

Preface

Catalysis by heteropoly acids (HPAs) has received wide attention in the past two decades. During this time new and promising developments have been reported at both the academic and industrial levels. HPAs chemistry is exciting and undergoes continuous revision and actualization. Heterogeneous catalysis is an attractive tool, particularly because it often satisfies some of the principles of green chemistry. Work on heterogeneous catalysis by supported HPAs has greatly expanded during the past few years and has recently emerged as an innovative method for green chemistry practices. There are a number of publications on HPAs/polyoxometalates by renowned scientists. Even though catalysis by HPAs, especially supported heteropoly acids, is an emerging field, no book is available on this aspect.

This book consists of general introduction (Chap. 1) followed by 11 chapters which is an overview given by several leading national and international scientists. Chapter 2, by Sai Prasad and co-workers, gives an excellent overview of synthesis of various types of ammonium salt of molybdophosphoric acid, vanadium incorporated molybdophosphoric acid and supported vanadium in ammonium salt of molybdophosphoric acid, their characterization and use for ammoxidation of 2-methyl pyrazine. K. Parida (Chap. 3) has reviewed nicely the synthesis and characterization of Cs salt of phosphotungstic acid, supported Cs-PTA, Fe and Pd modified PTA and their use as catalysts for carrying out acylation, Heck vinylation, bromination of phenol, oxidation of *trans*-stilbene and hydrogenation of *ortho*-nitrophenol, respectively.

Lingaiiah (Chap. 4) demonstrates synthesis, characterization of supported vanadium-substituted tungstophosphoric acid and their use as catalyst for the selective oxidative cleavage of olefins to carbonyl compounds at room temperature. Halligudi and co-workers (Chap. 5) have discussed in detail the supported HPAs (silicotungstic acid and phosphotungstic acid) and their applications in acid-catalyzed reactions as well as immobilized vanadium-substituted phosphomolybdic acid and applications in oxidation reactions. They have covered nicely a wide range of industrially important reactions such as alkylation, acylation, allylation and oxidation. In addition, they have also reported the use of new catalyst, molybdovanado

phosphoric acid supported on ionic liquid-modified SBA-15 for the oxidation of broad range of alcohols.

Chapter 6, by Nadine Essayem, focuses on the use of tungstophosphoric acid supported onto different supports for glycerol etherification followed by alkoxylation of terpenes over supported tungstophosphoric acid by Jose Castanheiro (Chap. 7).

Jose Dias, in Chap. 8, demonstrates effect of acidity, structure and stability of supported tungstophosphoric acid on different catalytic reactions such as *trans-alkylation* of benzene with aromatics, esterification of acetic acid as well as oleic acid and ethanol and cyclization of (+)-citronellal. Chapter 9, by Anjali Patel, describes biodiesel production over 12-tungstophosphoric acid anchored to different mesoporous silica supports. Further, one of the most recent emerging category of catalyst, supported lacunary polyoxometalate-based catalysts, was also covered by the same author (Chap. 10). It describes solvent-free oxidation of benzyl alcohol over supported mono lacunary phosphomolybdate. It is worth to notice that all the reported catalysts in the book are reusable and are promising environmentally benign catalysts.

Last two chapters cover two important areas of HPAs: recoverable homogeneous catalysts and electrocatalysts. Chapter 11, by Marico Jose daSilva, describes a versatile bifunctional reusable homogeneous phosphomolybdic acid for esterification of fatty acids and oxidation of camphene. Prof. B. Vishwanathan (Chap. 12) covered very emerging and highly attempted area of research for HPAs, electrocatalysis by HPAs.

Overall, best efforts have been made to cover a number of industrially important organic transformations using all types of catalysts based on HPAs (parent, salts, modified, lacunary). However, homogeneous catalysts are not included as they are beyond the scope of this book. The editor hopes that the present book is intended to open a new direction for both academic and industrial research by giving a major impetus for the development of third-generation catalysts. It will be of immense value to postgraduates, researchers and chemists, especially working in the field of heterogeneous catalysts.

Last, but not the least, the editor is thankful to all the authors for their hard work, timely submission and cooperation in spite of their busy schedule. The editor also thanks her research group, especially Dr. Pragati S. Joshi and Mr. Soye Pathan, for helping in various stages.

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