CHAPTER 5

CONCLUSION

The present work has been taken up to develop the instrumentation for X-ray diffraction and electrical resistivity studies up to 100 kbar. EN 24 alloy steel has been successfully used as the anvil material for electrical resistivity measurements for many cycles at room temperature. It is possible to get good reproducibility in the pressure calibration by controlling the gasket dimensions. For instance the initial gasket thickness should be nearly equal to the critical gasket thickness. Two types of high pressure cells have been constructed for X-ray diffraction studies and found that the cells are working well within their pressure limits. The proportional counter X-ray detector system developed for the high pressure X-ray diffraction work shortens the time of data collection compared to the film method. Further, it gives good signal to noise ratio at high pressures. It is possible to use the same sample cell for the pressure recycling to check the reproducibility of the results. In the clamp type cell it is possible to estimate the pressure from the load vs pressure curve within an error of ±2 kbar.

For the first time, pressure induced changes in quasicrystals have been studied by us through X-ray diffraction and electrical resistivity measurements. The anomalous behaviour observed in the quasicrystals is an interesting result. In Al_{62}Fe_{18} an electronic
transition is found to occur at 57 kbar associated with hierarchy of changes. \( \text{Al}_{0.90} \text{Mn}_{0.10} \) exhibits electronic transition over an extended range of pressures. \( \text{Al}_{0.86} \text{Fe}_{0.14} \) exhibits electronic transitions at 50 kbar. Similarly, ternary systems such as \( \text{Al}_{0.82} \text{Mn}_{0.11} \text{Fe}_{0.07} \), \( \text{Al}_{0.86} \text{Mn}_{0.14} \text{Fe}_{0.07} \), \( \text{Al}_{1.15} \text{Mg}_{0.35} \text{Ag}_{0.50} \), \( \text{Al}_{1.15} \text{Mg}_{0.35} \text{Cd}_{0.50} \), \( \text{Ge}_{0.15} \text{Mg}_{0.35} \text{Zn}_{0.50} \) and \( \text{Mg} \)(\text{Al},\text{Ag})_{49} \) exhibit electronic transitions. In \( \text{Al}_{1.15} \text{Mg}_{0.35} \text{Ag}_{0.50} \), above 37 kbar, the diffraction peak corresponding to 2.215 Å splits into two peaks and the splitting disappear when pressure is reduced below 30 kbar. In \( \text{Mg}_{0.32} \)(\text{Al},\text{Ag})_{49} \), above 35 kbar, a new peak appears and this peak disappears when pressure is reduced below 35 kbar. Throughout the pressure range, the quasicrystalline phase is retained.

The ternary phosphides \( \text{Zr}_2 \text{Ru}_{12} \text{P}_7 \) and \( \text{Yb}_2 \text{Ru}_{12} \text{P}_7 \) show the metallic behaviour under pressure. The resistivity decreases with pressure and the unit cell volume decreases monotonically with pressure. These phosphides are stable in their structures upto 100 kbar pressure. The superconducting compound \( \text{La}_{1.8} \text{Sr}_{2} \text{CuO}_4 \) and the non-superconducting compound \( \text{La}_2 \text{CuO}_4 \) are stable in their structures upto the pressure range of the present investigation. The electrical resistivity of \( \text{La}_{1.8} \text{Sr}_{2} \text{CuO}_4 \) decreases with pressure, while that of \( \text{La}_2 \text{CuO}_4 \) increases with pressure. In \( \text{YBa}_2 \text{Cu}_3 \text{O}_7 \), a reversible structural phase transition from orthorhombic to tetragonal in the pressure range 65-70 kbar at room temperature is observed. The change in slope of the electrical resistivity above this pressure range is perhaps connected with the orthorhombic to tetragonal transition in \( \text{YBa}_2 \text{Cu}_3 \text{O}_7 \).
Future directions

Introducing the internal heating systems in the present opposed anvil high pressure device, it is possible to measure the electrical resistivity at high temperatures. The clamp type cell can be used to take X-ray diffraction at low temperatures without any modifications in the cell. The only requirement is a modified dewar flask which has sufficient opening for the X-rays. The study of quasicrystals under pressure and temperature will give more valuable results about their structures. It is possible to draw phase diagram of the quasicrystals by studying them in different temperature and pressure conditions. The study of the superconducting compounds at low temperature and at high pressure will give interesting results. It is worth to measure the \( T_c \) of the \( \text{YBa}_2\text{Cu}_2\text{O}_7 \) above the transition pressure.