Open-framework inorganic materials constitute an important area of study in materials chemistry, because of their potential applications in areas such as sorption and catalysis. After the discovery of nanoporous aluminium phosphates (AlPOs) by Flanigen et al in 1982, there has been a tremendous growth in the area of porous solids that are based on phosphates. Apart from phosphates, phosphites, arsenates, sulfates, sulfites, selenates, selenites etc. have also been investigated. In addition to the different anions, the framework compounds now encompass almost all the elements of the periodic table. The compounds exhibit wide variety and structural diversity. New building units, such as thiosulfate and borate have also been explored as a network builder in the formation of framework structures. In this thesis, the results of the investigations on open-framework metal thiosulfates, metal borates and metal sulfates are presented. The studies are aimed not only at the synthesis of the new compounds based on the new anions, but also their possible applications.

In Chapter 1 of the thesis an overview of inorganic open-framework materials with different anions is presented. In Chapter 2 (Part A), the synthesis, structure and transformation of inorganic-organic hybrid open-framework cadmium thiosulfate are presented. The lack of stability of the thiosulfate ion in solution prompted the exploration of new approaches such as low temperature solvothermal methods, use of rigid linkers etc. The transformations of lower to higher dimensional structures have been accomplished. The possible mechanisms for such transformations were investigated. In Part B, the physical and chemical properties of the hybrid cadmium thiosulfate frameworks are presented. The studies indicate that the anionic dyes selectively adsorb on the compounds in the water medium and also desorb reasonably in alcoholic medium. The cadmium thiosulfate compounds appear to be reasonable photocatalysts for the photodecomposition of the cationic dyes under UV irradiation as well as under sunlight with good recyclability. The compounds also exhibit heterogeneous catalytic behavior (Lewis acidity) for the cyanosilylation of the imines.

In Chapter 3, a new family of organically templated open-framework borate materials is presented. The zinc and aluminoborate structures, prepared in the present study, are rationalized using the HSAB theory. The \([\text{B}_4\text{O}_6\text{H}_2]\) units polymerize
differently to form different zinc borate structures. The amine molecules act as a ligand by binding with the metal. The nature of the amine appears to control the dimensionality of the final zinc borate structures. The zinc borate compounds exhibit absorption of UV-light ($\lambda = 365$ nm) suggesting that the zinc borate compounds could be exploited for UV-blocking applications. Organically templated aluminoborates have connectivities between the Al$^{3+}$ ions and the [B$_5$O$_{10}$] cyclic pentaborate units. The aluminoborate structures exhibit graphite layer and three-dimensional diamond structure. Detailed studies and comparison of the various amine templated open-framework aluminoborate structures reveals subtle relationships between the organic amines (shape and length of the amines) and the final framework structures.

In Chapter 3, the synthesis, structure and catalytic studies of a variety of cadmium sulfate phases have been carried out. Polyaza-heterocyclic ligands were employed to study their possible role in the formation of such structures. All the compounds have structures built up by the connectivity involving the cadmium octahedra and the sulfate tetrahedra in which the heterocyclic organic molecules act as the ligand. The connectivity between the Cd$^{2+}$ and (SO$_4$)$_{2}^{-}$ ions form one-, two- and three-dimensionally extended cadmium sulfate phases, though the starting source is cadmium sulfate ($\text{CdSO}_4\cdot8/3\text{H}_2\text{O}$) in all the cases. The connectivity between Cd$^{2+}$ ion and the heterocyclic ligand also gives rise to one- and two-dimensional structures. The interconnectivity between the two units gives rise to the final observed structure. As part of the study, a variety of properties i.e. adsorption-desorption, photocatalytic degradation and cyanosilylation reaction, exhibited by the cadmium sulfate compounds have been investigated and the properties are comparable to the cadmium thiosulfate phases.

AlPOs are well known for their many important properties. The wide varieties in their structures and heterogeneous catalytic properties have been extensively investigated. The photocatalytic behaviors, on the contrary, have not been investigated in detail. The photocatalytic properties of the metal-doped AlPOs, for the photodegradation of organic dyes have been investigated in the Chapter 5. The metal ions (Mg$^{2+}$, Zn$^{2+}$ and Co$^{2+}$) have been substituted in place of Al$^{3+}$ and Ti$^{4+}$ in place of both the Al$^{3+}$ and P$^{5+}$ in a variety in AlPO structures and the synthesized phases are characterized by a variety of techniques. Photodecomposition studies of organic dye molecules under
UV-light were carried out in aqueous medium. The studies suggest that the photocatalytic activity is reasonable and appears to depend on the dopant concentration. Ti-substituted phase exhibits the maximum catalytic activity.