ACTIVATION ENERGY FOR HgI_2 CRYSTAL

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Abstract

The application of AC impedance method to HgI_2 crystal at temperatures between 350 K to 220 K is applied. The equivalent network representing the cell crystal and contacts in dark was deduced. This network represents the response between 1 Hz to 10 KHz. The results also confirmed an activation energy of 0.26 eV found recently by others.

Introduction

Photoelectric properties of HgI_2 crystals were extensively studied by Bube(1) both in the red phase, β-HgI_2, and the yellow phase β-HgI_2. More recently Hyder(2), De Blasi et al.(3), and Manfredotti et al.(4,5) applied different photoelectric techniques (temperature stimulated current (TSC), photovoltaic effect, photoconductivity etc.) not only to characterize trapping levels, hole lifetimes and mobilities but also to investigate possible techniques for evaluating HgI_2 as possible X-ray and γ-ray room temperature detector(6). Deterioration of efficiency with time of these HgI_2 detectors was observed and is refered to as "polarization effects". It is mainly interpreted as being due to trapping mechanisms.

Red HgI_2 is an insulator with a band gap of 2.13 eV at room temperature and a dark resistivity of about $10^{11}\,\Omega$-m. The electron mobility is around 100 cm^2/Vs and the hole mobility is 3-5 cm^2/Vs for a high purity crystal at room temperature.

Regolini and Saura(7) recently found complex impedance plane plots for a red HgI_2 crystal as a function of temperature between -3°C and 70°C. The frequency of the AC signal was between 10^2 and 2×10^4 Hz. They deduced an activation energy of 0.27 eV.

In spite of the large number of publications from various laboratories to characterize HgI_2 crystal, there seems to be very rare agreement between any two of them. The aim of the present work is to apply the AC impedance methods to HgI_2 crystal(8)

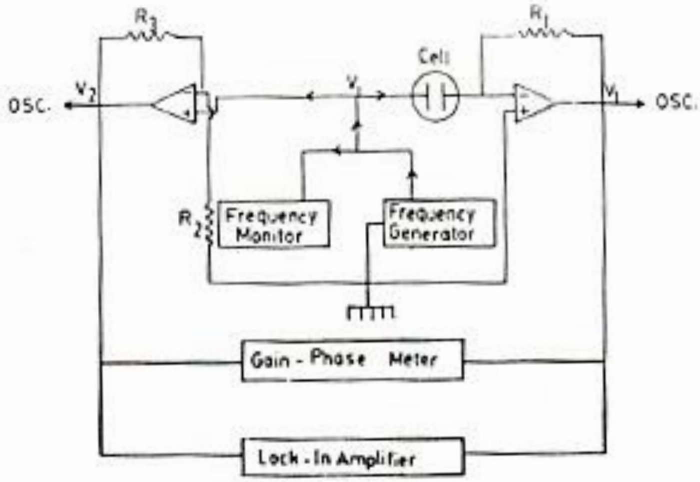

Figure 1: Circuit used for impedance measurements.

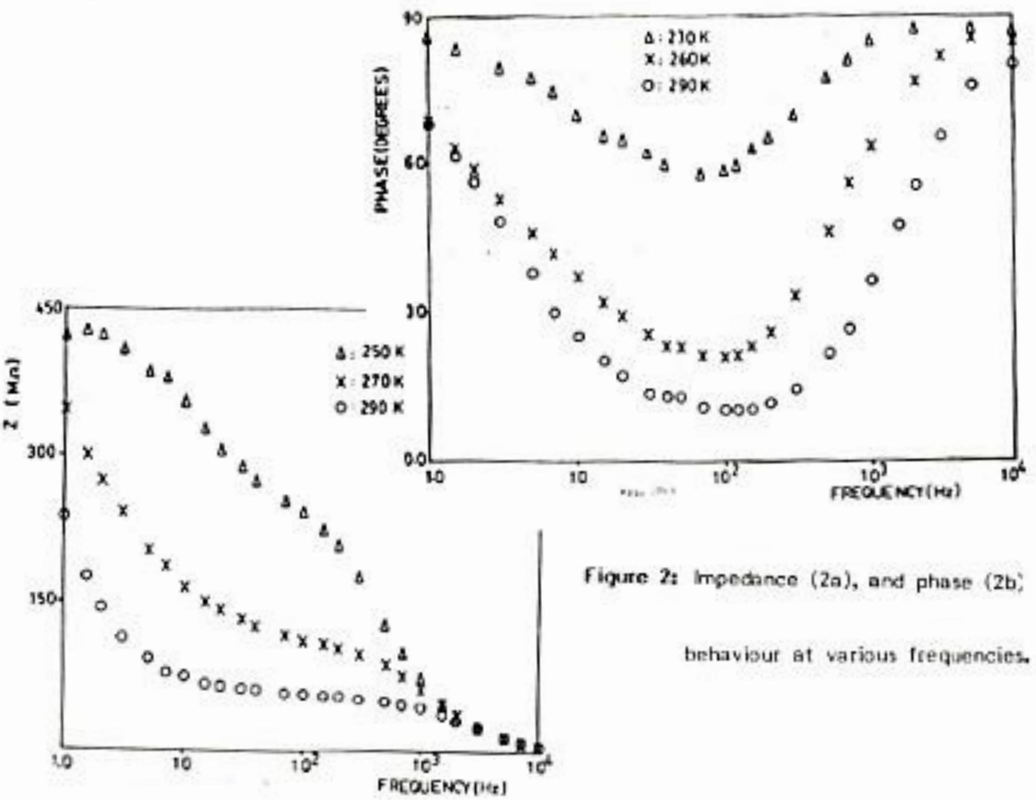

Figure 2: Impedance (2a), and phase (2b) behaviour at various frequencies.

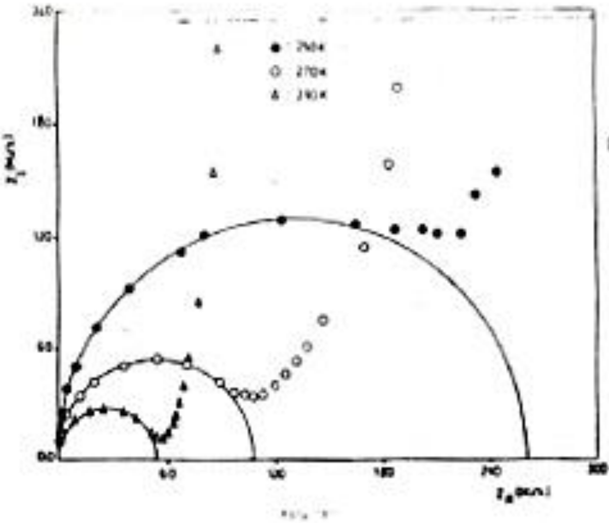

Figure 3: Complex impedance plane plots at different temperatures.

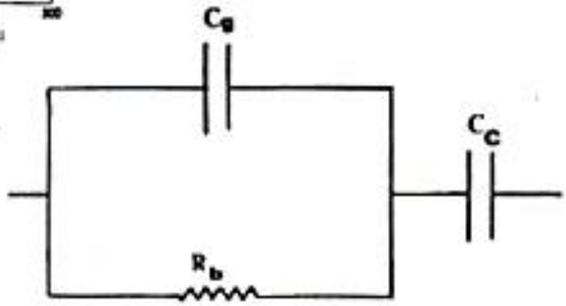

Figure 4: Equivalent network for the HgI_2-cell in dark.

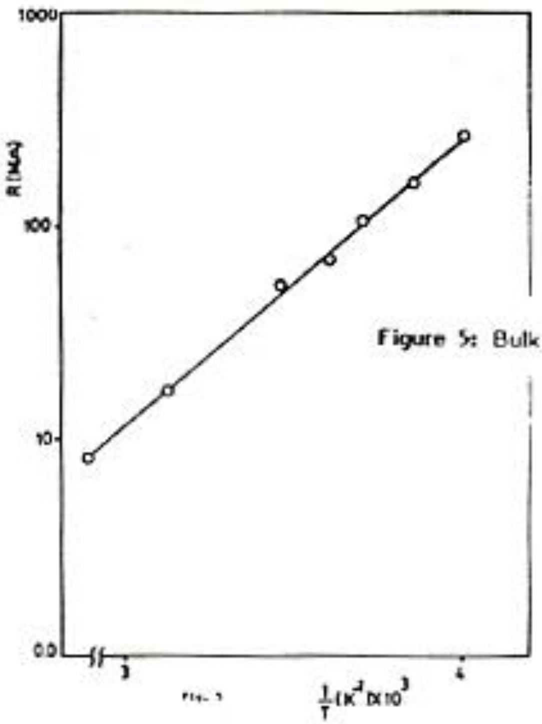

Figure 5: Bulk resistance R_b VS 1/T on a semi log plot.

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