Nano Material and Technology Application in Environment-protection and Energy-saving

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Abstract

Nanosized material refers to a material constituted of nanoparticles. Nanoparticles are particles between 1 and 100 nanometers in size. Nanotechnology (nanotech) is manipulation of natural or artificial matter on an atomic, molecular, and supramolecular scale ranged from 0.1 nm to 100nm. Nanotechnology would help to solve environmental pollution problems, treating hazardous waste water as well as PM 2.5 air pollution. In particular, nanosized material has a quite important application prospects in the field of environment-protection and energy-saving. Due to its new properties of absorbed radiation, catalysis and adsorption, etc., nanosized material can not only promote transformation and upgrading of traditional industries, but also have remarkable impact on hotspot high-tech industrial application.

Keywords

Nano, environment-protection and energy-saving, material technology.

1. Introduction

As nanosized material was known as “21st century’s the most promising material”, nanotechnology has both great theoretical value and practical value. Nano is a unit of length, 1 nanometer equals to 10^{-9} meter. Nanosized material refers to a material constituted of nanoparticles. Nanoparticles are particles between 1 and 100 nanometers in size. Nanotechnology (nanotech) is manipulation of natural or artificial matter on an atomic, molecular, and supramolecular scale ranged from 0.1 nm to 100nm. When a macroscopic object is made into a nanosized material, compared with conventional material, there are various different properties of sound, light, electricity, magnetism and so on, as well as small size effect, surface effect and quantum effects, etc. [1]. Nano-TiO_2 as a photocatalyst can effectively degrade pollutants [2]. A new discovery for TiO_2 photocatalytic degradation of organic pollutants in water has been found [3]. In the next 20 to 30 years, nano-science and nano-technology is expected to be widely used in environmental protection, information communication, biomedicine, generating new major technological change, which will not only promote transformation and upgrading of traditional

industries, but also have remarkable impact on high-tech applications and promoted to develop nano-based new industries.

2. Nanosized Material and Nanotechnology in Energy-Saving

We introduce that nanosized material and nanotechnology could apply in the following five energy-saving fields: building, ironmaking, vehicle, power generation and textile.

2.1 Building Energy-saving

Nanosized material and nanotechnology could apply in building energy-saving field. Building energy consumption accounts for more than 28% of total energy consumption in China. Ministry of Housing and Urban-Rural Development (MOHURD) released "12th Five-year" building energy-saving special planning. It demanded that public building energy consumption per unit area of key cities in 2015 is not less than 80% of that in 2010. Building energy-saving market is not only in line with national policy, but also contains significant business opportunity. For example, based on collosol jelly technology, in order to reduce thermal conductivity, a three-dimensional porous nanosized material of silica aerogel with good heat resistant could be made. Thus a kind of building cement wallboard with high thermal insulation can be made by mixing the above nanosized material with cement mortar [4]. For another example, in order to get effect of warm in winter and cool in summer, transparent insulation coating nanotechnology can apply in architectural glass. This kind of glass can not only effectively resist infrared radiation from the sun, but also let indoor object absorb 80% of visible light and retain more than 90% of longwave radiation from indoor objects.

2.2 Ironmaking Energy-saving

Nanosized material and nanotechnology could apply in ironmaking energy-saving field. High air temperature in blast furnace ironmaking process can effectively improve both pulverized coal replacement ratio and lower fuel ratio. This is a relative reassuring way to save a lot of fuel, meeting low carbon environmental requirements advocated in today's world. When a micro-nano energy-saving coating applied to heat accumulator surface in blast furnace hot blast stove, increasing ironmaking efficiency and reducing amount of fuel [5]. When a nanosized material coating applied to enclosure's heat shield of annealing unit in Cold Rolling Mill Plant of Benxi Iron and Steel Group Company, amount of heat radiation could be effectively increased and amount of fuel consumption could be declined [6].

2.3 Vehicle Energy-saving

Nanosized material and nanotechnology could apply in vehicle energy-saving field. With technological advance and rapid economic development, people's living standard can be significantly improved. As one of the representatives of science and technology, automobile slowly approach public view, and number of automobile is constantly growing significantly. A large-scale domestic automobile annually consumes about 95% of gasoline and 40% diesel made in China. Such a large energy consumption ratio considering China's large population makes China's energy gradually located tense position. Therefore, how to reduce energy consumption problem is needed to be solved. Nanosized material can apply to components and parts binding in automobile, effectively reducing loss of petrol and diesel, increasing dynamic coefficient in actual driving of automobile [7].

2.4 Power Generation Energy-saving

Nanosized material and nanotechnology could apply in power generation energy-saving field. Electricity has become an essential tool in social development and people's daily life. If without electricity, dark scene would restrict normal industrial production. If there is no electricity, human civilization and economy development would be retrograded. Thermal power is main source of electricity and accounted for 78% of the total electricity. Impact on environment is larger due to thermal power's huge energy consumption. Boiler water after nanoscale processing in thermal power unit effectively improved

thermal efficiency, reduced coal consumption for power generation and supply, brought significant energy saving effect [8].

2.5 Textile Energy-saving

Nanosized material and nanotechnology could also apply in textile energy-saving field. Textile industry is a rich and influential family with energy-consuming and environmental pollution. Its energy consumption accounted for 4.4% of national industry, its water consumption accounted for 8.5%, and pollution emission occupied the top five. That nanosized material applied to such a large polluting industry is what environmentalists are looking for. Lubricant using nanosized material in reduction gear of textile industry can decline current, save 3 kWh per hour and 8% of energy conservation, averagely.

3. Nanosized Material and Nanotechnology in Environment-protection

Along with economic development, environmental quality declined. Environmental pollution problems have become increasingly prominent. landslide, earthquake, tsunami, typhoon, desertification and other catastrophic event occur frequently, striking human's eye, environmental protection is imminent. We introduce that nanosized material and nanotechnology could apply in the following four environment-protection fields: air pollution control, wastewater treatment, solid waste treatment and disinfection.

Nanosized material and technology can apply in indoor air treatment and air pollution control. Nowadays advance in science and technology provides people's daily life a great convenience, thus people spend more and more time indoors. At first indoor air is relatively clean, but after a long time, air quality would decline drastically. In addition, lots of houses are built, that formaldehyde and toluene content in new house exceeded related national standard would do great harm to human body. Nanosized material of titanium dioxide photocatalyst can effectively catalyze degradation of harmful substances, reduce its indoor content and provide people a safe and comfortable living environment.

Air quality declined significantly, mainly pollutants of carbon monoxide, nitrogen dioxide and sulfur dioxide increased day by day. Nanosized material could apply to air, easing a certain degree of air pollution. Degradation efficiency of nitrogen oxides can reach above 90% [9].

Nanosized material and technology in the field of sewage treatment includes organic pollutant treatment and inorganic pollutant treatment in water. Sewage waste could be divided into organic waste water and inorganic waste water. Organic waste water contains organic pollutants mainly. High organic pollutant load could easily lead to eutrophication of waterbody, doing great harm to water quality and surrounding environment. Nanosized material with adsorption, catalytic and filtering functions can be used to treat organic pollutants in water. For example, because titanium dioxide has a strong light degradation and ultraviolet absorption ability, we could take advantage of its ability to handle more than 80 kinds of pollutants so far. Instead of toluene, hydrocarbons, nitrogen-containing organic compounds and surface active agent, it can oxidize an acid in water into water and carbon dioxide quickly [10]. Nanoparticle and nanosized material can effectively degrade various harmful organic pollutants as antimicrobial agents [11-12].

As for treatment of inorganic pollutant in water, inorganic contaminant in wastewater mainly contains heavy metal, precious metal and inorganic anion. Heavy metal in water can be easily enriched and expanded in the food chain with high toxicity. In addition, heavy metal in wastewater will make land no longer to grow plant, damaging human liver, brain, nerve and eyesight strongly. Nanoparticle of heavy metal in water has a strong effect on photoelectron reducibility. Titanium dioxide as a photocatalytic material can absorb a variety of heavy metals in its surface, through a certain reaction, reducing heavy metal waste into metal ions. Thus titanium dioxide can be used to recycle and save metal material, and to improve water quality [13].

China is one of the world's fastest solid waste growing countries. Increasing solid waste give great threat to environment and environmental quality is getting worse. Nanosized material can be used for municipal solid waste treatment. First, nanosized material could turn discarded printed circuit board into

fine powder for recycling after removing foreign matter. Second, titanium dioxide as a photocatalytic material could degrade municipal waste quikly [14]. Urban solid waste pollution would be solved to a great extent due to nanosized material and nanotechnology.

Nanotechnology can also be used in deodorization, disinfection and uvioresistant fields. For example, nano-zinc oxide with excellent thermostability is non-toxic, tasteless, non-irritating to skin, never decomposing and degenerating [15]. Zinc oxide is a skin anti-wrinkling drug with defensive function for external use as astringent, anti-inflammatory and antiseptic. Nano-zinc oxide can be used not only as an anti-bacterial deodorant sunscreen of cosmetics to prevent ultraviolet radiation; but also be used as deodorizing, anti-bacterial and anti-UV fiber material, absorbing odors and purify air. Nano-zinc oxide can also be used as a hospital disinfectant dressings, bandages, diapers, pajamas, curtains and textile in toilet. Ceramic added with nanosized material has a self-cleaning function of antibacterial, disinfection and decomposition of organic matter. Goods after the above treatment can be made into a bathtub, floor tiles and toilet. Nano-antenna sensing chip by both Terahertz spectra and images of transmittance has been verified and screening of various carbohydrates can be applied to test even real market goods with a high sensitivity and selectivity [16].

4. Conclusion

Numerous studies have shown that nanosized material will have a profound impact on the field of environment-protection and energy-saving due to its properties of radiation, absorption, sterilization, adsorption and photocatalysis. Study of nanosized material is still at a relatively shallow level. Although application time of nanosized material in the field of environment-protection and energy-saving is not long, more and more people pay great attention on its unprecedented broad application prospects. We believe that along with scientist's continuing interdisciplinary study and exploration of various types of physical and chemical properties of nanosized material, nanosized material and nanotechnology will bring a new industrial revolution to environment-protection and energy-saving.

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