ELECTROPOLISHING OF NIOBIUM MONO-CELL CAVITIES AT HENKEL ELECTROPOLISHING TECHNOLOGY LTD. (GERMANY)

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Abstract

A system for electropolishing niobium 1.3 GHz cavities has been built by Henkel Electropolishing Technology Ltd. (Germany). The system allows electropolishing of mono-cell up to four-cell cavities. The process includes rinsing with hot ultra-pure water after the electropolishing process. Final cleaning procedures take place in a classified clean room. Several mono-cell cavities have been electropolished showing gradients up to 40 MV/m.

CAVITY PREPARATION AND TEST SEQUENCE

For the preparation of superconducting cavities electropolishing (EP) of the niobium surface is a key technology to obtain very high accelerating gradients [1-5]. A facility to electropolish niobium cavities has been implemented at Henkel Electropolishing Technology Ltd. (Henkel). Additionally a setup for pure water rinsing has been introduced. The rinsing with diluted nitric acid which has been used for cavities described in an earlier paper [6] has been abandoned. Before shipment the cavities can be cleaned and finally packed inside the existing clean room infrastructure available at Henkel. The detailed preparation and measurement sequence is as follows:

- degreasing (US-cleaning + pure water rinsing)
- electropolishing (electrolyte 1 x HF : 9 x H2SO4 ; horizontal set-up)
- high pressure pure water rinse (90 bar, 16-20°C, 0.5-1 MOhm, particle filter 1 μm)
- final cleaning in Henkel clean room including rinse with hot ultrapure water (60-80°C, 17.5-18 MOhm, particle filter 0.1 μm)
- transportation into DESY clean room
- assembly of top flange
- high pressure water rinse (> 2x)
- assembly of antenna with vacuum connection, pumping + leak check
- first vertical test
- low temperature heat treatment between 100 C 140 C (“in-situ bake”)
- second vertical test

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The final high pressure rinsing is done at DESY after the installation of the top flange equipped with the pickup antenna to avoid particle contamination from this assembly.

Figure 1: Setup for electropolishing

Figure 2: Setup to rinse cavity with high pressure pure water.

TESTS OF CAVITIES

The data from an earlier batch of cavities treated at Henkel and DESY are shown in figure 3 for reference. Although one of the cavities achieved 34 MV/m, a wide range of gradients were measured. Some of the cavities show strong field emission, the source of which is not easily identifiable. Therefore, more detailed quality control procedures were introduced. This includes amongst other things improved parameter control during the electropolishing at Henkel.

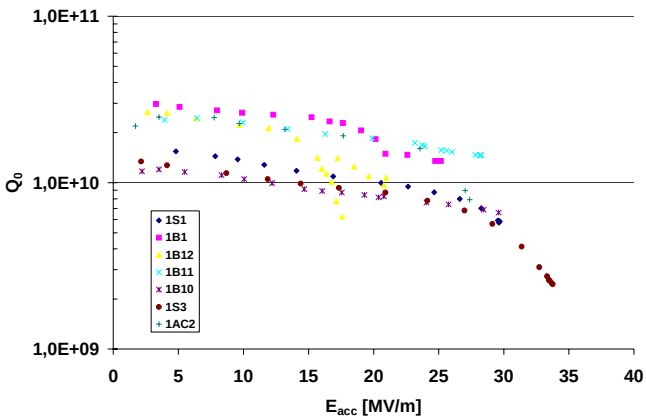

Figure 3: First test series of cavities electropolished at Henkel.

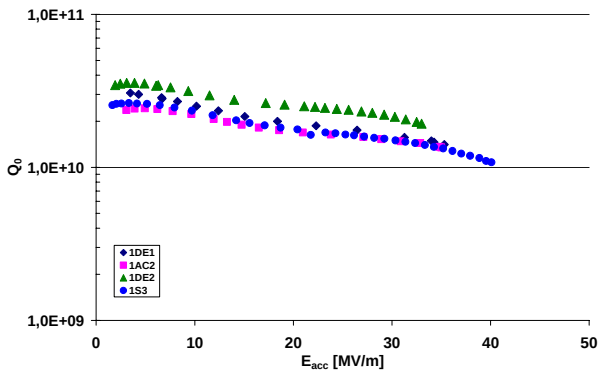

Figure 4: Second test series of cavities after Henkel EP. The tests were done after in-situ bake.

As compared to this, in the most recent series of measurements of cavities electropolished by Henkel very good results have been obtained after the 'In-Situ' bakeout. The results of the cavities are shown in figure 4. Cavity accelerating gradients of up to 40 MV/m were achieved. In general, there seems to be less field emission associated to the cavities of the recent test series.

Whether or not the rinse of nitric acid can be taken as the reason for large scatter in cavity performances, is not yet known.

In addition, there are indications, that the EP acid mixture needs to be monitored in more detail. Although nominally containing the same percentages of acid components the electrolyte mixed at Henkel and from another acid supplier show differences. For example, the rate of HF evaporation seems to differ significantly. First results indicate that the Henkel electrolyte has a larger HF content. Further investigations on the quality control of the EP bath are planned both at Henkel and DESY.

CONCLUSION

Electropolishing at Henkel gives now very high gradients similar to results from KEK, CERN or DESY. This promising result shows that the EP process can be transferred to industry and yield good results. Further cavities will be treated soon.

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