NOVEL SYNTHESIS OF NANOSTRUCTURED MATERIALS: SiO_2-TiO_2, SiO_2-Al_2O_3 AND SUZ-4 ZEOLITE FOR ENVIRONMENTAL APPLICATIONS

INTRODUCTION

Nanotechnology is concerned with the world of invisible very small particles defined by some as nanomaterials. It has been rapidly growing and is now surpassing the public investment projects and nanoparticles are considered one of the key elements in nanotechnology. From their different physical and chemical properties, they can be used in various applications: semiconductor, advanced composite materials, consumer products, catalytic and photocatalytic applications, gas sensors and other analytical devices, cosmetic products as well as environmental and medical applications.

Nano-based materials are turning out to be remarkably effective tools for cleaning up contaminated sources. Recent research has shown that many properties of these materials depend on particle size in the nanometer-sized range and surface reactivity. Their catalytic activities can be enhanced by the results of the structure of nanomaterials. Due to their special properties, many researchers have been increasingly interested in studying applications of nanomaterials in both chemical and environmental aspects.

There are several synthesis methods currently available to produce nanoparticles. Liquid and gas phases are two common techniques for nanomaterials production. Among the gas phase methods, flame aerosol reactor (FLAR) is one of widely used technologies and enables produce high purity material in single step with short production time and continuous productions for the formation of nanosized and nonporous particles. While liquid or a wet-chemical method is often performed in a batch system, sol-gel is one of the methods that can allow high-purity, high-

homogeneity nanoscale materials with porous particles to be synthesized at lower temperatures compared to competing gas phase methods.

Formations of single species oxide with nano-sized range by the flame method are reported in many articles. Pure oxide nanoparticles are already being produced on a variety of industrial scales. However, there are only a few studies related to the mix oxides formation in the flame reactor. SiO_2 is one of the major products that have a lot of usage for industry. Nanocomposite materials from SiO_2-based material are interesting to study and understand in their complex systems. Therefore, to control morphology and crystal phase of materials is imperative step toward designing advanced materials for different applications. This research shows the different parameters for flame synthesis of nanocomposite materials.

Zeolites are routinely used in heterogeneous catalytic reaction, ion exchange and gas separation. The regular nanoporous networks of zeolites and other crystalline molecular sieves have been put to extensive and increasing use in separations. SUZ-4 is a new type of synthetic zeolite and there are some researches demonstrated and claimed that it has stability in high temperature and organic solvents. It has a good catalytic properties as well as special crystal shape. Moreover, they are more than 150 different zeolite structures reported by the International Zeolites Association (IZA) data base and it is estimated that about 15 structures have been tried to prepare as a zeolite membrane (Caro *et al.*, 2005). However, SUZ-4 zeolite as membrane form has not been found yet. Therefore, it is interesting to synthesize, characterize and test SUZ-4 zeolite particle first and then try to prepare this type of membrane for further applications.

With increasing interest in global environmental protection, the social demand for cleaner emissions and lower fuel consumption has been growing worldwide. There are many environmental problem issues for heavy metals. Among them, mercury level is one of the environmental problems increased considerably since the on-set of the industrial age. It has been target for control due to its unique characteristics, such as high volatility, bio-accumulation as well as its toxic properties.

Mercury exists in three forms: elemental mercury, inorganic mercury compounds (primarily mercuric oxide and chloride), and organic mercury (primarily methyl mercury) (Lee, 1999). The releases of mercury to the biosphere can be grouped in four categories (UNEP Chemicals, 2002) including natural sources, from the Earth's crust, current anthropogenic associated with human activity, current anthropogenic releases resulting from mercury used and re-mobilisation of historic anthropogenic mercury releases previously. The emissions from stationary combustion of fossil fuels (especially coal) and incineration of waste materials account for approximately 70 percent of the total quantified atmospheric emissions from significant anthropogenic sources. As combustion of fossil fuels is increasing in order to meet the growing energy demands of both developing and developed nations, mercury emissions can be expected to increase accordingly in the absence of the deployment of control technologies or the use of alternative energy sources.

Control technologies have been developed for coal combustion plants and waste incinerators with the primary intention of addressing acidifying substances (especially SO_2 and NO_x) and particulate matter. Such existing technologies may provide some level of mercury control, but when viewed at the global level, currently these controls result in only a small reduction of mercury from these sources. Many control technologies are significantly less effective at reducing emissions of elemental mercury compared to other forms. Optimized technologies for mercury control are being developed and demonstrated, but are not yet commercially deployed.

While there are many studies examining the feasibility of sorbents for mercury capture, there is still a need to develop a methodology for sorbent selection based on the rates of reactions. Therefore, this research shows different nanostructured materials as sorbents in differential bed reactor for elemental mercury capture.

Moreover, it is also interesting to study the use of nanostructured materials for liquid phase application. Dye wastewater is one of the industrial wastes, which is difficult to degrade and it is environmentally serious and it is found out that methyl orange dye was more difficult to degrade than other dye compounds (Keiichi *et al.*,

2000). Therefore in this research it was useful to take methyl orange dye as a representative of compounds. Furthermore, colloidal dispersions are very useful for many applications. Colloids and colloidal systems impact on virtually every aspect of life and they are an integral part of modern life. They are used in the medical imaging to improve contrast and to reduce toxicity. They are used for better cleaning up oil pollutant. In cosmetics industry, they are applied as water-soluble and water-insoluble substances in skin care and sunscreen lotion. Additionally, they are also utilized in biological system, water treatment, agrochemical and other industries. These applications require controlled properties of colloidal dispersion. For better understanding the behaviors for further liquid system applications, the colloidal dispersion and stability behaviors also has been studied accordingly.