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Photodegradation of Organic Pollutants Using an Efficient Molybdate Intercalated Mg^{2+}/Fe^{3+} Layered Double Hydroxide (LDH)

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Abstract

Organic pollutants dyes are the highly toxic major waste products causing severe harmful environmental pollution. From the viewpoint of environmental issues, the removal of harmful organic dye compounds is of great interest and importance1. Traditionally physical and biological methods are generally used to decompose many organic pollutants. However, these methods suffers from certain disadvantages and are time-consuming process. 2,3 Visible-light photocatalysis has been renewable "green" technologies which can harvest solar energy in the environmental remediation capable of removing harmful heavy organic contaminations4. This presentation is focused on the design of a novel kind of photocatalyst that cover entire solar spectrum i.e. from ultraviolet to infrared (IR) regions to decolorize and degrade the organic dye such as rhodamine 6G in an effective way.

Now a days, the use of layered double hydroxides (LDHs) as active photo-catalysts has been receiving considerable attention over the layered metal oxides. A number of photocatalysts have been reported for the photocatalytic degradation of organic pollutants. Among the new generation photocatalyst, LDH was very much promising material for pollutant degradation5. However, designing novel visible light active LDH catalysts to meet present technical requirements is a great challenge. Intercalation of different polyoxometalic anionic species into inorganic layered materials like layered double hydroxide (LDH) offers a technique in which altering the properties of the two components are combined into a single modified material. By intercalating different anions, the characteristics of the layered double hydroxide (LDH) can be improved. Layered double hydroxide basically called Hydrotalcite consist of a cationic brucite like sheets with anionic moieties in the interlayer through electrostatic interaction. The unique structure, surface hydroxyl groups, interlayer spaces with intercalated anions, swelling properties, oxo-bridged

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linkage and high chemical stability are some of the added advantages of this group of materials. To harvest solar energy efficiently a series of Mg/Fe Layered double hydroxide materials has been synthesized by hydrothermal method and modified by intercalating molybdate anion by ion exchange. These materials have been characterized by various techniques and tested for their photocatalytic activity for the pollutant removal.

The broad absorption band in case of Mg/Fe LDH was found due to the metal ligand charge transfer band of O2p $\rightarrow Fe^{3+}$ and the metal-metal-charge-transfer spectra of Mg^{2+}-O-Fe^{3+}. The metal to metal charge transfer (MMCT) for an oxo-bridged bimetallic system with different oxidation states was defined to be an excitation transition of an electron from one metal to the other, which is known to absorb visible light and even near-IR light. 6,7 In the case of Mg/Fe/Mo LDH, the absorption edge shifted towards near IR is due to the HOMO-LUMO OMCT of Interlayer Molybdate where the HOMO is mainly derived from the O 2p orbitals and the LUMO is from the Mo 4d orbitals. These materials show enhanced photoactivity for the degradation of organic dyes such as rhodamine 6G. The enhanced photoactivity is due to edge shared metal oxygen octahedron of (MO6) of brucite sheet, visible light absorbing species, low recombination of charge carriers', metal-metal charge transfer spectra (MMCT) of the oxo-bridged bimetallic Mg^{2+}-O-Fe^{3+} system, long life time of photogenerated charge carriers and HOMO–LUMO oxygen metal charge transfer spectra of intercalated Molybdate anions. These modified photo catalysts can be reused easily with several times without substantial loss of catalytic activity, which is green alternative material for practical applications for degradation of organic dyes like rhodamine 6G.

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