Although the phenomenon of electroluminescence (EL) has been known for more than half a century, its utilization became a practical reality only after the development of conducting transparent electrode. Yellow emitting ZnS, still the best EL material known, is commonly used in flat panel displays which are now commercially available. The need for full colour devices has engaged the attention of scientists working in commercial, governmental as well as academic institutions and considerable efforts have been devoted in developing new efficient phosphor materials which can emit primary blue, green and red colours. This thesis contains the author's work in preparing efficient EL phosphors, the details of fabrication of low voltage operated thin film EL (TFEL) devices and DC TFEL devices, carried out in the past few years at the Physics Department of Cochin University of Science and Technology.

Some of the important work presented here are related to the white light emitting ZnS:Cu,Pr,Cl phosphor which can be colour tuned by changing the
excitation frequency, observation of energy transfer from Cu/Ag ions to rare earth ions in ZnS:(Cu/Ag), RE, Cl phosphors, development of TFEL device which can be operated below 50V, optimisation of the device parameters for long life, high brightness in terms of the active and insulating layer thicknesses, observation of dependence of threshold voltage for the onset of emission on frequency of excitation when a novel dielectric Eu$_2$O$_3$ film was used as insulator and the devices with multi-colour emission using ZnS doped with rare earth as active layer.

The results and observations, essentially based on the work carried out by the author are summarised in eight chapters. The reference to literature is made at the end of each chapter.

First chapter is the general introduction to the subject of electroluminescence with a comprehensive review of the phosphors together with a brief discussion of physical mechanism involved in electroluminescent process. A brief survey of different models to explain memory and non memory TFEL devices is also given.
Chapter two describes the experimental set up used for the various investigations. The phosphor preparation techniques are given in a detailed manner. The various measuring techniques used for recording EL spectra, brightness–voltage, brightness–frequency characteristics, recording of the brightness wave forms and measurement of brightness in absolute units are also outlined. This chapter also presents a concise description of various deposition techniques used for the fabrication of AC TFEL and DC TFEL devices.

The third chapter which is divided into two parts, is based on the preparation and characterisation of efficient EL powder phosphors using AC powder EL devices. Part A gives the details of preparation of white light emitting ZnS:Cu,Pr,Cl phosphor. The detailed investigation of Pr concentration dependence on EL emission spectra is presented. The frequency dependence of EL emission spectra of ZnS:Cu,Pr,Cl which makes it colour tunable by changing the excitation frequency is explained using Schön-Klasens model together with resonant energy transfer from Cu to Pr ions. The second part deals with the investigation of energy transfer from Cu/Ag ions to rare earth ions in ZnS doped rare earth phosphors.
Chapter IV presents the electrical conduction mechanisms, dielectric and optical properties of the insulator films used for TFEL devices. Detailed investigations of the dielectric properties of Eu$_2$O$_3$ films and its thickness, temperature and frequency dependence on dielectric constant and loss factor are given. This chapter also includes the dielectric studies of Sm$_2$O$_3$, MgF$_2$, CeO$_2$, Na$_3$AlF$_6$, BaTiO$_3$ and SiO insulator films. The Sm$_2$O$_3$ and Eu$_2$O$_3$ films are found to have large dielectric constant compared to other insulating material and these are found to be suitable for low voltage operated TFEL devices.

The fabrication of AC TFEL devices in MISIM and MIS structure using ZnS:Mn as active layer forms the subject of Chapter-V. This also demonstrates the frequency dependent threshold voltage for the onset of emission in the devices having MgF$_2$ and Eu$_2$O$_3$ as insulators, and this effect is explained on the basis of frequency dependent loss tangent of insulator materials. The optimisation of the device parameters for low voltage operation, high brightness and stability in terms of the insulator and active layer thickness are described.
The study on the effect of different insulators having different figure of merit on the EL emission brightness and on operating voltage shows that \( \text{Sm}_2\text{O}_3 \) and \( \text{Eu}_2\text{O}_3 \) films are best suited for low voltage operation. The study of aging of these devices is also presented.

Chapter VI describes the fabrication of low voltage driven multicolour emitting AC TFEL devices using rare earth doped zinc sulphide (ZnS:RE) as active layers (RE = Pr, Nd, Sm, Eu, Tb, Dy, Er). The EL emission spectra and the probable transitions giving these emission are given here. The device with ZnS:TbCl\(_3\) emitting blue green is found to be the most efficient one. The effect of halides on the EL emission spectra and B-V characteristics in the case of ZnS:Pr are also presented.

Chapter VII deals with fabrication of DC powder EL cells using ZnS:Mn phosphor. The mechanism of EL emission and forming process are also described. In this chapter the fabrication of DC TFEL devices in SnO\(_2\)-ZnS-Cu\(_x\)S-ZnS:Mn-Al structure is described in detail. The mechanism of light emission and forming process are explained to a certain extent from the electrical measurement data of these films. Characterisation of
other devices based on ZnS:Sm, ZnS:Pr, ZnS:Dy and their emission characteristics are also illustrated.

The concluding chapter gives the summary and evaluation of the investigations presented in the preceding chapters. The present status and the novel techniques adopted by the commercial and various R and D organisations are given in detail. The future possibilities of TFEL devices are also discussed in this chapter from an application point of view.

Part of the investigations presented in this thesis has been presented/published/communicated in the form of the following papers in Symposia/Journals:

(1) "Spectral characteristics of EL emission from ZnS:Pr,Cl phosphor", Proceedings of the National Conference on EOPS, March '87, Paper OOl6, Mithal Publications, Delhi.

(2) "EL emission characteristics of SnO₂-ZnS-CuxS-ZnS: Mn-Al structure thin film device", presented in the National Seminar on Crystallography, Changanachery, December 1987.

(3) "Electroluminescence of ZnS:Cu,Tb,Cl, ZnS:Cu,Gd,Cl and ZnS:Cu,La,Cl phosphors", XVI OSI Symposium held at CGCRI, Calcutta 1988.
(4) "Observation of energy transfer from Cu and Ag centres to rare earth ions in ZnS(Cu/Ag), RE EL phosphors", National Seminar on Physics and applications of new materials, IACS, Calcutta 1988 Indian Journal of Physics 63A, 480 (1989)


(12) "Dielectric and optical properties of Europium Oxide films", Thin Solid Films (In press).


(14) "Low voltage driven ZnS:Mn thin film device with MIS structure", Communicated to Thin Solid Films.