A.4: Buffered Chemical Polishing of Niobium Half Cells

Buffered chemical polishing (BCP) and electropolishing (EP) are the methods commonly used for the surface preparation of superconducting RF niobium cavities to improve their performance. In the development of SCRF cavities program being pursued at this centre, BCP process is presently required for carrying out pre-weld etch on niobium half cells before electron beam/laser welding. Fig. A.4.1 shows the experimental setup established in Chemical Treatment Facility of Proton Linac and Superconducting Cavities Division for carrying out buffered chemical polishing of niobium half cells, end pipes and niobium-titanium flanges.

Before carrying out the process on actual components, experiments were carried out initially on niobium test specimens for process optimization and weight loss measurements. Buffered chemical polishing was carried out in a mixture of nitric acid (69.5 % AR grade), hydrofluoric acid (40 % AR grade) and Ortho-phosphoric acid (88 % GR grade) in the ratio 1:1:2. The sample pieces were immersed in the solution for 25 minutes. The temperature change was monitored using IR non contact thermometer. Temperature of the solution varied from 15 to 18°C during the process. After polishing, the components were washed with ultra pure water, dried and weighed. Based on weight loss measurements, the removal rate was found to be approximately one micron per minute in BCP bath. No weight loss was observed after aqueous ultrasonic cleaning before BCP.

Fig. A.4.1: Experimental set up for BCP of Niobium

The actual half cell components were first cleaned ultrasonically in aqueous cleaning solution for 30 minutes. It was washed with ultrapure water followed by immersion in the buffered chemical polishing solution for 20 minutes. Figure A. 4.2(a) shows the immersion of half cells in double tank BCP set up (20 litres) established for carrying out this process. The temperature of the bath was maintained by circulating chilled water through titanium cooling coils in the external tank containing water. The solution was agitated manually by moving the cell holder up and down after every two to three minutes to ensure proper mixing of electrolyte and to maintain uniform temperature throughout the solution. The half cells were ultrasonically cleaned in ultra pure water followed by drying with nitrogen and packing in inert atmosphere.

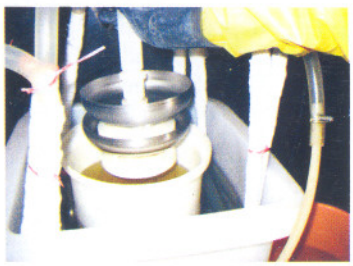

Fig. A.4. 2(a): Double tank BCP bath

Fig. A.4.2(b): Ultrasonic cleaning in ultra pure water

Fig. A.4.2(c): Drying with pure nitrogen

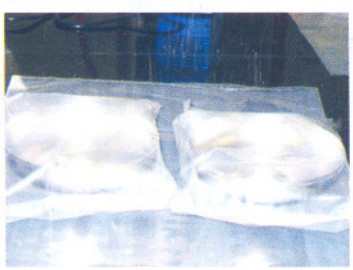

Fig. A.4.2(d): Packing in inert atmosphere

Figures A.4.2 (b)-(d) shows the process sequence adopted for the components after BCP. In half cells, the removal rate was found to be less than one micron per minute (15 μm/20 minutes) based on weight loss measurements. Six half cells along with their beam pipes and flanges were successfully processed in this set up.

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