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Introduction

An experimental facility for testing superconducting RF cavities is now in operation at Saclay (1). A brief description of the laboratory equipment is given. Five single cell 1.5 GHz cavities have been fabricated by the French company LEMER. Final chemical polishing and testing have been performed at Saclay. We give the results obtained for these cavities together with the next scheduled tests on multicell cavities.

Experimental equipment

Two vertical cryostats are now in operation and can be used simultaneously. A large one (ϕ =70cm, H = 3m) is used for multicell cavities and single-cell cavities in horizontal position with variable couplers fabricated according to the Wuppertal design [2]. A smaller cryostat, borrowed from CERN, is used for singlecell in vertical position and will be used for tests with a TEOll cavity at 3 GHz. A power dissipation of 20 Watts per cryostat at T = 1.6K is possible. Both cryostats are equipped with a rotating frame of resistances for subcooled thermometry.

A chemical treatment facility is available for final surface preparation which consists of a chemical polishing (\thickapprox 50 $\mu\text{m})$ in a 1:1:2 solution of HF:HN03:H₃P04 followed by rinsing in demineralized and filtered water. The drying and mounting of parts of the cavity take place in a class 100 clean room. Final assembly of the cavity on the insert of the cryostat is made before a laminar flow in a protected area.

The RRR of samples of Nb is controlled by measuring the resistivity at 4.2K with an applied magnetic field of about 2 Tesla produced by a SC coil. We have found that the sample must be prepared on a milling machine rather than cut in order to maintain the cristallin structure and so get a correct value of the RRR. A chemical polishing of the sample before the measurement lowers by almost a factor 2 the critical magnetic field. With these procedures, results are in good agreement with measurements made at HERAEUS on the same samples |3|.

Measurement of the thermal conductivity of Nb between 1.4K and 10K is available by measuring the temperature gradient of a sample heated by a known power source in an arrangement similar to the one used at CERN.

Fabrication of cavities

We have started a program with the company LEMER - located in Nantes - to develop an industrial fabrication of SC cavities which should lead to good performances and competitive prices. We have benefited for this program from advices from CERN and also from the experience acquired for the construction of the SC heavy ion linac cavities at Saclay |4|.

LEMER has developped a method of fabrication of the cups by hydroforming of Nb sheets which leads to a minimum deformation of the metal. The cups are then EB welded. Cavities are fabricated from high purity Nb sheets (RRR 1501.

Up to now five single-cell cavities have been fabricated and tested in several conditions. The results are given below. A fivecell cavity has been delivered and is being tested. Two single-cell cavities equipped with HOM couplers (as described in |1|) and side tube openings for variable couplers operation will be tested in July.

In addition five single-cell copper cavities are fabricated which will be used to make Nb deposition by magnetron sputtering in collaboration with CERN.

In the next future we plan to order a series of 10 single-cell Nb cavities in order to get a better statistical knowlegde of the fabrication process.

Experimental results

Since November 87, 14 tests have been performed with five single-cell cavities with different chemical polishing. The main results of these tests are summarized below :

- Qo's at 4.2K are between $4 x 10^8$ and $4.2 x 10^8$ which give, after substracting the residual resistance, a value for the measured BCS resistance of R_{bcs} (4.2K) = (660 ± 20) n Ω .

- Qo's at 1.8K range between $7x10^9$ and $2x10^{10}$. The best residual resistance obtained so far is 15 n.a.

- The maximum accelerating field is always limited by electron loading. In one case a quench occured near the equator at 8 MeV/m. The defect was successfully removed by mechanical grinding.

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A study of electron loading with X ray detectors and correlation with the results of trajectory calculations is under way [5]. Part of the electron current in the cavity is measured by the RF antenna. This information, together with the measurement of Q decrease, are used to fit the Fowler-Nordheim behavior of field emitted electrons and give values of the enhancement factor $oldsymbol{eta}$. We typically find values of β in the range 150-400, the lowest values being obtained after He processing.

- Systematic use of He processing is tested and always improves the maximum field after about 30 minutes.

Figure (1) shows a summary of the characteristics of several tests with the 5 cavities. The best one reached a field of 15 MeV/m at a Q of 10^{10} without any electron and a field of 20 MeV/m at Q of 610^9 (the test was interrupted by a breakdown at an RF feedthrough).

Figure (2) shows the maximum surface field reached (defined as the field for which the Q was degraded to 10^9 due to electrons) before and after He processing.

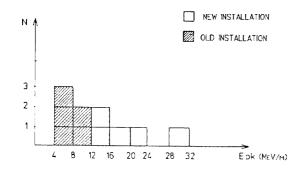
Figure (3) shows the field level at which electrons first appear during the test (before any RF processing). The effect of improvement of cleanliness of our installation is clearly demonstrated.

The influence of residual DC magnetic field during the cooldown of the cavity was evaluated by applying a vertical known component of \pm 100 mG. We found an equivalent resistance of about 0.4 n Ω/mG .

Future measurements

Measurements on 2 five-cell cavities are scheduled for next few weeks. The first five-cell cavity has been tuned to a field flatness of 95% by mechanical deformation of the cells.

The coaxial HOM couplers |1| will be tested on single-cell cavities. The next step will be to fabricate a five cell cavity equipped with its main coupler and two HOM couplers.

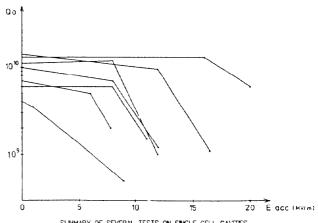


PEAK FIELD REACHED WITHOUT ELECTRON BEFORE ANY PROCESSING

Future equipment

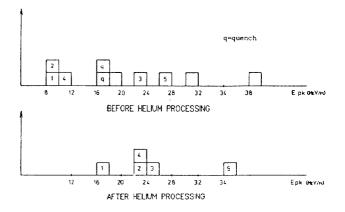
The diagnostic system used for systematic studies on electron loading in the single-cell cavities is being improved. New Xray detectors will be used after having been measured with a known electron beam on a test bench. Superfluid thermometry is being developped in a rotating system in collaboration with Wuppertal. A special cavity , with a dismountable part, will be used for studies of the effect of different surface treatments on fields emitters.

In parallel a TEOll cavity is under construction for studying the RF resistance of Nb or of other RF surfaces like NbN.









MAXIMUM SURFACE FIELD REACHED IN SEVERAL TESTS

Acknowledgements

Numerous discussions with the CERN EF/RF group and with the group of Pr PIEL at WUPPERTAL are gratefully appreciated.

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