Dielectric Breakdown of KCl Crystals Irradiated with γ Rays

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Irradiation with γ rays causes marked changes in the dc dielectric strength of KCl crystals both with and without illumination with visible light, whereas the impulse dielectric strength is not significantly changed. The results are ascribed to space charge and electron trapping.

EFFECTS of x-ray irradiation on the dielectric breakdown of KCl crystals have been reported by the authors.[1,2] The dc breakdown voltage of x-ray irradiated crystals in the dark increases with increasing coloration,[1] while dc breakdown voltage under F-band light illumination decreases with increasing coloration.[2] In this paper some effects of γ irradiation from Co^{60} are reported.

In Fig. 1, dc breakdown voltages with and without visible light illumination are shown as functions of γ-ray dosage. The breakdown voltage in the dark increases to a maximum after some threshold dosage (approximately 10^6 roentgen) and then decreases at much larger dosage. The breakdown strength of well-annealed starting samples (0.5 Mv/cm) increases to a maximum of 1 Mv/cm at an exposure of about 2×10^6 r. The dc breakdown voltage under illumination by visible light decreases with increasing dosage at the start. Figure 2 shows the effects of intensity of light illumination on the dc breakdown voltage of KCl colored by γ irradiation. The breakdown voltage decreases with increasing illumination. The impulse breakdown strength (0.5×100 μsec) was also measured and it was found to be not affected by γ irradiation through a wide range of dosage, being slightly higher than the dc strength of well-annealed unirradiated KCl as shown in Fig. 1. These facts seem to suggest that the abnormal change in dc breakdown strength by irradiation is due to space-charge effects at γ-ray-created imperfections. The decrease of dc breakdown voltage under illumination may be the result of enhancement of the cathodic field due to positive space-charge of ionized F centers as was suggested by von Hippel[3] in the case of photoconduction and was extended to the case of breakdown by the authors.[2] The increase of dc breakdown voltage in the dark is possibly due to (i) negative space charge of trapped electrons at vacancies and F centers created by γ irradiation, which suppresses electron injection[4] from the cathode, (ii) change in ionic space charge.

The mechanism of the decrease of breakdown voltage with no illumination at much larger dosage is unknown at present. X-ray, optical, and conduction current measurements are now in progress.

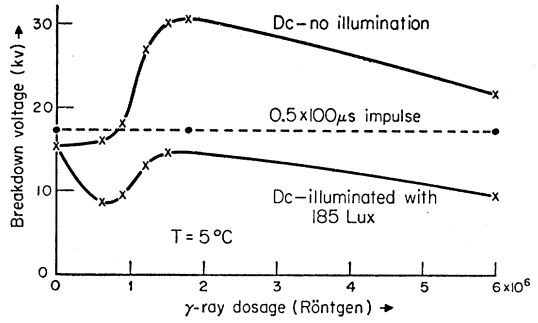

FIG. 1. Breakdown voltage of KCl crystal irradiated with γ rays.

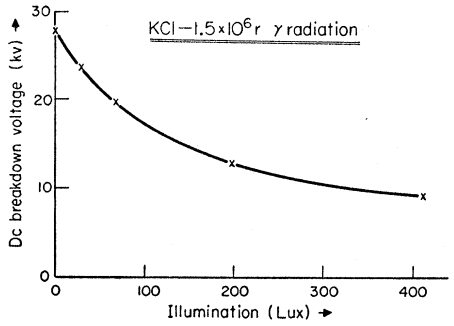

FIG. 2. Effect of illumination on the breakdown voltage of KCl crystals irradiated with γ rays.

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