Preface

There has been remarkable progress on the applications of layered based materials in the last two decades. Starting from the beginning of petrochemical industry, layered materials have been used as cracking catalysts. Since then a lot of developments have taken place on the synthetic modifications according to different functional applications ranging from catalysis to drug delivery. The possibility of pillaring the clay sheets with a variety of species gives a new dimension to this class of materials and afterwards the synthesis of pillared interlayered clays has expanded enormously. Increasing interests on various aspects of pillared interlayered clays such as new synthetic methods, mastering the property of resulted materials, applications in various domains have produced a large number of research papers and their finding have been well documented in several review articles, book chapters or special volumes. The need for catalyst material that could be used as cracking catalysts with larger pores than the available zeolitic materials spurred the synthesis of new porous materials from clays.

Apart from numerous catalytic applications, in the past two decades there has been a renewed interest on the possibility of using layered clay materials with intercalated inorganic and/or organic guests to prepare hybrid materials, nanocomposites, and multifunctional materials for specially applications as NLO materials, conductors, photoactive materials, polymer composites, ion-exchangers, electrodes etc. The use of layered as nanocontainers for the storage and selective release of drugs/biomolecules or as corrosion inhibitor has also gained the interest of many researcher across the globe. The low or null toxicity, good biocompatibility, and promise for controlled release make the layered clays suitable for their development in different biological purposes as a potential drug carrier for selective and controlled delivery in the biological system, as component in cosmetics etc. The potential of clay nanocontainers to store corrosion inhibitor for their use as a coating with self-healing properties has been demonstrated recently. The board spectrum of conventional and newer applications of clays will continue to attract the attention of researchers in future for further developments.

This special topic volume is a result from the contributions of twenty five experts from the international scientific community in their respective field of research. The volume focuses the use of clay based layered materials for different functional applications ranging from catalysis, biomaterials to self healing coatings. It gives a comprehensive picture of the possible applications and future developments of clay materials. It provide in depth discussion by the researchers with respect to chemical intercalation, drug delivery,

environmental, and engineering applications. All together the volume contains nine state of the art articles and reviews.

The chapter-1 by Gandia group aims at providing an overview of the potential of layered double hydroxides (LDHs) or hydrotalcite-like compounds (HTs) for contributing to the catalysis of the synthesis of biodiesel. Hydrotalcite is a magnesium-aluminum hydroxycarbonate with formula $Mg_6Al_2(OH)_{16}CO_3{\cdot}4H_2O$. A broad variety of hydrotalcite-like solids containing different combinations of M^{2+}, $M^{3+}$and A^{x-} ions can be synthesized. Moreover, the anions are exchangeable, and both inorganic and organic species can be hosted in the interlayer region. One of the most recent applications of HTs and their derivatives as catalysts is transesterification of triglycerides with short-chain alcohols leading to the synthesis of biodiesel. This review discussed in depth regarding the possibility of these materials use emphasizing the challenges ahead.

Chapter-2 by S. Si is also a review article which highlights the recent research efforts given to the LDH based nanocomposites systems containing various layered transition metal hydroxides for making solid polymer electrolytes. Also various approaches adopted to understand the ion conduction mechanism of solid polymer electrolytes has also been discussed. The use of inorganic nanoparticles in making organic-inorganic hybrid nanocomposites polymer electrolytes (NCPE) seem to be an alternative for SPE in electrochemical cells because of their improved mechanical, thermal, chemical, electrochemical stability and high conductivity at room temperature. Presented data provide the basis for further studies on LDHs as filler for the development of nanocomposite polymer electrolytes (NCPE) as well as for the development of new technologies.

Chapter-3 by S. Mandal *et al.* is a research article which deals with the mechanism of dye uptake explained with the help of adsorption isotherm and kinetic studies by hydrotalcite-like anionic clays with various compositions and concentrations. Synthesis of Mg/Al, Zn/Al and Ni/Al anionic clays with different M^{2+}:M^{3+} molar ratios and having Cl^- and NO_3^- interstitial ions and their application for the removal of two acid dyes namely, Acid Blue 113 and Acid Orange 7, in aqueous medium, is discussed.

Chapter-4 by Mohapatra *et al.* is a review article on the latest developments on the clay based materials including effect of different controlling parameters for the synthesis of the pillared clay based porous materials and its specific application for the low temperature VOCs decomposition. In particular the transition metal oxide pillared clays are evaluated

for the said application. It was noticed that the iron manganese mixed oxide pillared clay serves better for low temperature decomposition.

Chapter-5 by Mishra *et al* deals with the use of cation/ anionic clays as potential nanocontainers for the storage of corrosion inhibitors. These nanocontainers can be dispersed in the coating medium to impart self-healing property to the protective coating as and when required. Due to the disturbance in the pH and availability of chloride ions clay based nanocontainers can release the inhibitor to protect the surface. In the recent year use of these clays as nanocontainer is reported by number of researchers, which justifies compiling a comparative review on the new application of traditional clay. Critically analysis of the potentiality of these clays in the future development of self healing coating is presented.

Controlled drug delivery system is a protocol to develop nanostructures and materials that can efficiently encapsulate drugs at high concentration, cross the cell membrane, and release the drug at the target site in a controlled manner for a prescribed period of time. This system can reduces the patient expenses, and risks of toxicity, while it can increase the drug efficacy, specificity, tolerability and therapeutic index of corresponding drugs. Nanoclay minerals possess exceptional properties such as low or null toxicity, superior biocompatibility and guarantee for controlled drug release, thus giving rise to the incessant curiosity to their use for biological applications in pharmaceutical, cosmetic, biomedical and even medical purposes. Chapter-6 by Bajaj group highlights the applications of clay in pharmaceutics as controlled and efficient drug delivery carrier.

Chapter-7 by Chakraborty et al also discussed about the use of anionic clay like double hydroxide for drug delivery systems. The LDH can be used as an excellent inorganic carrier for an advanced biocompatible drug delivery system (DDS). It encapsulates the toxic drugs and thereby limits its side effects on the normal human tissues. In this regard, almost all the drugs exhibit controlled and extended sustained release profile and enhanced thermal stability within the layers of the anionic clay. Hence, the nanoceramic based biocompatible, biodegradable drug delivery system exhibits an immense potential for the treatment of cancer, specifically osteosarcoma, rheumatoid arthritis and other joint and muscele related diseases that can replace the existing therapeutics e.g., methotrexate, ibuprofen etc. and there by revolutionize the entire drug delivery concept.

Chapter-8 by NN Das deals with one-pot synthesis of methyl isobutyl ketone using multifunctional layered based catalysts. Methyl isobutyl ketone (MIBK) is one of the most

widely produced and used aliphatic ketones worldwide. The one-step MIBK process with no intermediate separation steps using multifunctional catalysts is an important development towards greener organic synthesis and generates tremendous interest among the researcher across the globe. The single step process is facile and more economically viable and has provided opportunity to develop new and improved catalyst systems capable of operating under mild conditions. The progress in one-pot synthesis of MIBK using different multifunctional catalysts with special reference to layered based catalysts is critically reviewed in this article.

Chapter-9 by Sabu group highlights the use of layered clay for rubber composite. Nanoscale layered clays, due to their high aspect ratio and high strength, can play an important role in forming effective polymer nanocomposites. Polymer nanocomposites have received much attention due to its large surface area and very high aspect ratio. Polymer nanocomposites especially rubber based nanocomposites is one of the many composite materials in which researchers and engineers have shown great interest due to their potential to be used in critical applications. Polymer layered silicate (PLS) nanocomposites often exhibit remarkable improvement in materials properties when compared with the virgin polymer or conventional micro and macro composites. These improvements can include high moduli and tear strength, improved heat resistance and electrical properties, decreased gas permeability, swelling to solvents and flammability.

We would like to take this opportunity to express our sincere gratitude to our group members and colleague those helped to complete this volume.

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