

LCLS-TN-99-10
September 1999

A Brief Report on a Brief Examination of the Electropolished GTF Cathode

R. Kirby and G. Mulhollan

A Brief Report¹ on a Brief Examination of the Electropolished GTF Cathode
R. Kirby and G. Mulhollan
Mon Sep 13 1999

The new cathode for the GTF RF gun (#2), which had been prepared several months ago, was examined for defects and contamination. The examination included both a visual inspection and a microscopic survey.

History

This cathode was prepared by oilless machining followed by chemical cleaning and electropolishing. It was subsequently brazed to a stainless steel tuning nut in a hydrogen furnace. The finished product was placed into a sealed, nitrogen filled bag and stored in a nitrogen dry box.

Visual inspection

The side onto which the nut is brazed exhibits some discoloration, perhaps indicative of slight oxidation. The vacuum side of the plate is very shiny, but two features stand out to the unaided eye. The first is a residual machining defect unavoidably brought about by the turning process; it is possible to remove such a feature, but it requires extreme care. The second defect is on a large radius of the cathode plate, but still in an area that will be exposed to RF. Overall the surface exhibits a slight orange peel quality which may be due to over vigorous electropolishing.

Microscopic examination

The cathode plate was examined to determine the size and composition of the

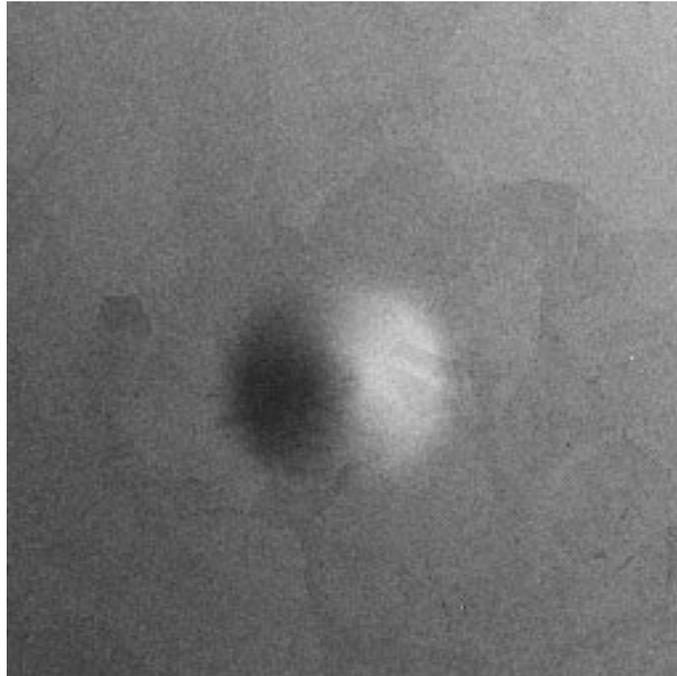


Figure 1. 50x view of center defect. The base diameter is ~400 microns. This feature is well rounded suggesting it was present during the electropolishing. Note the visible grain structure.

¹Carefull examination and useful comments by Bob Kirby; (mis)translation of data into report and kibitzing courtesy of Greg Mulhollan.

center peak, large radius defect and overall surface structure. The center defect, as seen above in fig. 1, is roughly conical in shape with smooth features and is composed of copper. Its size is sufficiently large that it is unlikely to act as an emitting site. This is due to both the roundness of the tip and the relatively small height to width ratio. Together these imply the field enhancement factor, β , is less than four².

The defect at large radii, though similar in size is morphologically undesirable as it possesses many sharp edges and protrusions. This particle, as seen in fig. 2, is

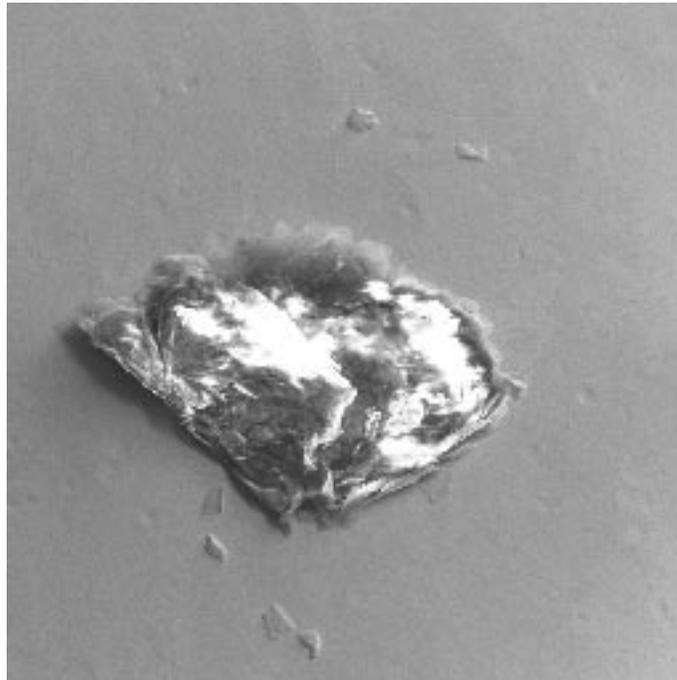


Figure 2. Particle located at large radius. Note the fine structure and many sharp edges.

composed primarily of carbon and should be removed before insertion of the cathode plate. The overall size of the particle is ~200 microns on an edge.

Several very small copper particles with diameters on the order of 1 micron were found during a general survey. As they are quite rounded, it is possible that they were present during the electropolishing phase of the cathode preparation. An example particle is shown below in fig. 3. These particles are primarily copper, but with significant quantities of carbon and oxygen. One particle with a primary composition of calcium, indicative of an origin as some form of airborne dust, was also observed. These particles are not likely to be easily removed since they may be partially fused to the surface.

The surface defects are not limited to the presence of adhering particles; voids or pits with sizes on the order of 10 microns were also observed. These pits are very likely the result of the excessive electropolishing the plate received.

²Latham, R., editor, *High Voltage Vacuum Insulation*, 1995, Academic Press Ltd. (San Diego).

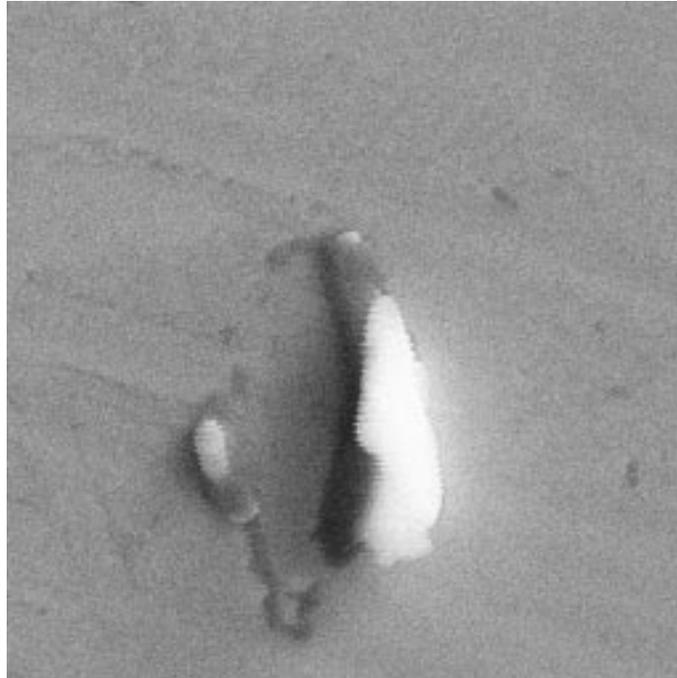


Figure 3. Copper particle found at random location on surface of cathode. Note the roundness of the edges and the 'slime trail' suggesting the particles moved during the brazing process.

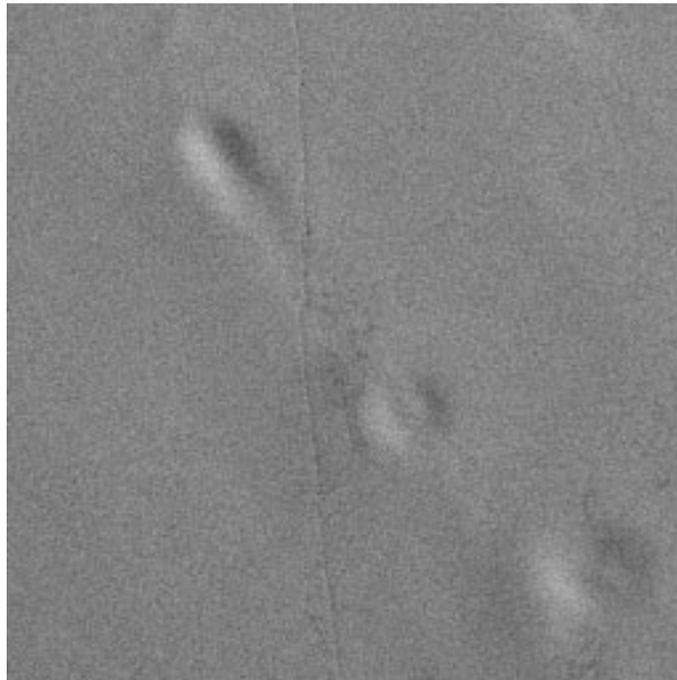


Figure 4. Indentations in the surface. The orientation of the shadow (to the right here) is the opposite of that of the cone in fig. 1. Due to this effect, we know that these are indentations and not extrusions.

Conclusions

With the exception of the large particle located far off-center, the cathode plate compares remarkably well with the Klystron test noses that received specialized handling. The lack of oxidation suggests good storage techniques were used.