SUMMARY

Thin film photoconductors are being extensively used in solid state device technology. PbS is one of the most extensively studied and used of all photoconductors. But the mechanism of photoconductivity is not completely understood. Also the details of preparative conditions in relation to the properties have not been published in the literature. It is known that adsorbed oxygen is responsible for photosensitivity. A systematic study of the photoconducting and related properties of chemically deposited thin films of PbS was undertaken with special reference to the effect of baking in air at different temperatures up to 300°C.

Thin films on glass substrate were prepared by chemical deposition using solutions of lead acetate, thiourea and sodium hydroxide. The conditions of preparation of good adhering film were standardised. The films were baked in air in stages at progressively higher temperatures up to 300°C. Another batch of samples was prepared by oxidation of the films in situ during their chemical deposition using hydrogen peroxide as an internal oxidant. A large number of samples were studied and representative values have only been reported.
The photoconductive and photosensitive properties were measured. It was observed that photosensitivity is reduced by baking the film in the temperature range 100°C-125°C while the same is enormously increased when baking is made at 300°C. The response times measured from rise and decay curves at this stage are only of the order of 10-100 μ secs.

One of the basic properties i.e. activation energy for conduction was measured from dark conductivity-temperature measurements. It was found to be (0.36 ± 0.01) eV. The carrier mobilities as determined from Hall effect studies were of the order of 5 cm²/V·sec. The nature of conductivity was p-type in all the films, as seen from thermo-e.m.f. studies. The carrier concentrations were relatively more for unbaked and highly baked than that observed for the films baked at intermediate temperatures (100°C-125°C).

As the properties of thin films are largely dependent on the nature of the surface, the presence of surface states would play a dominant role on the photoconductive properties. The field effect studies were, therefore, carried out to find out the nature of slow surface states. The surface state densities and field effect time constants were found to be maximum for films baked in the 100°C-125°C temperature range.
All the above results have been analysed and discussed in relation to the structure-sensitive properties of PbS. The films show good photosensitivity due to adsorbed oxygen which introduces energy levels such that they trap the photoelectrons and increase the hole photoconductivity. Baking in the initial stages causes desorption of oxygen and like impurities, creating new levels and introducing deep traps. A desensitization thus occurs because of reduction in the concentration of electron traps (shallow traps). The remarkable sensitivity observed due to baking at higher temperature has been attributed to a state of oxidation of PbS as a result of which the concentration of shallow traps (for electrons) is much increased producing an increase in hole concentration (as observed in thermo-e.m.f. data). The densities of surface states also show a correlation with the photoconductive properties.

The photoconductive property studies carried out for a few films oxidised in situ during their chemical deposition in an aqueous bath indicate that the method is not so effective in producing sensitive films compared to that of oxidation by baking at higher temperatures.