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EFFECTS OF ELECTRON IRRADIATION ON HIGH TEMPERATURE SUPERCONDUCTORS AND CONTACTS TO HIGH TEMPERATURE SUPERCONDUCTORS

N89-14900

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CD754412

The discovery of a new class of ceramic superconductors with transition temperatures above liquid nitrogen has opened the doors for exciting space applications. Energy storage, pointing maneuvers, magnetic shielding, and sensitive detection of electromagnetic radiation are some of the longer term possible applications. One near term application involves low electrical resistance, high thermal resistance connections between a detector operating at $\approx$ 4K and the electronics operating at $\approx$ 77K. The new high temperature superconductors could accomplish this providing the necessary electrical connections to the ground plane while isolating the system thermally, thus prolonging the life of the mission. With such possibilities it is clearly of value to study the effects of radiation that would be experienced during a typical space mission. In this work we focused specifically on the effects of the electron radiation environment.

We used the electron radiation facility at NASA Langley which has a beam current of 63.5 nA/cm^2. Through a series of three exposures the samples accumulated a total dose equivalent to 90 years in geosynchronous orbit (4.3×10^{17} el/cm^2). Last year we developed high-quality, low-resistance contacts to the ceramic superconductors. These contacts were used in the radiation studies on $YBa_2Cu_3O_x$ superconductors. Using facilities at Christopher Newport College we measured the transition temperature, the normal state resistivity, the critical current, and the contact resistance. Figure 1 shows a blowup of the superconducting transition for the various irradiations. From these data it is clear that the transition temperature is not effected to within 1K by the electron irradiations. In figure 2 the change in the normal state resistivity from irradiation is plotted as a function of dose. This total change is about 35% of the unirradiated value. The critical current is an important measure of the supercondutor's current carrying ability. It varied about 20% in a non-systematic manner throughout the irradiations staying around 85 A/cm^2 on the average at 77K in zero magnetic field. Finally, the contact surface resistivity must maintain its integrity during the space voyage. It varied from $\approx$2 to $\approx$4 $\mu\Omega$cm^2 from the unirradiated sample to the final dose - all acceptably low values. Clearly we observe changes in the important parameters of the superconducting material (in fact, our observations indicate more sensitivity to electron radiation than the lower transition temperature superconductors such as the A15 class). However, these changes will not significantly affect the operation of the superconductor in the applications mentioned above. The electron radiation environment should not compromise space missions using the new high temperature superconductors.

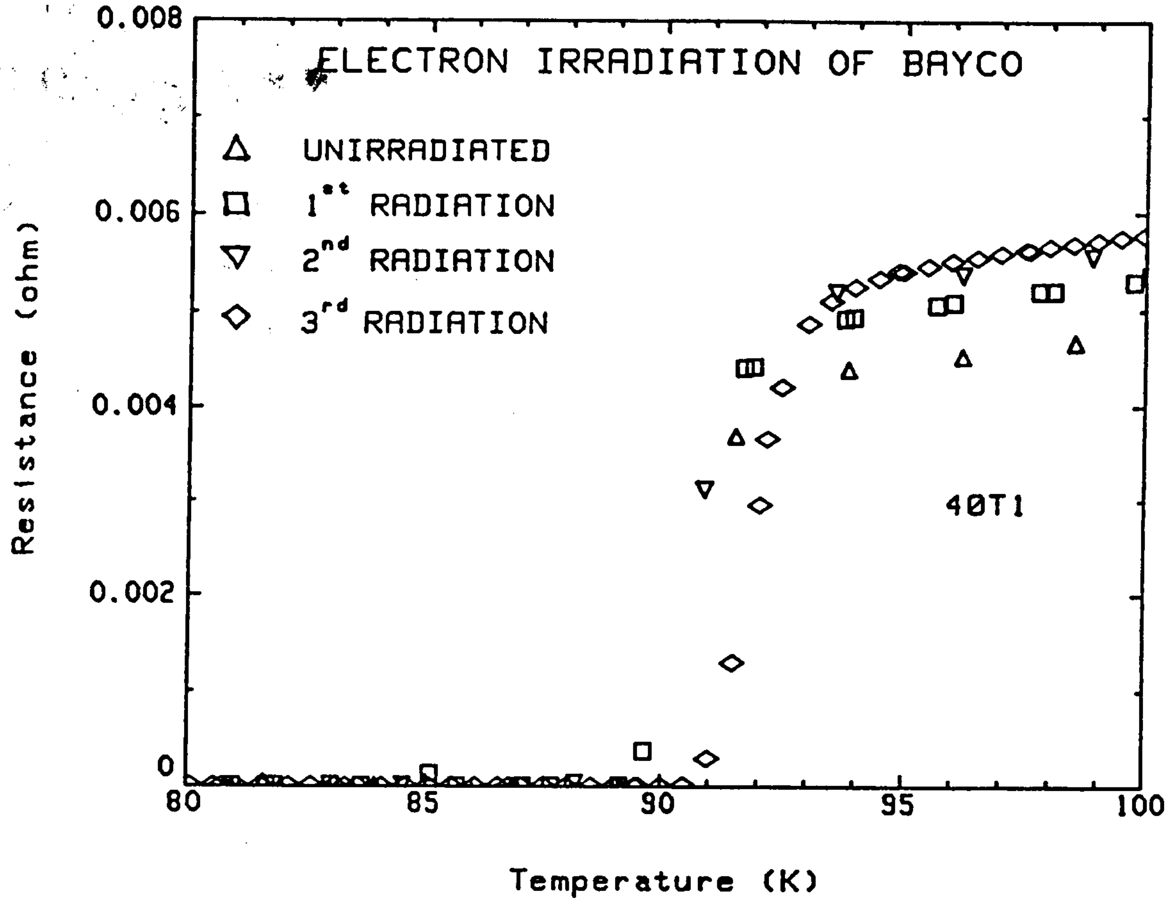

FIGURE 1

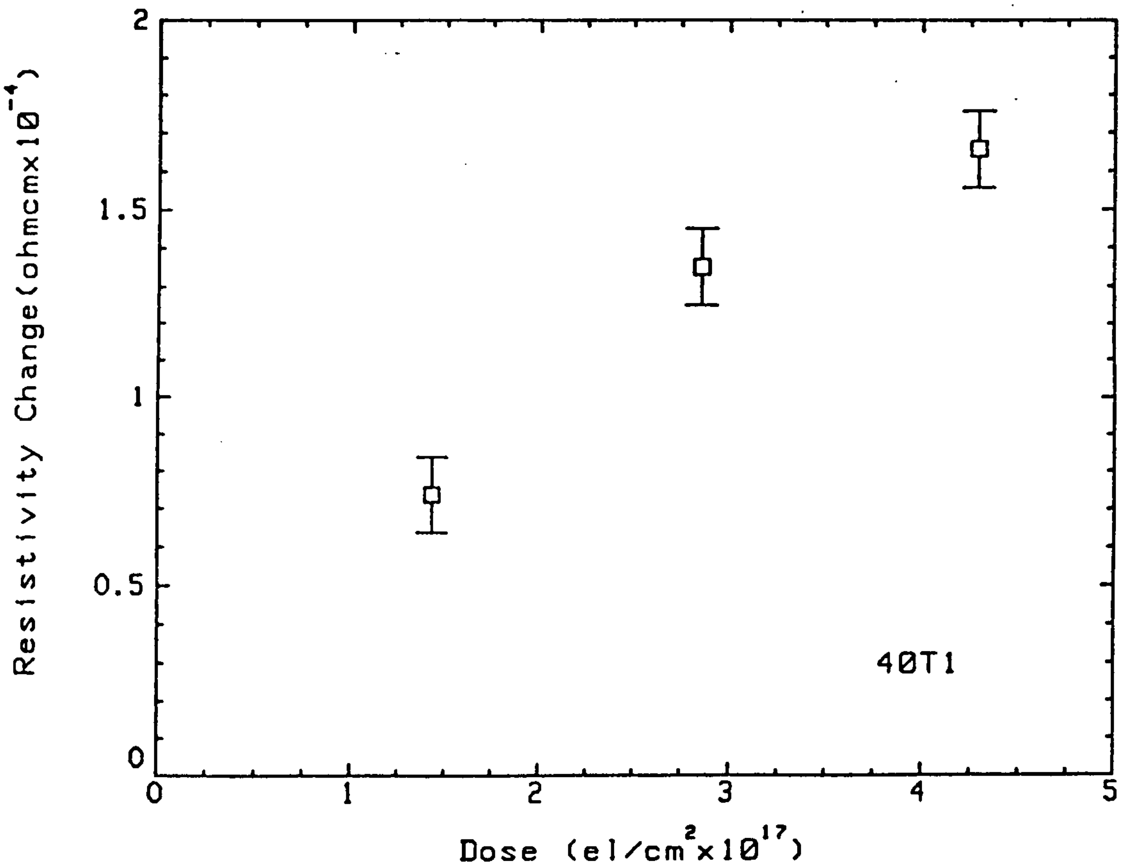

FIGURE 2