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Gas Desorption from Virginal CdS Crystals¹⁾

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When a virginal CdS crystal platelet is placed in ultra-high vacuo the dark- and photoconductance increases. After heating the crystal to temperatures up to 200 °C the conductance increases further; this cannot be completely accounted for by changes of the intrinsic defect structures (1, 2). Various authors (3 to 7) have shown that ambient gases at pressures as low as 10^{-5} Torr affect the electrical properties of the crystal through adsorbed or chemisorbed surface layers. For instance, chemisorbed oxygen creates acceptors, which can act as recombination centers at the surface and influence the dark- and photoconductance respectively. Desorption of oxygen has been observed at elevated temperatures.

It is the purpose of this paper to analyse the gas desorbed and to determine temperatures for maximum desorption. In the experiment to be described a CdS crystal was placed on a thermally-shielded copper crystal holder in an ultrahigh vacuum system which was pumped to the 10^{-10} Torr range using a triode ion and a Ti getter pump. The crystal temperature could be varied between -180 and +400 °C; crystal temperature and conductance were monitored continuously. A mass spectrometer, capable of measuring partial pressures down to 10^{-13} Torr, was mounted directly in front of the largest crystal surface and shielded against the crystal surroundings to allow desorption studies and to measure the partial pressure of ambient gases in the system.

Upon cooling the previously unheated crystal to liquid nitrogen temperature and then increasing the temperature time linearly, while monitoring the partial pressure of a specific mass number on the mass spectrometer one records a characteristic desorption curve, i.e. a plot of partial pressure versus

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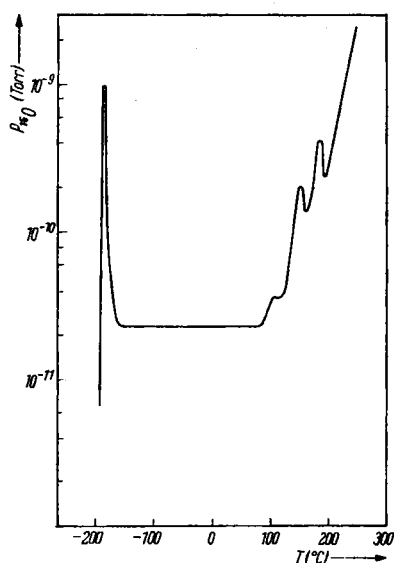


Fig. 1. Change in partial pressure of atomic mass 16 as a function of time linearly increasing CdS crystal temperature (0.4 deg/s)

increasing crystal temperature. A partial pressure maximum will indicate desorption with a certain activation energy.

Fig. 1 shows a typical desorption curve for atomic mass number 16 for a total initial pressure of 10^{-10} Torr. Four desorption maxima are seen. This indicates an adsorbed

layer of very low binding energy which desorbs at about -180°C and at least one²⁾ chemisorbed layer (possibly three layers) which desorb between 110 and 185°C . The observed desorption may have been enhanced by optical irradiation due to the electron source of the mass spectrometer.

Although a complete analysis of the mass spectrum of desorbed gases has not been carried out because of difficulties due to transient effects, it is probable that the main contribution to the mass 16 desorption spectrum is caused by oxygen rather than by other gas components of the same mass number (e.g. CH_4). After baking the CdS crystal at 300°C in ultra-high vacuo the desorption spectrum changes markedly and cannot be restored by oxygen adsorption only. This suggests that changes in the surface structure take place and also are responsible for the well known irreversible changes in electrical properties from the virginal to a later state.

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2) There exists the possibility of desorption from three sites at the surface with different binding energies, leading to the observed three peaks in the measured case.

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