The mutual solubility of GeTe and PbTe was investigated using x-ray techniques. An immiscibility region between Pb$_{0.925}$Ge$_{0.025}$Te to almost pure GeTe was found to exist at room temperature. Complete solubility does exist at and above 600°C but it was found that quenched supersaturated alloys were quite unstable upon heating to as low as 200°C, decomposing to GeTe and Pb/GeTe phases.

The range of solubility of metal rich Pb$_{1-x}$Ge$_x$Te


This paper is based upon research performed by M. Massimo under the guidance of Dr. I. B. Cadoff while at New York University, Bronx, New York, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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was investigated using Hall coefficient and electrical resistivity measurements for two alloys, Pb$_{0.98}$Ge$_{0.02}$Te and Pb$_{0.93}$Ge$_{0.07}$Te. A retrograde solubility very similar to that found in PbTe exists. Both n-type and p-type material can be generated by utilizing the solubility limits on the metal-rich side of the Pb$_{1-x}$Ge$_x$Te phase. Critical, intrinsic, crossover temperatures were found at approximately 590°C for the 2% alloy and 490°C for the 7% alloy.

Optical and thermal investigations of the physical properties showed that a two valence band model can be applied to this system.

Key words: Immiscibility region, Hall coefficient, electrical resistivity, retrograde solubility, optical, thermal, two valence band.

Introduction

As part of a study on the structure and electronic properties of PbTe, SnTe and GeTe pseudo-binary alloy systems, the present investigation was conducted on the PbTe-GeTe system. This investigation includes (a) the stability of single phase Pb$_{1-x}$Ge$_x$Te over the compositional range of $x = 0$ to $x = 1$ and from room temperature to 600°C as determined from x-ray lattice parameter data, (b) stoichiometry and retrograde solubility of Pb$_{0.98}$Ge$_{0.02}$Te and Pb$_{0.93}$Ge$_{0.07}$Te alloys and (c) energy gap of the two alloys as determined by thermal and optical measurements.

Experimental Procedures

Material

All samples were prepared from 99.999% pure Pb and Te and semiconductor grade Ge ($\rho = 20$ ohm-cm). All melting and heat treatment at elevated temperatures were performed in evacuated (or inert atmosphere) sealed quartz capsules.