A.5: Processing and testing of single-cell 650 MHz SCRF cavity

RRCAT has taken up a program on R&D activities for a 1 GeV, high intensity superconducting proton linac for proposed spallation neutron source (SNS). Development of superconducting RF (SCRF) cavities is an important accelerator technology to provide efficient, high current and high gradient accelerating structure for the 1 GeV injector linac for SNS.

A single-cell 650 MHz SCRF cavity was fabricated indigenously, processed and tested for the first time using the infrastructure facilities set up at RRCAT. The interior surface of the cavity was inspected using a specially developed high resolution optical imaging system for surface defects like pits, scratches, spattered material from electron beam welding, etc.

Facilities for processing and testing of 650 MHz SCRF cavities have been set up, which include electropolishing (EP) setup, high pressure rinsing (HPR) setup, high temperature annealing furnace, low temperature baking system and vertical test stand (VTS). The cavity was electropolished to remove 120 micron material from equator in the horizontal EP setup. In the EP setup, the cavity (anode) is held in a horizontal position during electropolishing. A solution of Sulphuric acid (98%) and Hydrofluoric acid (48%) in a volumetric ratio of 9:1 is used as electrolyte. The electrolyte is circulated in closed loop and cavity volume is filled with the electrolyte through an aluminum tube which also acts as cathode during the polishing. The electropolishing setup is shown in Fig.A.5.1. After electropolishing the cavity was ultrasonically cleaned followed by high pressure rinsing with ultra-pure water at around 100 bar pressure.

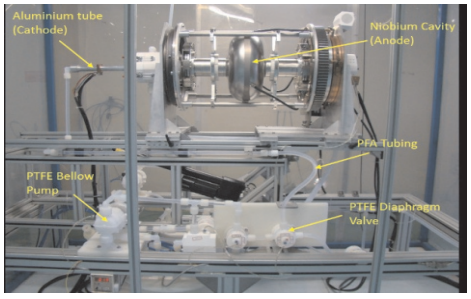

Fig. A.5.1 : EP of single-cell 650 MHz cavity

After the EP, cavity was annealed (thermal processing) at 800 ^{o}C for 3 hours in vacuum of 10^{-7} mbar range in high vacuum horizontal annealing furnace. The annealing is done to remove hydrogen gas absorbed during EP. The cavity loading in the furnace for high temperature annealing is shown in Fig. A.5.2. The thermal processing was followed by a light electropolishing to remove 25 micron material and high pressure rinsing. The cavity was dried and assembled with RF couplers for 2 K testing in a class 100 clean room. The single-cell SCRF cavity was baked at 120°C for 48 hours under ultrahigh vacuum.

Fig. A.5.2: Cavity loading in furnace

After the processing, the single-cell 650 MHz cavity was tested for the quality factor (Q) and accelerating gradient (E) at 4.2 K & 2 K in the vertical test facility. The cavity was loaded on the VTS insert assembly and lowered in the VTS test cryostat. The cavity mounted on the insert assembly is shown in Fig.A.5.3.

Fig. A.5.3: Cavity mounted on VTS insert

Around 1400 liters of liquid helium was collected in the cryostat for testing of the cavity. A temperature of 2 K was achieved by helium pumping to a pressure of 30 mbar. The cavity was low power RF tested at 2 K using indigenously developed 650 MHz solid state RF amplifier. A quality factor of 3.7 x 10^{10} and an accelerating gradient of 10.2 MV/m was achieved in the cavity. The result of VTS test is show in Fig.A.5.4

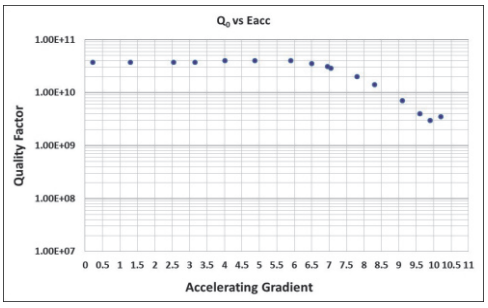

Fig. A.5.4 : VTS test results for the cavity at 2 K

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