ELECTRIC INSTABILITY IN CADMIUM TELLURIDE

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When a sufficiently strong field is applied to n-Ge doped with Au and Cu [1-3] and to semi-insulating GaAs [4], an electric instability is observed, connected with the increase of the cross section for the capture of electrons by negatively charged centers. A study of the electric properties of CdTe has revealed that when n-CdTe is heat treated for a short time in Cd vapor, multiply charged A_1 acceptors are produced, the second charged state of which is E_c - 0.06 eV [5]. In addition, it follows from our measurements that when n-CdTe is treated in vacuum, multiply charged A_2 acceptors are also produced, the second charged state of which is near the center of the forbidden band. In this connection, we investigated the possibility of observing such an instability in n-CdTe. The measurements were made at 95°K on high-resistance n-CdTe samples containing either A_1 or A_2 acceptors.

The stationary dark I-V characteristics of the samples containing the A_1 acceptors had negative differential resistance in medium fields ~170 V/cm. However, the entire field

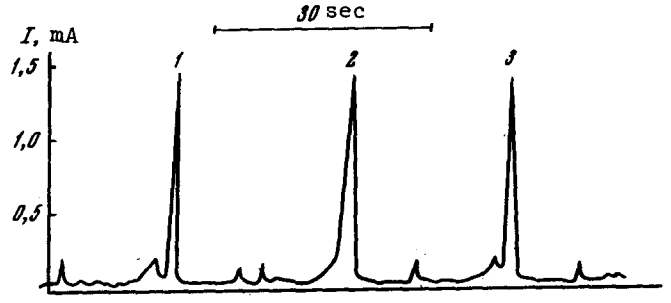

Fig. 1. Oscillations of current through a sample illuminated with white light (V_{sample} = 180 V).

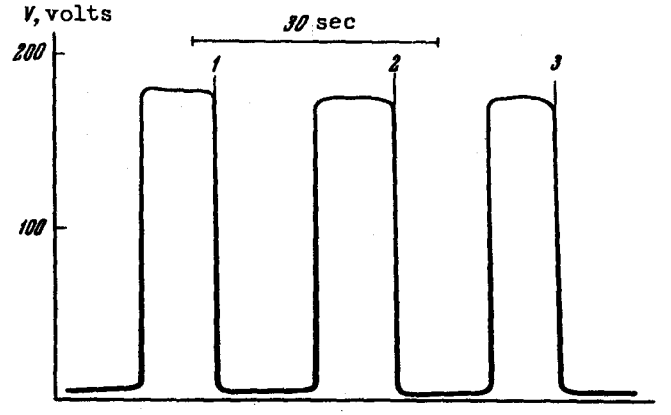

Fig. 2. Oscillations of voltage between probes located near the anode (V_{sample} = 180 V).

was concentrated in this case in a region ~0.5 mm long (stationary domain) located 2 mm from one of the ends of the sample, the sample length being ~6 mm. The domain remained stationary in the investigated voltage interval (up to ~10^3 V). It must be noted that at intensities lower than 70 V/cm the field is uniformly distributed and Ohm's law is satisfied. When the sample is illuminated with white light and also through Ge and Si filters, Ohm's law and the homogeneous field distribution remain in force up to fields on the order of several V/cm. At ~160 V, current oscillations are produced (Fig. 1), accompanied by voltage oscillations (Fig. 2) in the region of the sample between the stationary domain and the anode, i.e., the domain starts to move towards the anode. At voltages larger than 250 V, the oscillations become more complicated and aperiodic, this being apparently connected with the occurrence of a domain in more than one place. In the voltage region 160 - 250 V, we determined the domain velocity, which was strongly dependent on the intensity of the illumination and ranged in our experiments from 0.2 to 2 mm/sec. We also estimated the width of the domain from the rate of growth of the voltage between the two contacts (at a known domain velocity). The width of the domain increased with increasing illumination intensity and ranged from 200 to 400 μ. The change of the domain width and its motion can be explained qualitatively by regarding it as a unique p-n junction [4].

Current oscillations are also produced, at an average field ~500 V/cm, in samples containing the A_2 acceptors, with a frequency of several Hz. However, they start with a decreasing current and have a sinusoidal character. With increasing voltage, the oscillations become more complicated. The oscillation frequency increases with increasing illumination intensity. The stationary I-V characteristics of the samples are such that the average, maximum, and minimum currents through the samples remain practically unchanged when the average field is increased from 500 to 2000 V/cm. The pulsed I-V characteristics are practically linear up to 2000 V/cm. This indicates that the saturation of the current in the measurement of the stationary I-V characteristics is connected with the decrease in the electron concentration upon application of the electric field, since the momentum relaxation time is quite small and the mobility corresponds to the given applied field, whereas the concentration relaxation time is apparently larger by many orders of magnitude, and at our pulse durations (~10^{-6} sec) the concentration corresponds to a weak field.

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