I.3: Copper deposition of buncher cavity and RF power coupler

As a part of the Low Energy High Intensity Proton Accelerator program at BARC, Mumbai, stainless steel buncher cavity for the Medium Energy Beam Transport line is being developed by Ion Accelerator Development Division of BARC. The last step in this manufacturing is the copper plating of the cavity. A good quality of copper plating is required for achieving the designed Q value, for which the cavity was sent to RRCAT. The cavity consists of a centre ring with ports and two end plates made of stainless steel as shown in Figure I.3.1. The required plating thickness was around 60 to 100 microns.

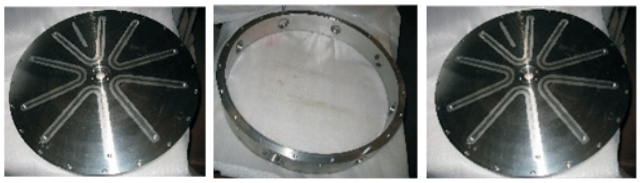

Fig. I.3.1: Components of buncher cavity.

Preliminary cleaning of the components was carried out to remove oil, grease and buffing compounds adhered to the surface during various stages of fabrication. This included vapor degreasing in trichloroethylene, immersion cleaning in ferrowash-15 alkaline cleaner and nitric acid – hydrofluoric acid solutions with thorough washing between each step. Masking of the external surfaces, that do not require copper coating, was done using chemical resistant polyamide tapes and masking off lacquer as shown in Figure I.3.2.

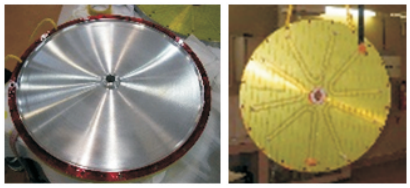

Fig. I.3.2: Masking with polyamide tape and lacquer.

Stainless steel forms a thin invisible oxide film by reacting with the atmosphere. The resistance to corrosion is due to this ever-present oxide film, which makes plating of metal very difficult. The buncher cavity parts were cleaned with pumice powder to produce a surface free of water breaks, followed by anodic and cathodic cleaning in sulfuric acid using lead electrodes for obtaining an adherent coating. Nickel strike upto a thickness of 2 to 3 microns was deposited from a solution containing nickel chloride and hydrochloric acid at a current density of 0.05 A/cm^2

Copper deposition was carried out from a solution containing copper sulphate and sulfuric acid (current density 0.01 to 0.02 A/cm^2). Periodic reversal power supply made by Power Converters Division of RRCAT was used for electro deposition. A 20 s forward cycle followed by 4 s reverse cycle was maintained throughout the plating process to produce a deposit with minimum roughness. Intermittent scrubbing of the deposit was also carried out to avoid growth of rough deposits. Thickness measurements were made using Fischer make PHASCOPE for controlling the thickness.

Electrodeposition of copper with good adhesion was successfully carried out over stainless steel buncher cavity ring and end plates to a thickness of 80 to 100 microns as shown in Figure I.3.3.

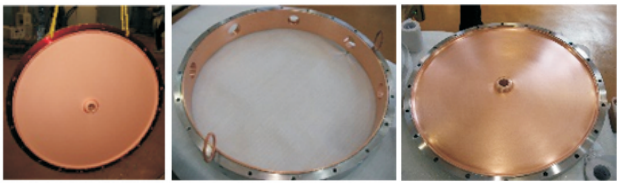

Fig. I.3.3: Copper deposited buncher cavity parts.

As a part of DAE-CERN collaboration, two numbers of stainless steel (SS Grade 304L) Radio Frequency (RF) coupler waveguides for CERN's linear accelerator, LINAC-4, were fabricated at Indo-German Tool Room, Indore. They also required copper plating to a thickness of 30 microns for RF applications. After fabrication and leak testing, electrodeposition of copper was completed to a thickness of 30 to 40 microns. Besides the base substrate (SS) which is difficult to plate due to the oxide film formation, the work was more challenging due to poor accessibility of the inner bottom surface. Surface preparation and chemical cleaning was carried out using custom made tools designed for reaching the bottom surface. Process sequence, including masking, was similar to that for the buncher cavity.

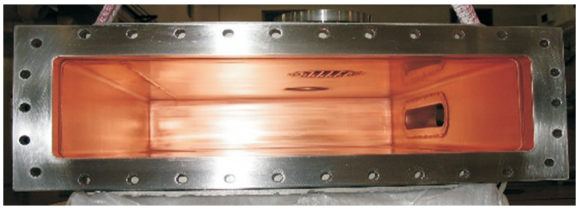

Fig. I.3.4: Copper deposited RF power coupler.

Copper coating of RF coupler was completed without any adhesion problems as shown in Figure I.3.4. The coupler was finally degreased in trichloroethylene.

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