The thesis work is focused on understanding of structural as well as dynamical properties of orientationally disordered crystals, using experimental techniques viz. Dielectric Spectroscopy (DS) and Differential Scanning Calorimetry (DSC). Plastic crystals offer orientational disorder which is of particular interest in understanding the dynamics of complex and still unsolved mystery of glass transition as plastic crystals are thought to be far simpler because of translational symmetry in the system.

The thesis as such consists of eight chapters, where Chapter 1 starts with the brief survey of the development in glass physics. It also discusses the dielectric relaxation in general as this particular technique is the most used technique for the study of glasses.

Chapter 2 is devoted to the description of the experimental techniques used in the study. A brief account is given on the DSC and dielectric spectroscopy techniques.

Chapter 3 deals with the effect of dopant on the plastic crystalline phase of some hexa-substituted benzenes viz. pentachloronitrobenzene (PCNB), dichlorotetramethylbenzene (DCTMB), trichlorotrimethylbenzene (TCTMB) along with some of their deuterated samples, and 1-cyanoadamantane (CNADM).

Chapter 4 deals with the dielectric relaxation investigations on three interesting supercooled plastic crystalline substances i.e. isocyanocyclohexane (ICNCH), cyanocyclohexane (CNCH) and 1-cyanoadamantane (CNADM). All of these have the main dipole moment situated in their side group -C≡N or -N≡C. Differential scanning calorimetry (DSC) was also employed as a supporting technique.

Chapter 5 deals with the investigations of two interesting (two-component) solid solutions, where one is a hydrogen (H-) bonded pair and the other is a non-H-bonded pair. The former is the two component system cyclooctanol (COOL) + cycloheptanol (CHOL), which forms a simple cubic phase. This solid phase has been investigated at
low temperatures and for several concentrations by means of low-frequency dielectric spectroscopy and differential scanning calorimetry (DSC).

Chapter 6 deals with the investigation is to see how various relaxation processes including the chair-chair transformation (as found by earlier researchers at room temperature in the mechanical relaxation spectroscopy) in cyclohexane derivatives evolve as the temperature is lowered. For this purpose, two remarkable (two-component) solid solutions that are orientationally disordered are investigated, where one is a hydrogen (H-) bonded pair, and the other is non-H bonded pair. The former is the two-component system of cyclohexanol (CHXOL) and 2,2-dimethyl-1-propanol or neopentanol (N POL), where the liquid mixture on cooling forms an orientationally disordered phase which is probably a face centered cubic phase and is a solid solution of the corresponding pure phases. This solid phase has been investigated at low temperatures and for several concentrations, by means of dielectric spectroscopy and differential scanning calorimetry (DSC).

Chapter 7 deals with the investigations on an extraordinary two-component (H-) bonded pair i.e. CHXOL-CHPOL. Where in CHXOL-CHPOL, the phase I/II(?) of cyclohexanol (CHXOL) beyond $x_m \geq 0.075$ forms a solid solution with the phase I of cycloheptanol (CHPOL). This solid phases has been investigated at low temperatures and for several concentrations, by means of dielectric spectroscopy and differential scanning calorimetry (DSC).

Chapter 8 gives a brief summary of the results and scope for further work.