CHAPTER - I

GENERAL INTRODUCTION

Photoconductivity was first observed in lead selenide at liquid nitrogen temperature in Germany, but no reports were made to the open literature (1). Subsequently it was Smith (2), who first discovered and correctly interpreted photoconductivity in selenium in 1873. Similarly as early as 1839, Becquerrel (3) observed photovoltaic effect, but was not paid much attention till early 1900. No attempt was made to correlate photoconductivity with infrared detection until 1904, when Bose (4) announced his discovery of photovoltaic effect in galena and patented an infrared detector based on this principle. This was also ignored, until Case (5) reported photoconductivity in a number of compounds except galena and demonstrated the first application of thin film infrared detector for military communication in 1917. The principal historical development of the period was the 'Thalofide Cell' of Case (6). Some infrared photoconductivity was found in pure thallous sulfide, proper heat treatment with the addition of oxygen enhanced the sensitivity appreciably. After a decade in 1930, Lange (7,8) described a galena photovoltaic cell for detecting infrared radiations. It was during 1930-40, serious attempts started for the development of sensitive photoconducting films of lead salts. In 1941, Cashman (11) started his work on thallous sulfide who later changed his attention to PbS in 1944. Further the lead salt detectors were found to be better than the thallous sulfide ones, i.e., thallous sulfide detectors are sensitive up to 1.3 microns whereas the sensitivity was pushed up to nearly 8 microns with the three types of lead salt detectors (PbS, PbSe, PbTe). Early work on the properties and their use as infrared detectors has been excellently reviewed by a number of workers (9-12).

Because of the scientific and industrial importance, photoconductivity in lead salts, has been exhaustively studied (12-16). Attempts to analyse the electronic properties of these materials using only electrical conductivity turned out to be complicated due to the variety of different effects that may be contributing to the measured values and have posed a series of enigmas for over 20 years. In order to assist the interpretation of electronic phenomena in these systems, attempts have been made to use the Hall effect and photo Hall-effect measurements separating the carrier concentration and mobility effects. Attempts to use the Hall and photo-Hall effects in understanding the mechanism of photoconductivity in PbS-like layers have been made and discussed by Levy (17), Woods (18), Bode (19), Volger (20), Davis and Greene (21), and Snowden and Portis (22), Petritz et al. (23), Bube (24). Similar increase in understanding of the electronic phenomena of these PbS-like layers might be expected from an application of thermoelectric and photothermoelectric measurements to these materials. There is little literature to date on the thermoelectric and photothermoelectric properties of these lead chalcogenide films. It was Bube (25, 26), who after a gap of over a decade returned to this problem with a detailed investigation of the mechanism of photoconductivity in chemically deposited PbS layers and solution sprayed CdS films.

Despite these sustained efforts, the principal mechanism for photoconductivity in these PbS-like films remains unexplained successfully and is one of the major problems which needs further investigation. Above all these, in most cases the PbS-like layers as-grown by vacuum deposition are not adequately photosensitive, but can be made so by proper heat treatment in air or oxygen (27). The role of oxygen in sensitising these films is rather obscure, and remains to be completely understood yet. Attempts have been made to correlate the photoconducting properties of these PbS-like layers with the structure of the films, but to date no definite relation is established excepting that these photoconducting properties depend on the structure of the film in a complicated way. Thus in the light of brief review given above, this particular program was undertaken to study some of the structural, photoelectronic properties, and to understand the mechanism of photoconduction in evaporated lead telluride polycrystalline films, details of which are presented in the subsequent chapters. The program of the work undertaken for the purpose is as follows .

1) Preparation of the films and structural studies of these by electron microscope and X-ray diffraction techniques.

2) Studies on temperature variation of conductivity, photoconductivity in the temperature range of 130K-300K.

3) Measurements of thermoelectric, photothermoelectric and Hall effect to study the temperature variation of carrier concentration, mobility in the temperature range of 130 K - 300 K.