A.4: Processing of 1.3GHz Single Cell SRF Cavity

RRCAT has taken up a program on R&D activities for 1GeV high intensity superconducting proton linac for Spallation Neutron Source (SNS). Under the program, development & setting up of infrastructure facilities for fabrication, processing & testing of superconducting RF (SRF) cavities are taken up. For reliably achieving an accelerating gradient >35MV/m, it is required to have surface finish in tens of nanometer on the internal surface of the cavity. This is achieved by centrifugal barrel polishing (CBP)& electropolishing (EP) of the cavity. RRCAT has fabricated several 1.3 GHz single cell SRF cavities. A few of these cavities were sent to Fermilab, USA under Indian Institution Fermilab Collaboration (IIFC) for processing and testing.

Cavity processing facilities have been set up at RRCAT which include CBP machine, EP setup & high pressure rinsing (HPR) station. To develop the cavity processing recipe & generate required experience, a 1.3 GHz single cell SRF cavity fabricated indigenously was processed for the first time at RRCAT using these facilities. The cavity was inspected on an optical inspection bench developed indigenously and few locations were identified on the internal surface of the cavity where some irregularities were observed on the electron beam weld under-bead. Replica moulds were casted using Room Temperature Vulcanized (RTV) polymer to characterize the defects. These moulds were analyzed using 3D Laser scanning confocal microscope, whose topography are shown in Fig.A.4.1. Defects' sizes were in order of micrometers. A polishing process using CBP and EP was planned to remove these defects.

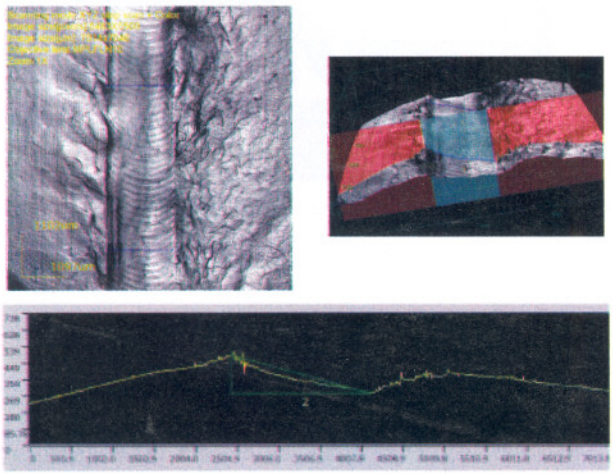

Fig. A.4.1 : Topography of RTV polymer replica by 3D Laser scanning confocal microscope

As a first stage of processing, the cavity was mechanically polished to remove a maximum of 105 μm material using CBP machine. The cavity was barrel polished for a total of 95 hours with various media, including 50 hours continuous polishing by 0.04 μm colloidal silica solution. A mirror finish was obtained with a surface roughness of 0.12 to 0.15 μm as measured on the beam pipes. Figure A.4.2 shows the picture of cavity loaded on barrel polishing machine & polished cavity.

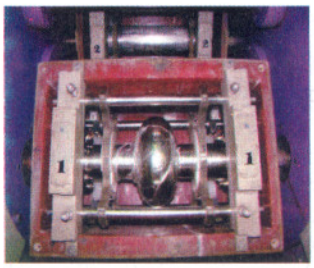

Fig.A.4.2 (a) : Cavity loaded on barrel polishing machine

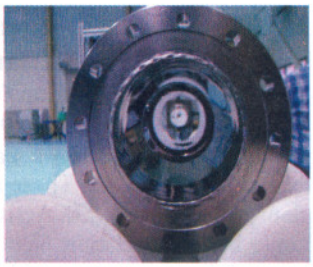

Figure A.4.2(b) : Barrel polished cavity

After the mechanical polishing, the cavity was chemically polished by electropolishing. The cavity was set as anode with an Aluminium tube as cathode. A solution of Sulphuric acid (98%) and Hydrofluoric acid (48%) in a volumetric ratio of 9:1 was used as electrolyte. An average of 25 μm material was removed by electropolishing. The cavity was ultrasonically cleaned with Micro-90 surfactant at 50°C followed by high pressure rinsing with ultra pure water at 80-100 bar pressure. The cavity was dried in a clean enclosure of HPR station and assembled for vacuum leak test in Class 100 clean room facility. The cavity is ready for cold test in the vertical test facility at RRCAT. Figure A.4.3 shows picture of the EP process & electropolished cavity.

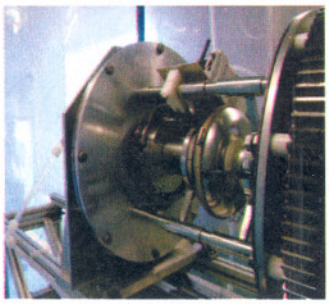

Fig. A.4.3(a): Cavity on EP setup

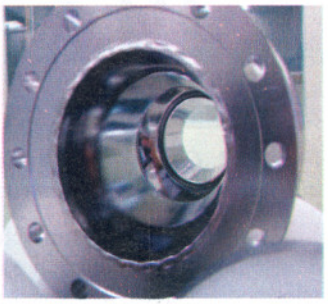

Fig. A.4.3(b): Electropolished single cell cavity

The present processing facility is currently being upgraded for processing of five-cell 650 MHz SRF cavities. An electropolishing setup for 650 MHz cavities is under fabrication. Procurement of a large centrifugal barrel polishing machine suitable for polishing 650MHz cavities is under process. For thermal processing of the cavities at 600-800°C, an ultra high vacuum annealing furnace has been ordered.

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