

REPORT OF THE WORK DONE

(A) TITLE OF THE PROJECT:

“Photoelectrochemical and optical studies of $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.50, 1.0$) single crystals grown by vapor transport technique.”

(B) WORK DONE:

The project was started from 1st April, I have started my project through latest reference work for the growth of germanium monosulphoselenides materials i.e. $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.25, 0.5, 1$) crystals by chemical vapor transport technique using NH_4Cl as transporting agents through the University library and also through the internet. It was found that some work has already done for these crystals grown by direct vapor transport technique and chemical vapor transport technique using Iodine as transporting agents but limited work has been done for the growth of crystal by chemical vapor transport technique using NH_4Cl as transporting agents.

It is seen from the literature survey that crystal of germanium monosulphoselenides can be grown by using two horizontal furnaces developed by University Science Instrumentation Centre (USIC), Sardar Patel University, Vallabh Vidyanagar. I have calibrate the furnace in the department of physics with help of alumel, chromel thermocouple for the growth of $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.50, 1.0$). I have procured the required chemicals from the company. I have purchased quartz tube of 22 outer diameter and 20mm inner diameter of length 1 meter and prepared ampoule with cleaning process. Stoichiometry proportion of 10 gm chemical $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.50, 1.0$) in powder form has been filled inside in the capillary and then sealed off at pressure of 10^{-6} torr at USIC and insert in the horizontal furnace arranged at different temperature.

Crystal of $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.50, 1.0$) grown by chemical vapor transport technique using NH_4Cl as transporting agents, the nature and quality of transporting agent affects the dimension and morphology of the grown crystals and due to presence of transporting agent the process of vapor transport takes place at relatively low temperatures. However in DVT a direct transport of material in pure vapor form takes place and hence highly pure crystals are obtained using this method.

After the growth of $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.50, 1.0$) by chemical vapor transport technique using NH_4Cl as transporting agents, started photoelectrochemical properties of above crystals. Various solar cell parameters have been measured e.g. short circuit current, open circuit voltage, fill factor, efficiency, dark current and dark voltage etc. for semiconductor electrodes prepared using $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.5, 1$) single crystals. It also shows semiconductor electrolyte interface characterized by locating valence and conduction band edges, for which flat band potential measurements were carried out by using Mott –

Schottky plots. These studies justify the selection of appropriate electrolyte for PEC work.

This project includes study of optical properties of $\text{GeS}_x\text{Se}_{1-x}$ ($x=0, 0.5, 1$) single crystals using absorption. The optical absorption data were obtained by using DK-2A spectrophotometer in the wavelength range 200nm to 2000nm. The two and three dimensional models for direct and indirect transitions of photogenerated carriers have been investigated using spectral analysis. This chapter describes the in-depth study of optical spectra. It was found that all the samples possess the direct as well as indirect band gap. Various optical parameters have been calculated using optical absorption spectra.



Principal Investigator
Minor Research Project
Physics

A SUMMARY OF THE WORK DONE FOR THE PERIOD OF PROJECT

The project was started from 1st April, 2011 and then carries out a through reference work for growth of germanium monochalcogenides crystals by vapor transport technique.

From the literature survey it was found that very little amount of work has been carried out on these crystals. In first year, I have grown GeSe, GeS_{0.5}Se_{0.5} and GeS crystals by chemical vapor transport technique using NH₄Cl as transporting agents by two zone horizontal furnace developed by University Science Instrumentation Centre (USIC), Sardar Patel University, Vallabh Vidyanagar, Gujarat. From these crystals, we have seen that enhancement of sulphur content how it change the properties and characteristics of the pure material and also see the effect of transporting agent. The generated data are in good agreement with reported one and they are presented at various seminar/conferences.

In second year, we started photoelectrochemical properties of above crystals. Various solar cell parameters have been measured e.g. short circuit current, open circuit voltage, fill factor, efficiency, dark current and dark voltage etc. for semiconductor electrodes prepared using GeS_xSe_{1-x} (x=0, 0.5, 1) single crystals. Also included study of optical properties of GeS_xSe_{1-x} (x=0, 0.5, 1) single crystals using absorption spectra.



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