Department of Chemistry
Indian Institute of Technology Madras

PhD Research Colloquium

Study of Oxidative Processes Involving Inorganic-Organic Hybrid Materials in Corrosive, Photocatalytic and Photoelectrochemical Environments

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Guide: Prof. G. Ranga Rao

Venue: CB 310

Date: 05 Nov 2019
Time: 3:00 pm

Inorganic-organic hybrid materials containing polyoxometalates, layered double hydroxides and graphitic carbon nitrides as well as their functionalized variants have been studied extensively over the years as potential materials for adsorption [1], photocatalysis [2-4], heterogeneous catalysis [5], and electrocatalysis [6]. Polyoxometalates (POMs) are a group of polyanionic nanoclusters containing transition metals in their highest oxidation state linked together in a 3D framework by shared oxygen atoms [7]. By controlling pH, temperature, ionic strength of the parent polyoxometalates in solution, lacunary polyoxometalate defect structures can be obtained by losing one or more MO units. Layered double hydroxides (LDHs) constitute 2D layered matrices, having positive layers, with negatively charged ions and/or water molecules intercalated between the layers [8]. Graphitic carbon nitride (g-C_3N_4) is a very promising 2D material in the field of materials science as predicted by Liu and Cohen, owing to its special layered and electronic structures [9]. The success of g-C_3N_4 as photocatalyst (2.7 eV) is largely due to the presence of N-containing species in the form of $-NH_2$ groups on the edges of the graphitic and tertiary amines connecting the heptazine rings [3].

In the present work, synthesis of 3D-3D and 2D-2D inorganic-organic heterostructures involving, respectively, POMs and ferrocene, LDHs and g-C_3N_4 have been synthesized and their properties explored for applications based on the oxidizing nature of the resultant hybrid material. For corrosion inhibition studies, hybrid materials of ferrocene with phosphotungstic acid and phosphomolybdic acid are coated on stainless steel (316 grade) plates, and analysed comprehensively using weight loss, electrochemical, microscopic and computational techniques. A new inorganic-organic material is synthesized using tetrabutylammonium salt of lacunary polyoxometalate reacting with ferrocene. This material has a band gap of 2.9 eV and is found to be active for photocatalytic degradation of organic pollutants such as, Rhodamine B and p-nitrophenol by photo Fenton reaction mechanism. LDH and g-C_3N_4 based semiconductor materials are designed for photoelectrochemical water splitting via Z-scheme mechanism keeping in mind the two essential conditions, efficient separation of charge carriers and stability of the photoelectrode against corrosion [10]. The experimental as well as mechanistic details of the corrosion inhibition, photocatalytic degradation of organic pollutants and photoelectrochemical processes involved will be presented.

References

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