The Achievements of Professor Dr. Piyasan Praserthdam

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Professor Dr. Piyasan Praserthdam was born on the 12th of April of 1950 in Bangkok. He received his Bachelor of Engineering from the faculty of Engineering, Chulalongkorn University in 1974. Since the completion of his Doctorate of Engineering, at I.N.S.A, Toulouse, France, he has conducted research in the area of catalysis until today. Catalysts are very important materials for oil refinery and the petrochemical industry since they can accelerate reactions to obtain more valuable products. About 10 years ago, Professor Dr. Piyasan Praserthdam, and his research team including Master and Ph.D. students, started to do research in the area of nanocrystals. These crystals can be applied as catalysts and catalyst supports. In addition they can be used as electronic materials such as capacitor and ferroelectronic materials. In 2003, Professor Dr. Piyasan Praserthdam and his research group discovered a novel concept for material and energy utilization. It is believed that this new concept will help our nation and mankind to develop strategies for sustainable living.

Two directions for catalyst research have been pursued by the research group of Professor Praserthdam. One was to study catalyst deactivation and how to prevent catalyst deactivation by applying a second metal in the catalyst. The second one was to develop new catalysts that were more active than commercial catalysts.

Catalysts Deactivation

In general, catalysts that are used for a certain period of time would deactivate. The main problem of catalyst deactivation is that the active sites are continuously fouled by coke. The most favorable condition for coke deposit is high reaction temperature, especially for reactions where oxygen is absent. Thus propane dehydrogenation to propylene is a good model reaction for coke deposition studies. Detailed understanding of the coke formation mechanism has been found to be extremely important and relevant for practitioners in the petrochemical industry.

Beyond the prevention of coke processor in the feed stream, it was found that the addition of a second metal, such as alkali metal, on a catalyst can promote the draining off coke from the active sites to the catalyst's support. This phenomenon can prolong the activity of the catalyst. In addition, it was found that zeolites catalysts can be used at high temperatures when Pd is added into their framework. Finally, the size of the zeolite particles has

a significant effect on the durability of zeolite catalysts at high temperatures. As mentioned above, these findings will lead to important benefits for catalyst design in the future.

Catalyst Development

It was found by Professor Dr. Piyasan's research group that a small amount of Pt on catalysts such as Ni and Cu catalysts can promote their activities for benzene hydrogenation and CO oxidation respectively. The proposed mechanism is based on a spin over of reactant from the support to the active sites. This phenomenon can promote reaction activity. It was also found that oxygen containing compound gases can activate catalysts which are composed of I B metals. This technique had been patented in the US in 1998. The reaction example is selective acetylene hydrogenation in excess ethylene. By passing N_2O on Pd-Ag catalyst before use, the catalyst's activity was increased by about 20% and the ethylene gain also increased. In addition, it was found that initial hydrogen feeding has some advantage for vegetable oil hydrogenation. It can promote catalyst activity by more than 20%. It was expected that the coverage of hydrogen on the active sites of Ni Catalyst can prevent catalyst poisoning by the impurities present in the oil. Currently, some Thai vegetable oil hydrogenated plant is applying this technique to produce waxes.

Nanocrystals

Significant correlations between thermal stability of nanocrystals and origin crystallites size and calcined temperature have been discovered by Professor Or. Piyasan Praserthdam and his team. This knowledge can be applied to the control of the size of nanocrystals. In addition they have found how to control the defects on nanocrystals. There are several methods to control crystal defects such as preparation, solvent, calcining and quenching atmospheres. It was realized that nanocrystals synthesized by solid state reaction have more defects than the ones produced by crystallization. Thus nanocrystals obtained from sol-gel and precipitation processes have more defect than the ones obtained from a glycothermal process. It was also found that nanocrystal calcined in the presence of oxygen have more defects than in the absence of oxygen. In addition, defects on nanocrystals increase when the quenching temperature decreases.

This valuable knowledge can be applied into two major areas, that is, catalysis and electronics. For catalyst production, it was found that the catalytic activity of nanocrystals, such as TiO_2, ZrO_2 and CeO_2 depends on the amount of defects on the surface of crystals. Also, the activities of these nanocrystals are higher than the activities of commercial catalysts. These defective nanocrystals can be used as supgorts for 'specific catalysts. It was found that

some catalysts that use those defective nanocrystals have their activity and selectivity significantly improved as compared to commercial catalysts. On the other hand, nanocrystals that have fewer defects are suitable for use as electronic materials such as ferroelectronic material, capacitor etc. It was found that Fe_2O_3 and $BaTiO_3$ nanocrystals with fewer defects have superior magnetic and capacitance properties than commercial powders. This discovery might lead to a novel strategy to synthesize other nanocrystals which at present are using high purity precursors and very high vacuum techniques that are difficult and costly for mass production. Wet chemistry methods are suitable for commercial production of nanocrystals.

Concept for Materials and Energy Utilization

It is public knowledge that the world is currently facing a major oil price problem. This is due to the increasing demand for oil, especially by China and other industrialized countries. Many have attempted to develop other energy resources such as renewable energy from biomass and solar energy etc. At the same time, energy conservation is also an important step to reduce oil consumption. Although these efforts are important, there is no a clear strategy to develop and utilize energy. Materials utilization should be also a concern since material production requires energy.

Professor Dr. Piyasan Praserthdam and his teams has developed a new methodology for material and energy utilization that is based on a new concept to be referred to as the potential index which is calculated as the difference between a high potential minus a low potential and deviding by the high potential. There are three main principles to be used in this methodology as follows.

Principle1: When the potential of a system changes, the potential of the surrounding will change in the opposite direction.

Principle2: The selected process is the process that has highest potential index

Remark: process composes of system and surrounding

Principle 3: Products, i.e. materials or energy, that are derived from low potential indexes processes have high values.

If our nation and mankind can apply these three principles, we expect that sustainable living will occur in the world. For example:

* The use of pure material that is produced from physical separation processes as fuel should be avoided.

* The use 9f electricity that is derived from a low potential index process as heat should be avoided.