Journal of Thermodynamics & Catalysis
ISSN: 2157-7544

Shehadi, J Thermodyn Catal 2014, 5:1
DOI: 10.4172/2157-7544.1000e126

Editorial Open Access

An Overview on Recent Trends in Catalysis

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The vast majority of chemical and biological activities and processes involve catalytic steps. Catalysis (homogeneous or heterogeneous) play an important role for chemicals manufacturing, utilizing of energy resources, energy conversion systems, devices and environmental control system, biological activities and drug discovery and design. However, the most important issues in any catalytic process are the activity and the selectivity of the catalysts by which processes are performed. In order to understand and control how a catalysts function, one must understand the energy profile through which the catalytic processes must go through. The energy content and transfer of any catalytic processes is easily understood by applying the principles of thermodynamics which provides an insight whether the process is attainable or not. Therefore, thermodynamics is used to describe the macroscopic behavior of chemical systems through understanding the properties of atoms and molecules. The area of thermodynamics is fully established and all laws that govern the energy flow and transfer are developed. Alternatively, the routes and the rate of the chemical processes happening are not yet fully comprehended. Hence, the application of chemical kinetics to understand catalytic activity and selectivity is still under investigation. Moreover, tremendous amounts of scientific discoveries are continually being achieved and more are to be revealed in the years to come. Even though a unifying principle has been identified in the area of chemical kinetics and compiled, but none are faultless. Each principle has its own defects and limitations. Understanding the mechanistic behavior of chemical systems in general and catalysis in particular, lead to significant discoveries in current scientific research. These days, scientists can study, monitor and characterize fast and ultra-fast reactions using laser pulses involved in numerous techniques.

One of the most prominent areas of catalytic research these days is to understand the electronic and ionic transfer in biological systems. Functional ion channels in particular are the focus of many recent catalytic research works directed to understand gating, closing and filtering mechanism of the channel. In order to understand the basic channel mechanics, researchers have focused upon questions surrounding the functioning, selectivity, and gating mechanisms of ion channels. Another attractive area for research is to study electron transfer in proteins and enzymes in order to understand functions and properties. Such areas have boomed after the discovery of the genomic code of many living organisms which led to the discovery of thousands of proteins and enzymes of unknown functions and structures. However, recent advances in biophysics especially in X-ray crystallography, high-resolution electron microscopy and molecular biology have helped shed light on some of the issues in scientific quests.

Homogeneous or heterogeneous transition metal catalyst is another hot area of research especially in industrial applications. These days, scientists from all over the world are working on synthesizing, cracking and reforming catalysts for energy productions and conversions. In such area, synthesis of transition metal and organometallic catalysts hold tremendous potential.

Understanding the basic principles of thermodynamics is essential to design and control the selectivity and activity of unforeseen catalysts. Almost all chemical industries nowadays rely on development, selection, and application of catalysts. The impact of thermodynamics and catalysis is highly observed in biochemistry, biology, engineering, environmental sciences, material sciences, medicine, Nano-sciences and henceforth on emerging technologies.

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Received February 26, 2014; **Accepted** February 28, 2014; **Published** March 07, 2014

Citation: Shehadi IA (2014) An Overview on Recent Trends in Catalysis. J Thermodyn Catal 5: e126. doi: 10.4172/2157-7544.1000e126