Copper-plating of prototype cavities for the Proton Linac Accelerator

K. Dermati[1], J. Boensch[1], N. Boensch[1], R. Brodhage[1], T. Dettinger[1], R. Erlenbach[1], R. Fuchs[1], E. Kammer[1], E. Merz[1], M. Müller[1], N. Norcia [1], R. Reiter[1], M. Romig[1], T. Schiemann[1], T. Schneidler[1], S. Teich[1], D. Volz[1], W. Vinzenz[1]

[1]GSI, Darmstadt, Germany

Introduction

The FAIR anti-proton research program required a dedicated 70 MeV proton injector. The main acceleration of protons in the Proton-Linac will be provided by normal conducting, Crossed-bar, H-mode (CH) cavities according to the requirements and specifications of the accelerator physicists [1], [2]. For a high power RF test at GSI two prototype CH cavities are copper plated in the Galvanic of GSI. The requirement to be achieved was a constant, shiny (mirror finish) copper layer with a thickness of 50 µm all over the inner surface of the stainless steel CH cavities.

There have been two goals to be achieved during the electroplating work. First an exact, high quality copper layer and second the identification and optimisation of the procedure for the copper plating of all the CH cavities of the Drift Tube Linac Structure.

Electroplating / Copper Plating

To comply with the requirements a couple of dummies were produced and copper plated before processing the prototype cavities.

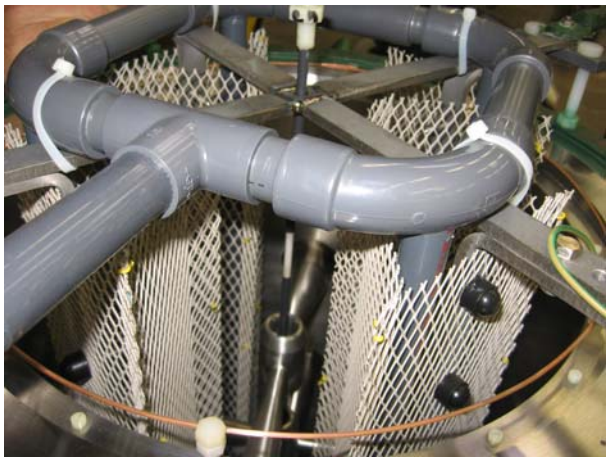

Figure 1: A CH-Cavity prepared for the Electroplating.

Electroplating started after suitable preparation including coating, forming and mounted the expanded metal anode gates. Various parameters should be considered and steered during all process: Shape of the anodes, distance to the surface of the cylindrical wall and stems, deflector plates, amperage, consistence of the baths, agitation during the plating, flow of the electrolyte and action time of each step of the plating.

After a cleaning and strong activation of the surface of the cavities a 15 µm nickel-strike base layer was given. Copper is an active metal and it is difficult directly plating iron-based surfaces. For this reason, such surfaces are first given a nickel-strike base coat, to which the copper can adhere.

The nickel strike bath is based on hydrochloric acid. Its deposition rate was 4,5 A/dm^2. A pulsed current process of 2 minutes current tact and 30 seconds current off was performed to avoid the forming of hydrogen bubbles, “pitting” on the surface. Electrolyte was transferred over the inner surface of the cavity during the current less tact.

The copper bath is based on sulphuric acid with additives which are responsible for the brightness and levelling of the deposited layer. The deposition rate was 3 A/dm^2. According to this ratio and the total inner surface the cavities stayed about two hours in the bath. A final polishing is necessary to get the shiny surface, Figure 2.

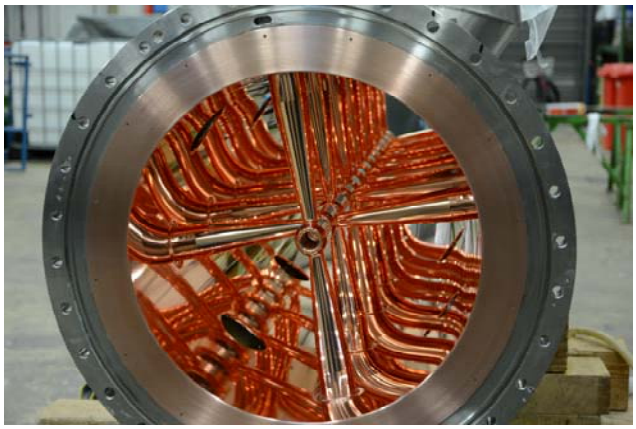

Figure 2: Shiny Copper plated prototype CH-Cavity.

Result

The copper plating of the two prototype CH cavities was commissioned with the expected performance. The required quantity and quality of the copper layer was achieved. The developed procedure and the gained experience might be used for the upcoming accelerator CH structure.

References

[1] Technical Report ”Proton Linac”, https://edms.cern.ch/document/994418/1.

[2] Status of the 70 MeV FAIR Proton Injector, Proceedings of IPAC2013, Shanghai, China, THPWO008.

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