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Conductivity Studies of Multilayer Thin Films

Engineering
KEYWORDS :

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ABSTRACT

Alzarin dopped gallium arsenide and germanium multilayer thin films of different thickness between 5nm to 25nm were deposited on clean glass substrate at room temperature in a high vacuum of 510 -6 torr. In this paper, we report the preparation of doped GaAs/Ge multilayer thin films using electron beam (e-beam) evaporation technique. The conductivity of the film was determined by measuring the developed between two probe points of four probe systems. It is found that the conductivity decreases with reciprocal temperature and also with film thickness. From the slope of the plot, which is nearly linear throughout the temperature region studied the activation energy was evaluated to be about 400meV. It has been concluded that at lower temperature the conduction is due to hopping of carriers whereas at higher temperature and for thick films band model is prevailing. The ferroelectric algirin provides electron injection into the solid.

Introduction

Technologically the polycrystalline semiconductors have gained a tremendous importance because of their application in device and integrated circuits. Full utilization of the advantages offered by the use of polycrystalline semiconductors provides an improved quantative understanding for the electrical properties of the semiconductors.

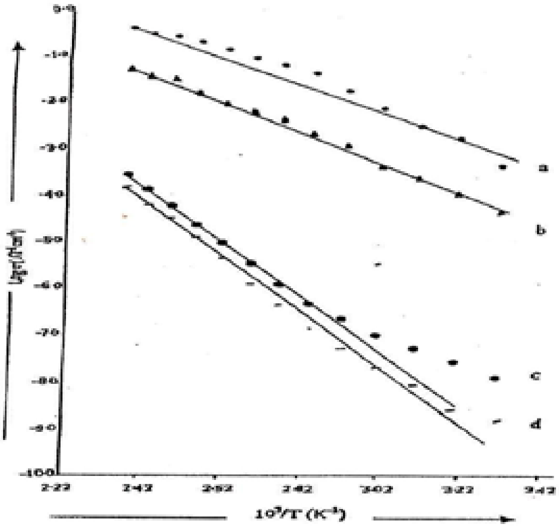
The study of thr physical properties of semiconductors in the form of multilayer has become an active field in the applied physics. The salient features of crystalline semiconductors e.g., the existence of sharp edges at valence and conduction band leading to a well-defined forbidden energy gap, are direct consequence of the longer range order [3-9]. Multilayer form of the material which may produce to be efficient for device applications [10-13]. Electrical properties of thermally evaporated GaAs and Ge films have been reported by some workers [14-16]. However it has also been found that the increase if the film thickness decrease its activation energy [17-19]. A good description of conduction mechanism has been provided by Gupta and Mishra [20-22], to decide whether it is hopping of carrier at localized sites or coherent band model.

Experiment details:

The multilayer thin films of algerin doped GaAs/Ge of thickness varying from 5nm to 25nm were prepared, by electron beam evaporation of material having 99.9% purity, on optically plane pyrex photographic glass substrates of dimensions 2.5cm×7.5cm×2cm under the vacuum of the order torr at room temperature. Before deposition, glass substrates were cleaned first with chromic acid and then with distilled water. They were further cleaned using teepol detergent, isopropyl alcohol and distilled water. The source to substrate distance was 12cm. The thickness of the films was measures using a quartz crystal monitor. In order to ensure the correct composition of the GaAs/Ge multilayer thin film formed in each evaporation, a known quantity of the material was taken in the crucible and was completely evaporated at a fast rate. All the evaporation were carried out in nearly identical deposition conditions. In the present study the two points of the four probe system was employed the measurements of the current. The distance between probe point was 1.5mm and was interfaced to source measuring unit (SMU Kaithley model 236), When voltage is applied at a time current developed through the film was measured by SMU. The electrical property of the film investigated in the temperature range of 300 to 450K.

Result and discussion:

The temperature dependence log of conductivity of GaAs/Ge multilayer thin films, evaporated onto glass substrate of different thickness at temperature T_s of 300K is shown in fig. It is seen from the plot that for all the films, the conductivity is a linear function of the reciprocal temperature, decreasing with decreasing temperature, in the temperature range studied. Linearity of the plot is nearly same for all films (a to d) the activation energy is evaluated from the slope of log versus 1/T in the higher temperature range plots and is found to vary between 290to 400meV. It is also noted that there exists an extrinsic region at lower temperature range where conduction is through hopping of carriers is localized sites. For more thick films where crystallinity is pronounced, we observe higher slops (films c and) and as such band model is expected to prevail.



Conclusion:

Multilayer thin films of GaAs and Ge have been studied as a function of temperature. It has been found that the conductivity is an inverse function temperature. From the Log vs 1/T, which is linear in the high temperature region, the activation energy is found between 290 to 400meV for films studied. It is also seen that at lower temperature, extrinsic region is existing and conduction is due to hopping of carriers. For thick films and at higher temperature band model is prevailing.

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