A.3: Development of 1.3 GHz Single Cell SCRF Cavities with Improved Performance

RRCAT has developed two more prototype 1.3 GHz single cell SCRF cavities, under Indian Institution Fermilab Collaboration (IIFC). These have been successfully tested at 2 K to achieve accelerating gradient E_{acc}>37.5 MV/m.

Last year RRCAT had developed 2 nos. of 1.3 GHz prototype Single cell SCRF cavities TE1CAT001 and TE1CAT002. These were tested to achieve E_{acc} of 21-23 MV/m at Q >1.5 E10. *(RRCAT newsletter - article A.3 vol.23 issue 2,2010 and article A.8 vol 24, issue1 -2011).*

Development of forming tools, forming of half-cells, machining of components, development of welding fixtures along with RF and vacuum qualification were carried out at RRCAT. The electron beam welding was carried out at IUAC. The fabricated prototype cavities were tested for RF and vacuum leak tightness up to 77 K at RRCAT before shipment to FNAL. Processing, consisting of Centrifugal Barrel Polishing (CBP), Electro Polishing (EP), heat treatment and high pressure rinsing (HPR) was carried out jointly by FNAL and Argonne National Laboratory in USA.

Some of the major modifications made during fabrications of these two single cell cavities TE1CAT003 and TE1CAT004 are ; i) 20 µm overall buffer chemical polishing (BCP) in addition to 3 µm pre-weld etch, ii) Beam oscillation and weld parameter optimization during electron beam welding (EBW) iii) Careful handling of niobium components during each stage of cavity manufacturing iv) Formulation of an elaborate inspection plan and its rigorous implementation at each intermediate stage of cavity manufacturing.

The processing and 2K testing of TE1CAT003 and TE1CAT004 for their performance evaluation were done using facilities of FNAL and ANL under IIFC, as shown in the Fig. A.3.1.

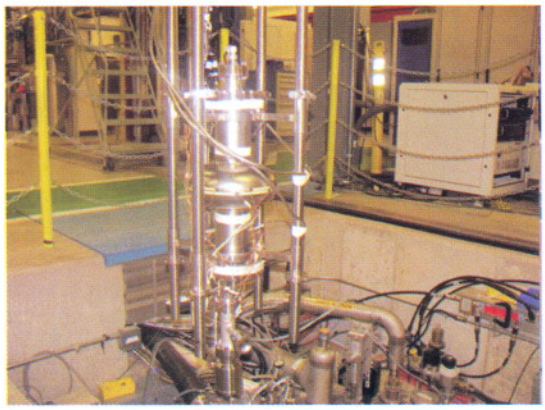

Fig. A.3.1: 1.3 GHz Single cell SCRF cavity under preparation for 2 K cold testing.

After qualifying the incoming optical and RF inspection, TE1CAT003 was processed using standard recipe and was quench limited at 15.5 MV/m when tested at 2 K. The cavity was reprocessed along with TE1CAT004 using 120 µm CBP, 20 µm light EP, 800Cx3 hrs heat treatment, 20 µm light EP, HPR, clean room assembly and 120Cx48 hrs low temperature baking.

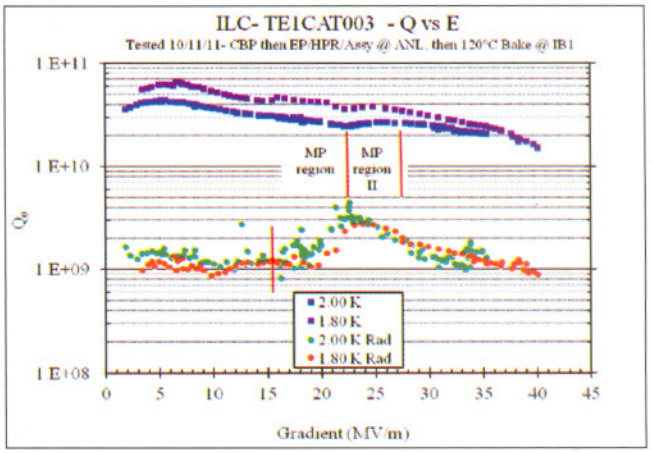

Fig. A.3.2: 2 K Performance test curve of TE1CAT003.

The cavity successfully recovered the performance and achieved Eacc 35.5 MV/m with Q > 2.1 E10 during testing at 2K . The E_{acc} further improved to 40 MV/m with Q > 1 E10 when tested at 1.8 K as shown in Fig. A.3.2. The measured residual surface resistance of 1.1 ± 0.3 nΩ is among one of the lowest measured on 1.3 GHz single cell cavities.

The cavity TE1CAT004 was successfully tested in the first test itself to achieve E_{acc} was 37.5 MV/m with a Q > 8.4 x E09 as shown in Fig. A.3.3.

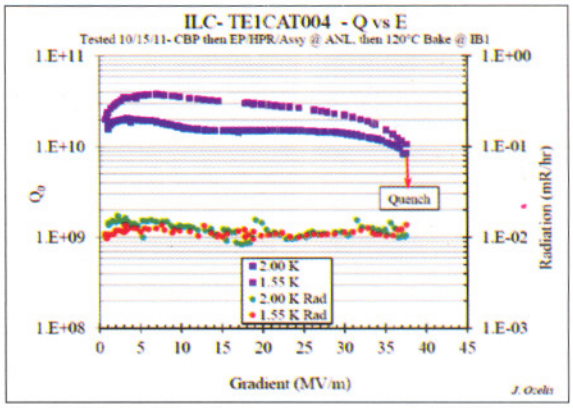

Fig. A.3.3: 2 K Performance test curve of TE1CAT004.

The results of improved single cell cavities meeting the ILC accelerating gradient goal are very encouraging. Our next plans are now to develop 1.3 GHz multi-cell and 650 MHz single cell cavities.

Reported by:
M. Bagre (manish@rrcat.gov.in), A. M. Puntambekar and S. C. Joshi