

EXECUTIVE SUMMARY OF UGC MINOR RESEARCH THE PROJECT

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“Investigation of magnetic and photocatalytic properties of coordination polymer based phosphomolybdates” - by Dr. Jency Thomas

Phosphomolybdates (PMOs) are an important class of inorganic materials owing to their structural versatility and potential applications in areas such as anti-tumor agents, catalysis, magnetism and as sensors [1]. Conventionally, soft-chemistry routes such as solvent evaporation and hydrothermal synthesis favour the formation of PMO cluster based solids [2] predominantly, Strandberg type $\{P_2Mo^{VI}_5O_{23}\}^{6-}$, $\{P_4Mo^V_6O_{31}\}^{12-}$, Keggin $\{PMo^{VI}_{12}O_{40}\}^{3-}$ and Wells-Dawson cluster $\{P_2Mo^{VI}_{18}O_{68}\}^{18-}$ [3]. However, the formation of these cluster based solids is highly dependent on synthetic parameters such as pH of the reaction medium, temperature of the reaction medium and presence of organic ligands or transition metal complexes [4].

In the presence of transition metal complexes, formation of solids ranging from discrete clusters to 3D architectures [5] is possible. Among these, coordination polymer (CP) incorporating PMO clusters are of particular interest. CPs have been classified as solids in which the metal ions and organic ligands, self-assemble in such a way that there is a direct metal ligand coordination at least along any one of the dimensions. The ligand must have at least one carbon atom between the donor atoms [6]. By carefully selecting the organic ligand one can tune the physical properties and thus realize various applications, such as catalysis, electrical conductivity, luminescence, magnetism, non-linear optics or zeolitic behaviour [7]. Linking CPs with PMO clusters can therefore lead to new opportunities to be explored.

On the basis of the above considerations, an attempt was made to synthesize CP incorporating PMO cluster based solids. This required a careful monitoring of the reaction parameters namely (i) Choice of phosphorus and molybdenum precursors, (ii) Temperature and pH of the reaction medium, (iii) Concentration of reacting species and (iv) Nature of organic ligands and transition metal centers. The synthetic methodology resulted in the crystallization of several solids, of which, a few have not been reported in literature so far. Unambiguous structure elucidation and characterization of the synthesized solids was carried out using Fourier Transformed Infra Red Spectroscopy, Thermogravimetric analysis and powder X-ray diffraction. In cases wherein crystals were obtained, the structure

determination of the synthesized solids was done using single crystal X-ray diffraction. Magnetic susceptibility measurements were carried out for selected solids wherein transition metal centers had been incorporated. The observed magnetic moments were found to be in good agreement with values reported in literature [8].

In the second phase of the project, an attempt has been made to synthesize ammonium phosphomolybdate (APM) and investigate its photocatalytic behaviour towards degradation of cationic dye-stuffs from waste waters. Four dyes *viz.* Methylene Blue (MB), Eosin Y (EY), Malachite Green (MG) and Methyl Red (MR) were selected and their solutions were treated with APM. The decolorisation of dye-stuffs was recorded with respect to the change in intensity of absorption peaks using UV-Visible spectroscopy. It was observed that absorption peaks for MB, MG and MR had disappeared upon treatment with APM, indicating that the dye had been removed. Effect of variables such as nature of dye, concentration and pH was further investigated and a plausible mechanism for the action of APM on dye-stuffs has been proposed.

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Paper presentations/ Publications:

1. "Influence of ligand in the crystallization of organic-inorganic hybrid solids" UGC Sponsored National Seminar on Advances in the Frontier Areas of Chemical Sciences (NSAFC-2016) St. John's College Anchal, Kerala, 9-10 Nov, 2016.
2. "Anti-bacterial activity of chromotropic hybrid solids" International Conference on Emerging Frontiers in Chemical Science (EFCS) Farook College (Autonomous) Kozhikode, Kerala, 23-25 Sept, 2017.
3. "Photocatalytic activity of phosphomolybdate cluster based solids" International Conference on Emerging Frontiers in Chemical Science (EFCS) Farook College (Autonomous) Kozhikode, Kerala, 23-25 Sept, 2017.
4. "Investigation of ammonium phosphomolybdate for photocatalytic activity" International Conference on Advanced Functional Materials for Energy, Environment and Biomedical Applications (AFMEEB-2017) Madurai Kamaraj University, Madurai, Tamil Nadu, 11-12 Dec, 2017.
5. "Crystallization of Multifunctional Hybrid Solids" 6TH International Congress on Technology - Engineering & Science Conference (ICONTES) Kuala Lumpur, Malaysia, 19-20 July, 2018.
6. "Synthesis, Structure and Photoluminescence studies of Hybrid Solids based on Strandberg-type Cluster" (Manuscript under preparation).
7. "Role of Ammonium Phosphomolybdate as an Adsorbent for Cationic Dyes" (Manuscript under preparation).
8. "Crystallization of Multifunctional Hybrid Solids" (Manuscript under preparation).