ELECTRON AND HOLE GENERATION IN ANTHRACENE UNDER ELECTRON BOMBARDMENT

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In order to study the effect of trapping and release of carriers in anthracene, short electron pulses of energy up to 50 KeV and dose $2.5 \times 10^{-14}$ C per pulse were used to excite the anthracene crystals and the induced charge transferred was measured for a series of increasing bias voltages of either sign at room temperature. It is found that the hole charge collected at transit time is only half of the total hole charge eventually collected which always equaled the electron charge. An interpretation is given in terms of a trap release mechanism. Shallow hole traps with an activation energy of the order of 0.13 eV are estimated in anthracene crystals at room temperature. The electron mobility normal to "ab" crystallographic plane is $0.38 \pm 0.02$ cm$^2$ V$^{-1}$ s$^{-1}$ and agrees well with other published values.

1. Introduction

Experimental results regarding electron and hole production in anthracene crystals are discussed with emphasis on the relevance of the mechanism of trapping and release of carriers in such low mobility crystals. KOXADO and SCHNEIDER [1] using a conductivity "glow curve" technique, have observed hole traps about 0.8 eV above the valence band. In these experiments irradiation at low temperatures was performed with highly absorbed light, so that it is probable that the traps are characteristic of the surface only. BREE and KYDD [2] have suggested that adsorbed oxygen is responsible for them, and such traps appear also to play an important role in electron bombardment experiments (see Sections 3 and 4).

The method adopted for studying trapping and release of carriers in anthracene crystals is the drift method essentially pioneered by SPEAR [3]. This method has been used for studying many different materials [3] and in particular for anthracene [4, 5].
2. Experimental

2.1. Preparation of specimens

Single crystals of anthracene were grown from the melt, following extensive purification in specially designed crystal growing tubes [6]. The growth vessel was cut open to tip out the ingot and all further operations were carried out within an N₂-filled dry glove box. The plates cleaved from the crystal boule had surfaces of 5 mm × 5 mm, which were “ab” planes,* and thicknesses varying between 0.35 and 0.5 mm.

Specimens were prepared for electron bombardment by evaporating circular semi-transparent metal electrodes, onto each face in turn. The plates were placed in the vacuum system (pressure \( \leq 10^{-5} \) torr) for about half an hour prior to evaporation in order to ensure fresh surface by sublimation. Aluminium was then flash evaporated from a 3-strand tungsten helix covered by a radiation shield with a hole 4 mm in diameter, and at a distance of about 150 mm from the crystal specimen placed on a brass mask. The layers produced were highly opaque and conductive and when viewed against the light had a mirror-like finish. Such layers were estimated to be about 200 Å thick. The specimen was mounted behind an aperture of 1–2 mm in diameter in the copper lid of the specimen chamber, which could be heated or cooled from outside. Electric contact was made by sandwiching the crystal, painted with Aquadag rings on the aluminium, between a washer of platinum foil and a copper disc. The front (bombarded) electrode was connected to the bias supply, the rear (collecting) electrode to the current integrator as described below.

2.2. Apparatus

The electron bombardment apparatus** was based on that developed by SPEAR [3]. The crystals were equipped with evaporated aluminium electrodes (see Section 2.1) on two opposite faces. Carriers were generated at one electrode by the incident single electron pulses (typically 90 ns long, of energy between 20 and 50 KeV and carrying \( 2.5 \times 10^{-14} \) C total charge \( Q_b \)) and drifted through the crystal under an applied field to be collected at the other electrode. The resulting pulse was displayed on 85 MHz oscilloscope (Tektronix type 581 with 86 preamplifier) as an integrated charge pulse and recorded photogra-

* The orientation of the cleavage planes was kindly checked by Professor J. W. JEFFERY of the Crystallography Department, Birkbeck College, University of London.

** Fuller details of the apparatus and experimental technique are given by M. SALEH Ph. D. thesis, University of London 1972.

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