



Modified catalysts: what and how?

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Abstract

There are multiple goals behind promotion or inhibition of catalysts. These objectives will be addressed in this research taking into account that the promotion or activation process is the opposite of the process of inhibition. The author believes that the agent of promotion or inhibition can be called modifier. In the field of the chemistry of catalysis and solids, this agent can be called doping agent as the scientists of catalysis saw.

Keywords: Promotion or activation, inhibition, modifier, catalyst, doping agent or dopant

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1. Introduction

Catalyst is the key element or the driving force of most processes affecting our economic life containing industrial, environmental and business applications. Without the catalyst, no chemical reaction takes place to production of various industrial products and the different environmental reactions such as oxidation of carbon monoxide by oxygen in order to inhibit the air pollution by this toxic oxide [1]. In other words, many important chemical reactions require inputs of energy to proceed. If a catalyst is present less energy will be required to complete the reaction. This means that the catalyst is used to decrease the activation energy of reaction, so reaction become easy. Thus, catalysts play an essential role in industry not only in economic terms but also in reducing pollution of the environment [2]. This is significance of catalyst.

The importance of catalysts is increased by their development through many routes, including the use of modifier. The addition of modifier to the catalysts resulted in different changes in the properties of catalysts yielding promotion or inhibition of these catalysts [3-6]. This article aims to identify the modifier and its negative or positive effects on the different properties of the catalysts. Thus, the possibility of classification of the modifiers, according to the properties that affect it or according to the type of effect which is negative or positive, can be achieved.

2. Modifier

It is a trace impurity element or additive that is incorporated into a substance (in very low concentrations) to alter some or all properties of this substance. These properties may be physical or chemical characteristics. Consequently, the modifiers can be classified into physical or chemical modifier depending upon the nature of the modified properties for the guest substance. In addition, the type of change in the properties of treated material could be positive or negative. Thus, the modifier can be called promoter or activator and inhibitor if its effects were positive and negative, respectively.

In the field of catalysis, the catalyst scientists had a scientific term that expressed all meanings of modifier. This term called doping agent or dopant and also the process of introduction of foreign substances in the catalyst is called modifying or doping process.

3. Classifications of Modifiers

The modifiers can be classified according to two categories:-

The first category

This category depends on the nature of the changed properties, Are these properties chemical or physical?. Thus, the modifiers can be classified into physical and chemical

modifiers. The physical properties of the catalyst are affected the physical modifier while that of the catalyst are affected the chemical modifier. However, the chemical modifier has not any activity or selectivity towards the investigated catalytic reaction. In additional, the chemical modifier for example lithia resulted in modification in the activity, selectivity and lifetime of the catalyst. Moreover, the physical modifier has a high melting point for example alumina which results in change in the thermal stability and mechanical resistance of catalyst.

The second category

This category arises from the promotion and inhibition behavior of the modifier. From this point, the modifier can be classified into promoter or activator and inhibitor. The promoter resulted in an enhancement of the properties of catalyst. In other words, the promoter enhances the catalytic activity and selectivity of the catalyst. This is the positive effect of modifier. An opposite behavior was observed in case of inhibitor.

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It is desirable for catalyst to be able to withstand sintering and agglomeration of its particles when the catalytically material expose to elevated temperature preparation and high loading, respectively. Failure to resist sintering and agglomeration is a common feature of catalytically materials and this entry discusses the way in which catalysts can be used as toughening additives to overcome these problems. These additives are the modifiers or doping agents.

Modified or doped catalyst is supported or unsupported catalyst involved modifier or dopant. The addition of modifier or dopant to catalysts to prepare the modified catalyst can be achieved by different techniques such as impregnation, precipitation, microemulsion and combustion techniques [7-12]. However, the introduction of foreign substances in the catalyst can be achieved by the diffusion and ion implantation [13].

4. Mechanism of modifiers

Mechanism of action of the modifier depends upon the mobility of this modifier in the host material. This mobility comes from the diffusion of modifier in the host material. The action of modifier increases by increasing the contact surface area between the modifier and the host material. In fact, the dopant or modifier redistribution process in case of supported catalyst depends on the ratio of the solubility of the doping material in both the active constituents of the catalyst and its support. In case of the unsupported catalyst, the redistribution process could be attributed the ratio of the solubility of the doping material in both the bulk and surface layer of the host matter. In deed, the dissolution of the dopant in the lattice of catalyst resulted in creation of anionic and/or cationic

vacancies which stimulation the mobility of active species yielding new active centers or their redistribution [10-13]. In fact, the author noted the previous behaviors during his scientific journey in the preparation of modified nano materials and catalysts, especially similar ferrite ones, for example alumina doped zinc and cobalt ferrites and magnesia doped nickel ferrite [10-12].

What are the factors affecting the action of modifier?

There are different factors affecting the action of modifier. These factors can be summarized in the ionic radii of the dopant and the host materials, conditions and method of the modified catalyst preparation, precursor of modifier, the amount of modifier, the temperature preparation, the nature of catalytic reaction and so on.

5. The economic return of the use of the modifiers

Using of the modifiers led to achieve significant economic gains in many fields and the world of catalysis. In catalysis, the modifier or dopant brought about an increase in the catalytic properties in the desired reaction and in the same time a decrease in the side reaction according to the determined aim from the use of modifier. In other words, the doping process resulted in stimulate the solid state reaction between the species of host materials yielding new active compound [10-12]. In addition, the modifier displays an increase in the thermal stability and mechanical properties of the modified catalysts and so on [14, 15].

6. Conclusion

The author believes that the modifier is the dwarf who possesses the magic wand to achieve industrial and environmental purposes that are not capable of achieving them. The author also believes that the modifier is the one that drives the inherent strength of the ordinary catalyst and makes it an excellent catalyst at the lowest cost and in the shortest time. All this is due to strong effects of the modifier on both the physical and chemical properties of the catalyst. These effects are due to the strong insertion of the modifier in the crystal lattice of catalyst. Control of this process is through a good choice of the appropriate modifier to reach the desired goal.

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