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Amorphous thin films of Se_{75} Te_{25} Prepared by Vacuum Evaporation Technique.

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ABSTRACT

Se_{75} Te_{25} Thin film were prepared on cleaned glass substrate by vacuum evaporation technique at a pressure of 10^{-7} Torre. Prepared Thin film is annealed at a temperature to show crystallization nature, partial crystallization is achieved. Result show due to thermal annealing the d.c. conductivity and photoconductivity increase. Result on crystallization D.C. conducting. Steady and transient photo conductivity was studied which indicate photosensitivity decreases on crystallization. The band gap and optical absorption coefficient may also influence photoconductivity. Photo current decay as the extent of crystallization continues to increases. The results are show in term of the defects in the mobility gap in the present material.

Keywords: amorphous thin film, conductivity, photo current, photoconductivity, crystallization

INTRODUCTION

Amorphous thin films have truly emerged as multipurpose materials and have been used to fabricate technologically important devices such IR detector, electronic and optical switches, electronic resist and optical recording media [1-9].

Development of chalcogenide based rewritable optical memories is recently done. Crystallization of chalcogenide films is accompanied by a change in optical band gap [13-15]. The change in optical energy gap could be determined by identification of the transformed phase. The effect of thermal annealing has been explained on the basis of defects in mobility gap of Se_{75} Te_{25}. The mechanism of recording memories in an optically, thermally or electrically induced reversible phase transition between amorphous to crystalline state and vice versa in thin films [11-13]. Thermal processes are known to be important in inducing crystallization in semiconducting chalcogenide glasses [10-12]. Different crystalline phase's separations are observed on ternary glasses with thermal annealing. [16-18].

Se-Te has low crystallization temperature. It is quite important to study the effect of crystallization on its electrical properties. Studies on D.C. conductivity has been made [19, 20] and it is found that D.C. conductivity increases by several orders of magnitude on crystallization. A closer survey into the literature reveals that no systematic study has been made on the effect of partial crystallization on the photoconductivity of Se-Te. The present work report the effect of thermal annealing on the photoconductive behavior of amorphous $Se_{75}Te_{25}$ thin films prepared by vacuum evaporation. Crystallization is achieved by annealing the amorphous films, near the crystallization temperature for different annealing times. The extent of crystallization is calculated by measuring D.C. conducting. Steady state and transient photo conductivity was studied. The result indicates that the photosensitivity decreases on crystallization.

METHODOLOGY

A dielectric thin film of Se_{75} Te_{25} was prepared by a quenching technique. 1N pure materials were weighed according to their atomic percentages and sealed in a quartz ampoule (length ~ 1cm; internal diameter ~ 3mm) under a vacuum of ~10^{-7} Torr. The sealed ampoule was kept inside a furnace where the temperature was raised to 500° C at a rate of 1-2°C min^{-1}. The ampoule was rocked frequently during the 7 h at maximum temperature to make the melt homogenous. The quenching was done in cold water. The homogenous nature of the prepared thin films was verified by x-ray diffraction.

Photoconductivity of the amorphous films was studied by mounting them in a specially designed sample holder in which illumination could be achieved through a transparent window. A vacuum of ~10^{-2}Torr was maintained throughout these measurements. The results were, however, found to be the same under a higher vacuum of ~10^{-7} Torr. The planer geometry of the films was used for the photoconductivity measurements.

The light source used for the photoconductivity measurements was a 200W tungsten lamp. An interference filter was used to obtain light of the desired wavelength. Light intensity was measured by a ditigal lux meter (Testron, India; Model LX-101). The photocurrent was obtained after subtracting the dark current (I_d) from current measured in the presence of light. The current was measured by a digital electrometer (Keithley, model 614). For the measurement of transient photoconductivity the sample was irradiated with red light (660nm) and the rise in photocurrent was noted manually using the digital electrometer. The measurements were made on amorphous films. The sample was then annealed at 385 K for 30 min in the same sample holder under a vacuum of 10^{-3} Torr. The measurements were then repeated with the temperature kept below the annealing temperature. The process continued till saturation in dark conductivity and photoconductivity was reached. The extent of crystallization was calculated using the DC conductivity values at room temperature.

RESULTS AND DISCUSSION

Amorphous thin film of $Se_{75}Te_{25}$ was annealed at 380 k for different annealing times and the value of D.C. conductivity (δ_d) was measured at room temperature. The result of measurements show that D.C. conductivity increases drastically on annealing. The saturation value of (δ_d (2.83x10^{-8} to 1.92 x 10^{-5} 1/Ωcm)) is obtained after annealing for total time period of 225 min which occur in state of crystallization state. The extent of crystallization **(α)** is calculated by the formula as $\log \delta m = \alpha \log \delta_C + (1-\alpha) \log \delta_a$. Where δ m= d.c. conductivity measured at room temp in partially crystallized state. δ_a represents the d.c. conductivity in amorphous state. The value of '**α**' is (0 to 0.93). The activation energy for d.c. conduction (ΔEd) is calculated and the values (0.45 to 0.18 eV).

Increase in photoconductivity, δ_{ph} (1.78x10-7 to 2.12x10-5 1/Ω cm) measurement indicates that the thin film material is becoming more photoconductive. The band gap and optical absorption coefficient may also charge during crystallization which may also influence photoconductivity. The observed increase in δ_{ph} related to the increase in carrier mobility due to crystallization. A maximum in the rise of photocurrent was observed in amorphous state of Se_{75} Te_{25} reported in [21]. Rise and decay of photocurrent was studied at room temperature in amorphous and crystallized film.

CONCLUSION

The prepared amorphous thin films of $Se_{75}Te_{25}$ were obtained by thermal evaporation on dielectric substrate. The films are amorphous and their nature charges from amorphous to crystalline with increase annealing temperature. Chalcogenide film is accompanied by a change in optical band gap and interpreted in terms of an increase in higher density of defects in crystalline state than in amorphous one..

Conflicts of interest: The authors stated that no conflicts of interest.

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