input port is designed so that the Q-value of the input, Q_{in}, will be $1{\cdot}10^6$, following the specifications of TESLA(TeV Energy Superconducting Accelerator)(1). In addition, the cavity shape is designed by KEK to the form optimized for TESLA(2).Table 1 shows the cavity parameters.

Table 1 Table of cavity parameters

Resonance frequency fo	1288.6 MHz
Shunt impedance R/Q	110 O
Surface magnetic field Hsp/Eacc	42.10 e/MV/m
Surface electric field Esp/Eacc	1.73
Geometrical factor G	269O

3. Performances of Cavity before Modification

The accelerations gradient of the cavity before its modification was 12 MV/m and was limited by quench[3].

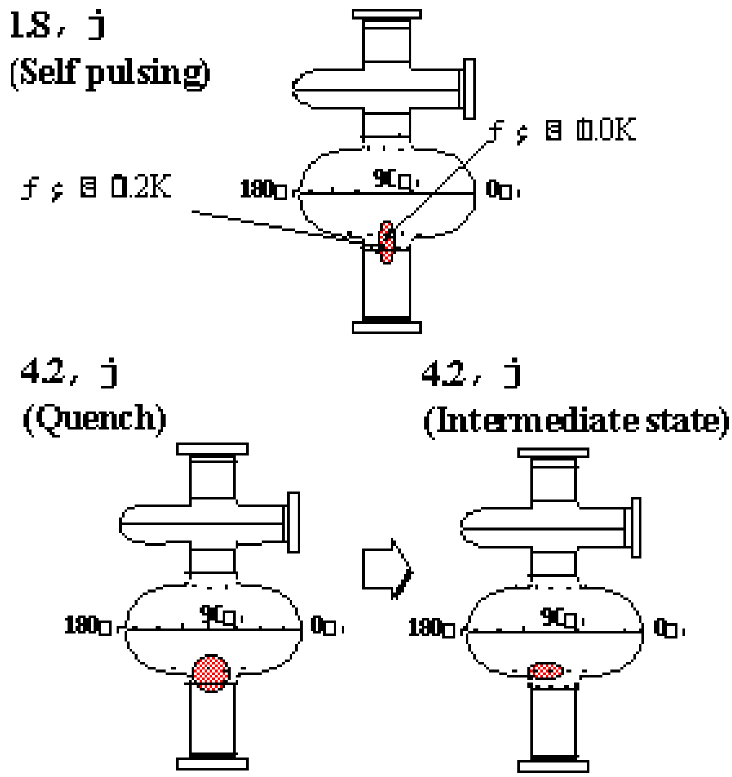

Fig.1 Location of the heating spot

4. Cavity repairing Process

On the basis of the measurement results of Item 3 it was decided to replace the cell section including the welded sections of the iris section, which are considered to be the cause of quench, with the new ones. Fig.2 shows this processes.

The cavity was cut through wire cutting. After cutting, the prepared welding edges were worked and finished.

Between the input port section and beam pipe section, the newly-manufactured cell section (made of RRR = 200 Niobium manufactured by Tokyo Denkai Co., Ltd) was connected by electron beam welding, Fig.3, shows the completed single-cell cavity with an input port.

After the cavity was completed, its welded sections were observed with the cavity inside face observation unit[4] of KEK. Fig .4 shows the welded section of the beam pipe side iris section. The improper welded section seen in the old cavity was not seen and it was confirmed that welded sections including those in the equator section were good.

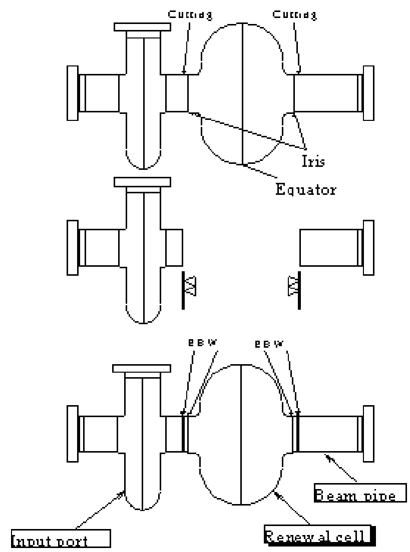

Fig.2 Removal processes of improper welded sections

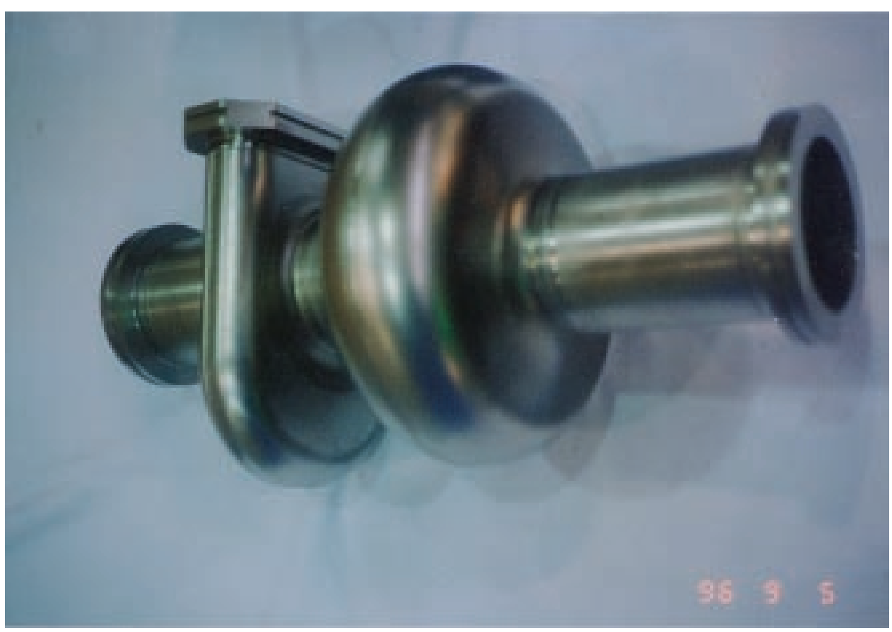

Fig.3 Photograph of M-5 Cavity

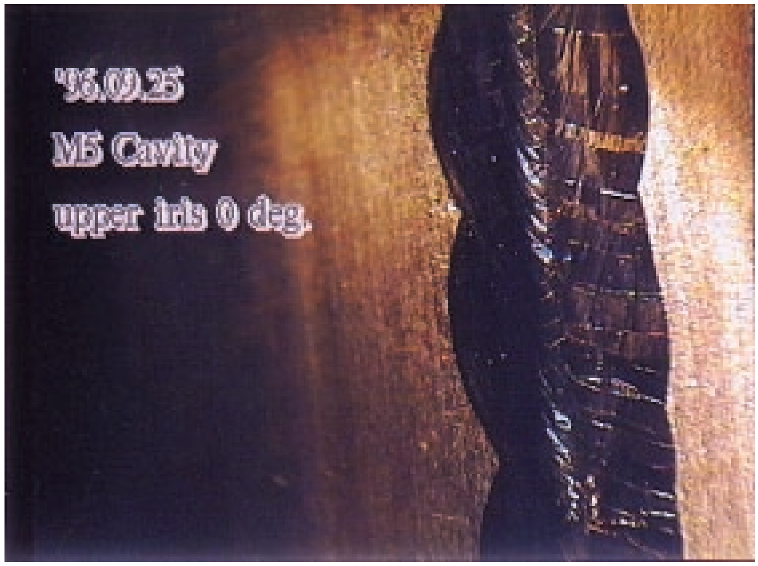

Fig.4 EBW seam in the M-5 Cavity

5. Low-Temperature Performance Measurement

(1) Surface Treatment

For surface treatment of the cavity, chemical polishing was adopted similarly to that carried out for the old cavity. (Polishing was carried out in Nomura Mekki Co., Ltd)

After polishing, high-pressure water rinsing was carried out and the performance of the cavity were measured. Since field emission was generated, the cavity was re-rinsed and measurement was carried out again. However, the performance was limited to 18 MV/m by quench, and the target performance was not attained. In this case, local heat generation at the cavity welded sections was not observed.

To improve the performance, the cavity was re-treated. After chemical polishing to 40 μm, for the purpose of increasing the rinsing effect, megasonic rinsing with 60 °C pure water was carried out additionally before high-pressure rinsing.

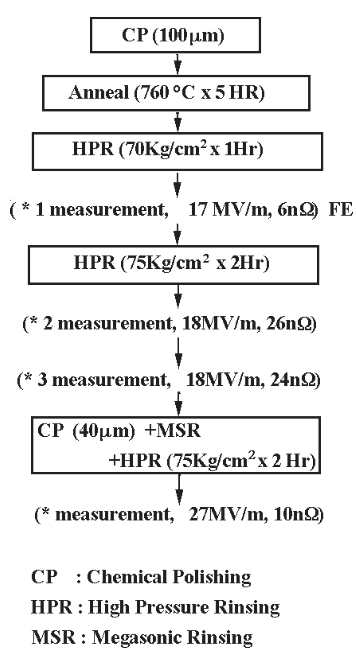

Fig.5 Surface treatment of the M-5 cavity
(after repaired)

(2) Low-Temperature Performance Measurement Results

The performance measurement results of the cavity are shown in Fig.6. Until quenching at 27.4 MV/m, breakdown did not occur and any X-ray was not observed.

Besides, the surface resistance of the cavity was 10nΩ and this is nearly same as the value before repairing.

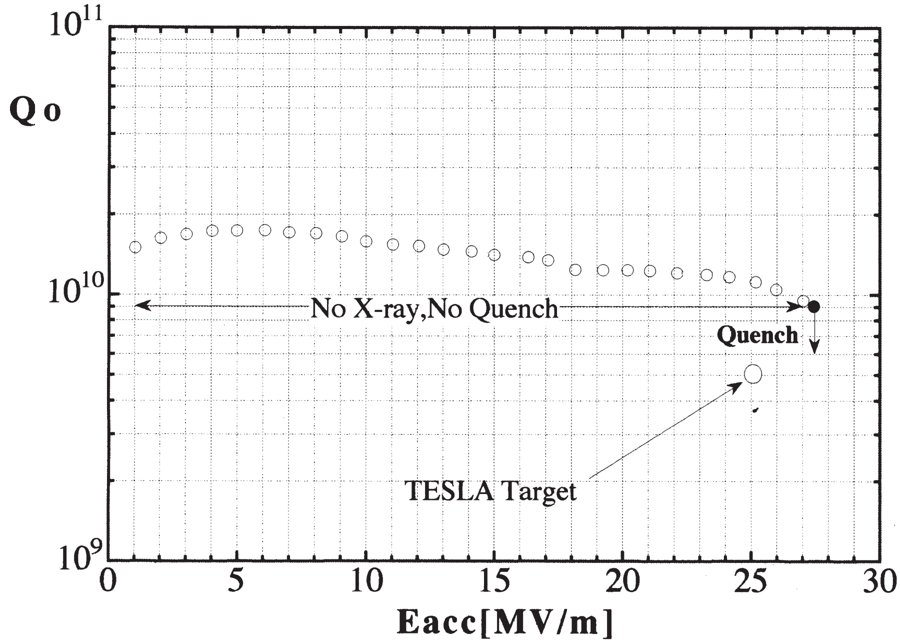

Fig.6 Q_0-E_{acc} plots in the cold test of the M-5 cavity

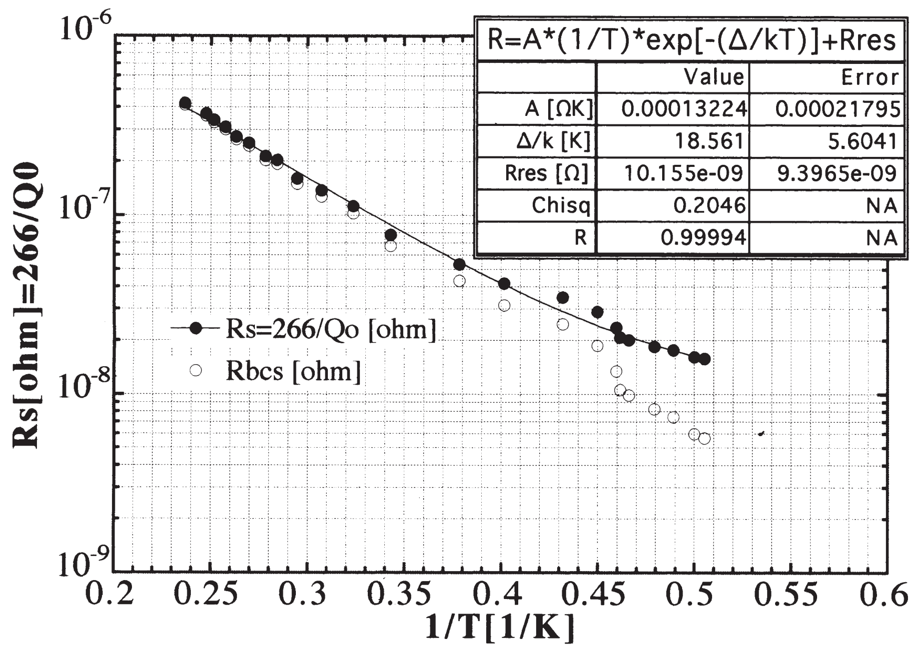

Fig.7 Temperature dependence of surface resistance the M-5 cavity

6. Conclusion

(1) We removed the improper welded sections that limited the performance of the single-cell cavity with an input port, modified the cavity, and attained the TESLA target performance.

(2) Consequently, it was demonstrated that the input coupler of the waveguide type dose not affect the high-electric field performance of the cavity.

(Reference)

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(4) Kenji Saito , etc. Proc. of the 21st Linear Accelerator meeting in Japan,1996, pp.219-221