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OPTICAL PROPERTIES OF AMORPHOUS Se FILMS PREPARED BY PECVD

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The optical transmission spectrum of amorphous Se films prepared by plasma-enhanced chemical vapour deposition was measured over the 500 to 2000 nm spectral region. The absorption coefficient values plotted vs photon energy according to Tauc's law yielded an optical gap, E_g, of 1.94 eV. The temperature dependence of E_g was measured between 13 K and 300 K and was found to be well described within Fan's one-phonon approximation. Photo-induced darkening of the optical gap was studied by illumination at 13 K and 77 K. © 1997 Elsevier Science Ltd

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1. INTRODUCTION

A decrease in the optical gap (photodarkening) for amorphous chalcogenides after bandgap illumination is a well-known effect. In amorphous Se (*a*-Se) reversible photodarkening is observed only if the material is illuminated below room temperature, in fact, at a temperature close to that of liquid nitrogen. Most studies on *a*-Se, a simple twofold coordinated material, have dealt with thin films prepared by thermal evaporation. In our study we have prepared films of amorphous selenium by plasma-enhanced chemical vapour deposition (PECVD).

The optical transmission was measured as a function of the photon energy in order to derive the refractive index and absorption coefficient of these films. The procedures that have been proposed by Swanepoel [1] for this optical characterization have been applied here. This involves the construction of continuous envelopes around the extremes of the interference fringes. The optical gap of *a*-Se was determined from the calculated values of the absorption coefficient. We also studied the temperature dependence of the optical gap, $E_g(T)$. Furthermore, we summarize our results of the investigation of the influence of temperature on the shift of the optical absorption edge induced by illumination. The aim is to show that the light-induced red shift of the gap is connected with an increase of localized states at the band edges.

2. EXPERIMENTAL PROCEDURES

Amorphous Se thin films were prepared by PECVD using the hydride H_2Se as precursor gas. Details of the deposition conditions have been described by us in previous papers [2, 3]. Information concerning the structure of the films was obtained from Raman spectroscopy. The spectra indicated that the dominant molecular structure is the eight-membered ring and/or a chain with Se_8 molecular fragments [2]. The optical transmission was measured in the temperature region 13–300 K, using an optical cryostat fixed in the sample compartment of the spectrophotometer. The sample illumination was made at 13, 77 and 300 K by a halogen lamp equipped with an infrared-cut filter. During illumination, the lamp was fixed in the sample compartment of the spectrophotometer, so that the position of the beam was always the same. We also recorded the reflectivity spectrum at room temperature.

3. RESULTS AND DISCUSSION

Figure 1 shows a typical optical transmission spectrum of an as-deposited amorphous Se film recorded at room temperature. Two features are immediately apparent: