

Preface

The field of chemical sciences is vast, complex, and ever evolving. As researchers consistently uncover new insights into the molecular mechanisms that shape the material world, this book entitled "Exploration of Chemical Complexity," offers a compilation of groundbreaking essays that showcase the latest advancements and discoveries in the field of chemistry related subfields.

The first chapter of this book discusses the Chromogenic Sensor for Cu^{2+} detection. Colorimetric sensors for Cu^{2+} ion detection is in high demand because of their simple visualization with the naked eye and rapid implementation. An azo-phenol moiety-based Cu^{2+} ion chemosensor was synthesized and different spectroscopic techniques have been used for its characterization. The chemosensor showed a significant colour change from faint yellow to purple while making a complex compound with Cu^{2+} ions.

Barun Kumar Mondal and Soumendu Bisoi delve into the promising domain of SAPO-34 Zeolites and Polyamide (PA) in their discussion, particularly focussing on the construction of Mixed Matrix Membranes (MMMs) for the efficient separation of CO_2 and CH_4 gases. According to their results, adding more SAPO-34 as a filler material and polyamide (PY-PA) as the base polymer makes the permeance go up by a noticeable amount. This innovative approach paves the way for the development of advanced membranes, potentially revolutionizing sustainable gas separation applications.

Rupankar Paira's chapter "A Brief Review on Recent Rh-Catalyzed C-H Bond Activation in Pyridines and Quinolines" attempts to highlight the latest developments in Rh-catalysis for C-H bond activation. The author has mainly explored the developments based on pyridine and quinoline substrates, due to their diversified biological importance. This chapter mostly talks about changes that have happened in the last ten years. The author hopes that using these changes on other pyridine, oxazole, and aza-heterocycle derivatives will lead to more research and teamwork, which will help people learn more about the endless possibilities of chemistry of rhodium.

According to Piyali Mitra's chapter, nanoconjugates are more relevant than ever in the realm of innovative photo-based nanodevices for drug administration and photocatalysis. Furthermore, it elucidates the fact that nanostructured materials fabricate the electronic excited states, or excitons, during light-matter interactions. The photophysical properties of semiconductor nanocrystals are also very different from those of bulk materials. This is due to the quantum confinement effect and the higher surface-to-volume ratio. The primary objective of this chapter is to emphasize that nanoconjugates are ushering in a new era for the upcoming generation.

Suranjan Chatterjee explores the quantitative oxidation of nitrous acid and its conjugate base nitrite to N(V) species in aqueous acidic media (pH 2.0-6.0) facilitated by a tetranuclear higher valent manganese complex, $[\text{Mn}_4(\mu\text{-O})_6(\text{bipy})_6]^{4+}$ (1, bipy = 2,2'-bipyridine), and its conjugate acid $[\text{Mn}_4(\mu\text{-O})_5(\mu\text{-OH})(\text{bipy})_6]^{5+}$ (1H^+). The study reveals that the protonated metal oxidant 1H^+ reacts faster than 1, with an unusual kinetic predominance of HNO_2 over its conjugate base NO_2^- . Additionally, the reaction exhibits a remarkable kinetic isotope effect, with an increased reaction rate in D_2O media.

The article by Chhandasi Guha Roy Sarkar explores the anticancer properties of 1,3-diaryltriazene-based compounds, emphasizing their significance in cancer treatment. It offers a comprehensive overview of recent advancements and potential therapeutic applications in the ongoing fight against cancer.

The chapter "Redefining Chemical Practices for a Low Carbon Future through Sustainability with Eco Chemistry" explores the cutting-edge strategies supported by Eco-Chem in the pursuit of a sustainable future. Eco-Chem aims to minimise environmental effect and maximise chemical process efficiency by following low-carbon chemistry concepts. This book chapter highlights the Eco-Chem's tactics to improve sustainability and drastically reduce carbon footprints using green solvents, renewable feedstocks, and energy-efficient techniques. This comprehensive approach facilitates industries' transition to a low-carbon economy and a sustainable future by providing scalable and cost-effective alternatives to conventional methods.

Traditional solvents and reaction conditions often pose significant challenges due to their toxicity, volatility, and adverse effects on human health. Aniruddha Mondal, Amit Kumar Kundu and Prasenjit Mandal in their article, provide an overview of the environmental challenges associated with traditional solvents and reaction media and discuss the principles of green chemistry and their significance in sustainable development. Additionally, it explores the classification, properties, and examples of commonly used green solvents, highlighting their role in promoting environmentally friendly practices in the field of chemistry.

In recent years, pyrazolines have emerged as a crucial heterocycle due to their diverse biological activities. The 2-pyrazoline scaffold is part of a lot of important drug molecules, including antipyrene, phenylbutazone, oxyphenbutazone, ibipinabant, and ramiphenazone. This chapter, written by Attreyee Mukherjee, delves into the biological significance of compounds containing the pharmacologically active 2-pyrazoline moiety in medicinal chemistry. It also explores Structure-Activity Relationship (SAR) studies aimed at enhancing their therapeutic implications, providing a comprehensive overview of their role and potential in drug development.

Food ingredients are labeled differently on the packaging of processed foods. It is necessary to comprehend and be aware of these substances' impacts on health. In this chapter, Subhrajit Banerjee makes an effort to enumerate some of these important substances along with recent health effects associated with their use. Apurba Biswas's article gives a full and up-to-date summary on the synthesis of polynuclear complexes of first transition metals and their magnetic properties. It also briefly talks about the working of magneto-structural correlations.

In his chapter, Amit Kumar Dutta aims to provide an overview of various low-cost, large-scale hydrogen fuel production systems using limitless water supplies and infinitely free solar energy. The goal is to produce commercially zero-emission hydrogen fuel. Therefore, researchers have developed solar-energy-driven water-splitting technology using a heterogeneous photocatalyst, utilizing nano-sized semiconducting catalyst materials. This technology aims to enhance the efficiency of solar-to-hydrogen conversion, boost the rate of hydrogen production, and commercialize it for the benefit of society.

This chapter, written by Biswajit Panda, talks about the latest progress made in understanding how gold helps the cycloisomerization of ortho-nitro-alkynylbenzene. It provides detailed mechanistic insights, shedding light on the key intermediates and transition states that govern this transformation. The discussion extends to the implications of these mechanistic findings for optimizing reaction conditions and expanding the scope of this synthetic strategy. Through this exploration, the chapter aims to enhance the efficiency and applicability of gold-catalyzed cycloisomerization in organic synthesis.

The last chapter, written by Sugata Samanta, examines the behaviour of lactic acid and propionic acid based on the pKa values with respect to temperature and finds a parabolic relationship between the two. The study also calculates the equivalent conductance at infinite dilution for these acids, yielding values of 451.60 and 445.86 $\text{Ohm}^{-1}\text{cm}^2\text{eqv}^{-1}$, respectively. These findings are supported by Python program analyses, providing a comprehensive understanding of the acids' thermodynamic properties and contributing valuable insights to the field of physical chemistry.

This book sheds light on the intricacy of chemical processes through several in-depth investigations and state-of-the-art studies, offering invaluable insights into theoretical frameworks and real-world applications. By deciphering these complexities, it seeks to foster creativity and advance the science of chemistry, ultimately driving scientific research and technological innovation. In this way, "*Exploration of Chemical Complexity*" serves as a profound journey through the multifaceted world of chemical systems. The diverse perspectives and innovative research presented not only illuminate the profound complexity inherent in chemical phenomena but also highlight the importance of interdisciplinary approaches in unraveling these mysteries. As we stand at the forefront of this constantly evolving field, the insights and discoveries shared in this volume are believed to inspire future research and deepen our appreciation of the chemical sciences. Consequently, this book will serve as a valuable resource for scholars, practitioners, and students alike, propelling continued exploration and understanding in the dynamic landscape of chemical complexity.

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