

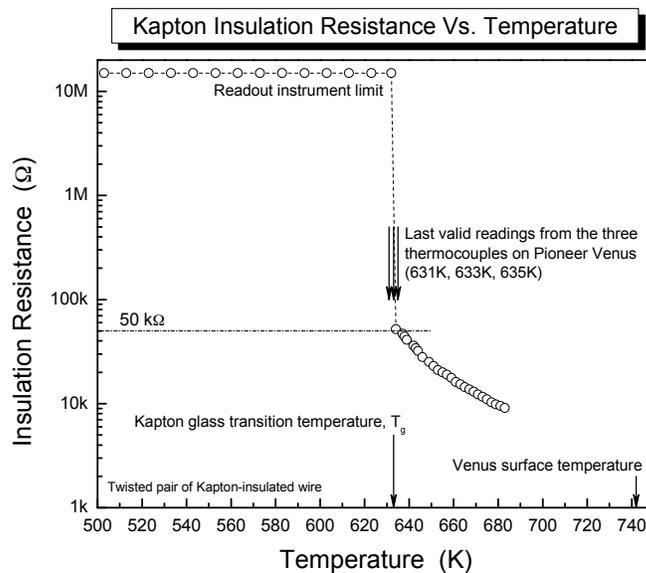
# NEW INSIGHTS TO THE PIONEER-VENUS 12.5 KM ANOMALY

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The Pioneer Venus probe mission, which was highly successful in advanced the understanding of the Venus atmosphere, experienced unexpected behavior in all four external probes at and below an altitude of 12.5 km. Numerous plausible scenarios were investigated, but deemed improbable due to the complex chain of events required for them to occur, and the general lack of common factor that could explain the behavior of all instruments. In 1993, a probable common cause was found during a workshop on this topic [1]. The report concluded that the most likely culprit was Kynar, a fluorinated polymer used in shrink tubing. It was proposed that Kynar degraded at  $>600\text{K}$  to hydrofluoric acid, and degraded underlying Kapton, used in the dressing of field joints. While the chain of events needed for the occurrence of the 12.5 km anomaly remained complex, the appeal of the proposed explanation is in the single cause that relates to the all failures.

This work demonstrates a simpler explanation, which solely relates to the physical properties of Kapton, namely, its glass transition temperature ( $T_g$ ). Being a polymer, Kapton undergoes a second order phase transition at  $T_g = 633\text{K}$ , below which is hard and brittle, and above which it softens and loses its mechanical strength. As Fig. 1 shows, the last valid readings of the three external thermocouples coincide exceptionally well with the  $T_g$  of Kapton, and the failures occurred in a very narrow temperature interval. Electrical shorts, caused by the loss of Kapton's structural integrity coupled with mechanical vibrations during descent, provide a highly probable explanation of the Pioneer Venus 12.5 km Anomaly. Although Kapton was suspected and tested in investigations quoted in the report [1], the relevance of  $T_g$  may have been missed as conclusions were drawn at the end of the experiments at RT, when the Kapton polymeric structure was reformed below  $T_g$ .



Conductivity tests with mechanically-stressed twisted pair of Kapton insulated wire.

[1] A. Seiff, *et al.*, Pioneer Venus 12.5 km Anomaly Workshop Report, *NASA Conf. Publ. 3303*, 1993