Note on Vertical Test Results of Cavity TE1AES005

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Cavity TE1AES005 is a single-cell Tesla-shape cavity manufactured by AES Corporation. The cavity was originally processed (BCP) and tested at Cornell, where it reached a maximum gradient of 26.7MV/m with a Q_0 there of 1.2 x 10^9 and a low-field Q_0 of 1.0 x 10^{10}. The cavity was then sent to Fermilab, where it was electro-polished (EP), HPR'd, and assembled/evacuated exclusively at the ANL/FNAL facility using procedures recently developed over the course of several single-cell processing cycles. The cavity was then tested and reached a maximum gradient of 31.3MV/m with a Q_0 there of 9.5 x 10^8. There was no field emission observed, nor were there any multipacting barriers. While the cavity maximum gradient and low field Q_0 improved when compared to the Cornell tests, the cavity still exhibited substantial Q-drop behaviour, beginning around 25-26MV/m. It was felt, therefore, that this cavity would be a good candidate for a 120º C bake, which would likely reduce or eliminate the Q-drop, and potentially lead to improved cavity performance.

After the first vertical test at FNAL, cavity was removed from the test stand, and baked out a 120° C for 48hours at the A0 facility, with active vacuum pumping maintained throughout the bakeout cycle. The cavity was then transported back to FNAL, to the VCTF at IB1, where it was mounted on the test stand, connected to the pumping system, and instrumented with the prototype single-cell diode thermometry system.

The cavity was cooled down from 4K to 2K, and some Q_0 vs T measurements were performed in the temperature region just above the λ-point transition. Once at 2.00K, CW measurements of Q_0 vs E were performed. The cavity initially reached a maximum gradient of 34.7MV/m with a Q_0 there of 5.7 x 10^9, being limited by quench. Very soon, however, the cavity experienced a "processing event" which then allowed it to reach a maximum gradient of 36.3M/m with a Q_0 there of 5.7 x 10^9, again limited by quench (see Figure 1). There was no field emission observed except at maximum gradient (36.3 MV/m) where the radiation level was just barely above background. It is unclear what this processing event was that allowed the cavity to increase in maximum gradient from 34.7 MV/m to 36.3 MV/m. It is conceivable that a field emitter quickly processed away, leading to the improvement. The fact that no radiation was observed at this gradient level (34.7MV/m) could be due to the FE electrons being accelerated downward, away fro the radiation detector location (top plate). The strong Q-drop observed during the Cornell and first FNAL vertical tests has now been eliminated, presumably as a result of the 120°C bakeout (see Figure 2), with additional improvement of the low-field Q_0 observed also. As a consequence, this cavity now meets the ILC performance specification.

After performing the Q_0 vs E run at 2K, the cavity was further cooled down to 1.51K while Q_0 measurements were made. From these measurements, we find the cavity had a residual surface resistance of about 9.1 ± 0.5 nΩ (see Figure 3). This value of R_s is somewhat higher than recent single-cell measurements, but is consistent with that measured recently on TE1AES004, a single cell cavity that was also baked at 120°C. The

R_s for TE1AES004 was 9.4nΩ. Though it is a small sample size, it appears that the residual surface resistance of cavities that have received the low temperature (120°C) bake are a couple nΩ higher than unbaked cavities.

Diode thermometry was mounted to this cavity and scans were performed at various times during Q_0 vs E runs at 2K, primarily at quench field and at low field. A distinct "hot spot" was observed during cavity quenches, and effort is presently underway to determine the geometric location of the hot spot. This will allow the corresponding location on the inner surface of the cavity can be optically inspected in an effort to localize and identify the quench-inducing defect.

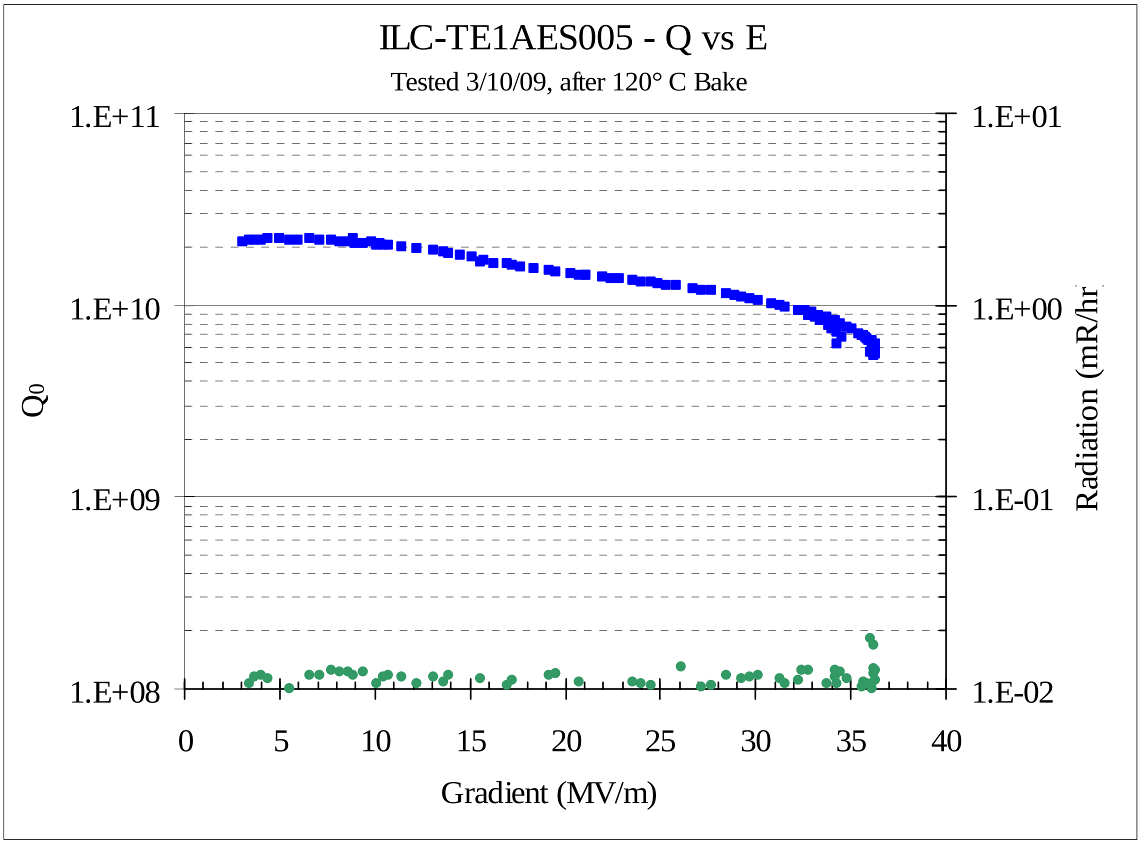

Figure 1.) Initial Q_0 vs E run at 2K

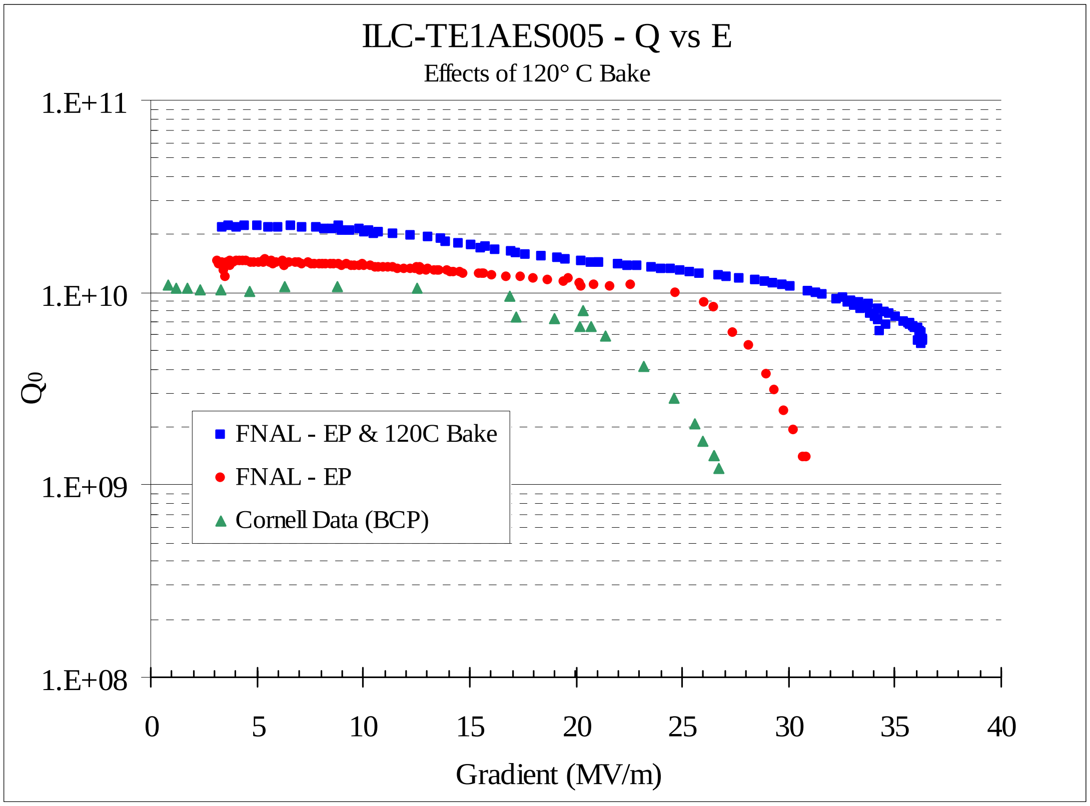

Figure 2.) Q_0 vs E run at 2K. Data from the previous Fermilab and Cornell tests are shown for comparison.

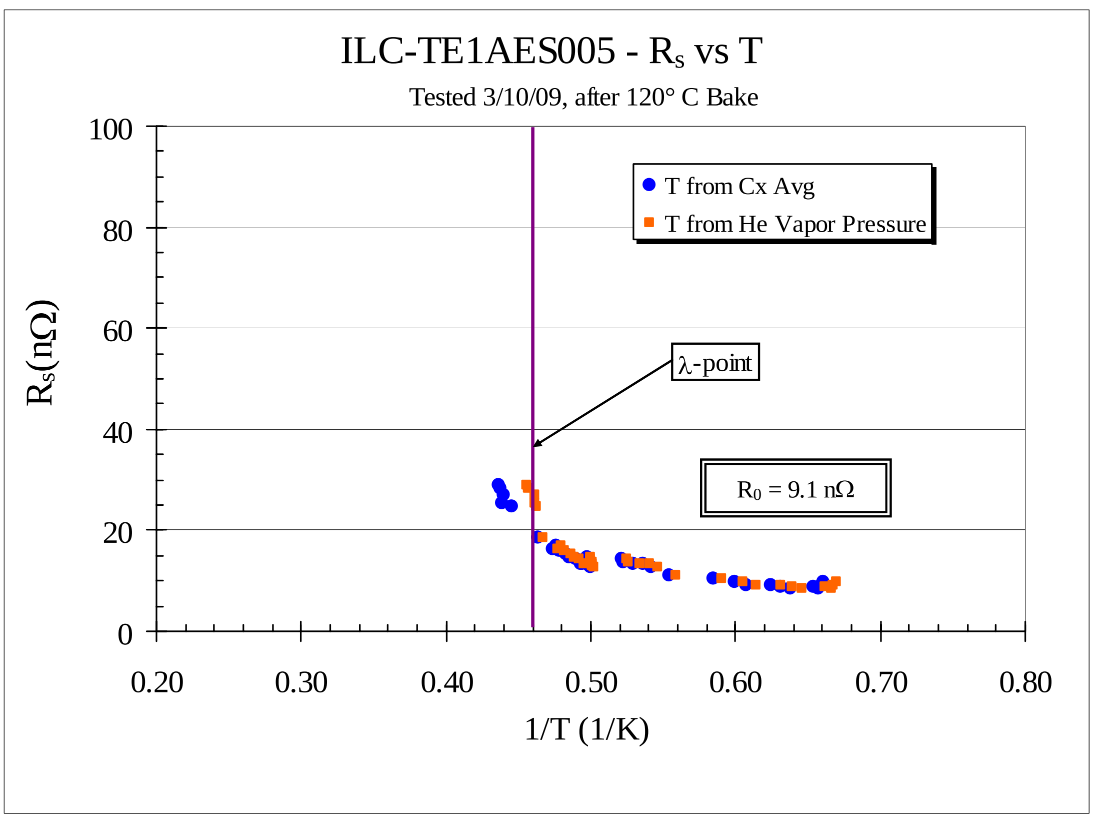

Figure 3.) R_s vs 1/T, yielding a residual resistance of 9.1± 0.5 nΩ