19CH101– ENGINEERING CHEMISTRY

Unit-3 NANOCHEMISTRY

APPLICATIONS OF NANOTECHNOLOGY

(i) ELECTRONICS

1. Nanoelectronics means using nanotechnology in electronic components, there are many applications such as computing and electronic products include Flash memory chips for iPod Nanos, antimicrobial and antibacterial coatings on the mouse, the keyboard, and the cell phone castings.

2. NanoTechnology is used for printed electronics for RFID, smart cards, smart packaging, It is used for more life-like video games and flexible displays for e-book readers.

3. Nanotechnology is used for nanoscale transistors that are faster, more powerful, and increasingly the energy-efficient, You will see soon that your computer's entire memory may be stored on a single tiny chip.

4. Nanotechnology is used in many new TVs, laptop computers, digital cameras, cell phones, and it is used in many devices to incorporate nanostructured polymer films known as organic light-emitting diodes or OLEDs, where OLED screens offer brighter consumption and longer lifetimes.

5. Nanotechnology is used for magnetic random access memory (MRAM) enabled by nanometer- scale magnetic tunnel junctions that can quickly and effectively save even encrypted data duringa system shutdown or crash, So, It enables resume- play features.

6. Nanotechnology in electronics provides faster, smaller and enhanced handheld devices, It provides advanced display technologies with conductive nanomaterials, data storage, quantum computing, printable and flexible electronics, and magnetic nanoparticles for data storage.

7. Nanotechnology can actually revolutionize a lot of electronic products, procedures, and applications such as electronic products include nano transistors, nano diodes, OLED, plasma displays and quantum computers.

(ii) ENERGY SCIENCE

Lithium-sulfur Based High-performance Batteries

The Li-ion battery is currently one of the most popular electrochemical energy storage systems and has been widely used in areas from portable electronics to electric vehicles.[15][16] However, the gravimetric energy density of Li-ion batteries is limited and less than that of fossil fuels. The lithium sulfur (Li-S) battery, which has a much higher energy density than the Li-ion battery, has been attracting worldwide attention in recent years. A group of researches from the National Natural Science Foundation of China (Grant No. 21371176 and 21201173) and the Ningbo Science and Technology Innovation Team (Grant No. 2012B82001) have developed a nanostructure-based lithium-sulfur battery consisting of graphene/sulfur/carbon nano-composite multilayer structures. Nanomodification of sulfur can increase the electrical conductivity of the battery and improve electron transportation in the sulfur cathode. A graphene/sulfur/carbon nanocomposite with a multilayer structure (G/S/C), in which nanosized sulfur is layered on both sides of chemically reduced graphene sheets and covered with amorphous carbon layers, can be designed and successfully prepared. This structure achieves high conductivity, and surface protection of sulfur simultaneously, and thus gives rise to excellent charge/discharge performance. The G/S/C composite shows promising characteristics as a high performance cathode material for Li-S batteries.

Nanomaterials in Solar Cells

Engineered nanomaterials are key building blocks of the current generation solar cells. Today's best solar cells have layers of several different semiconductors stacked together to absorb light at different energies but still only manage to use approximately 40% of the Sun's energy. Commercially available solar cells have much lower efficiencies (15-20%). Nanostructuring has been used to improve the efficiencies of established photovoltaic (PV) technologies, for example, by improving current collection in amorphous silicon devices, plasmonic enhancement in dye-sensitized solar cells, and improved light trapping in crystalline silicon. Furthermore, nanotechnology could help increase the efficiency of light conversion by utilizing the flexible bandgaps of nanomaterials, or by controlling the directivity and photon escape probability of photovoltaic devices. Titanium dioxide (TiO_2) is one of the most widely investigated metal oxides for use in PV cells in the past few decades because of its low cost, environmental benignity, plentiful polymorphs, good stability, and excellent electronic and optical properties. However, their performances are greatly limited by the properties of the TiO_2 materials themselves. One limitation is the wide band gap, making TiO_2 only sensitive to ultraviolet (UV) light, which just occupies less than 5% of the solar spectrum ultraviolet (UV) light, which just occupies less than 5% of the solar spectrum which just occupies less than 5% of the solar

. Recently, core–shell structured nanomaterials have attracted a great deal of attention as they represent the integration of individual components into a functional system, showing improved physical and chemical properties (e.g., stability, non-toxicity, dispersibility, multi-functionality), which are unavailable from the isolated components.

For TiO_2 nanomaterials, this core–shell structured design would provide a promising way to overcome their disadvantages, thus resulting in improved performances. Compared to sole TiO_2 material, core–shell structured TiO_2 composites show tunable optical and electrical properties, even new functions, which are originated from the unique core–shell structures.

Nanoparticle Fuel Additives

Nanomaterials can be used in a variety of ways to reduce energy consumption. Nanoparticle fuel additives can also be of great use in reducing carbon emissions and increasing the efficiency of combustion fuels. Cerium oxide nanoparticles have been shown to be very good at catalyzing the decomposition of unburnt hydrocarbons and other small particle emissions due to their high surface area to volume ratio, as well as lowering the pressure within the combustion chamber of engines to increase engine efficiency and curb NO_x emissions. Addition of carbon nanoparticles has also successfully increased burning rate and ignition delay in jet fuel. Iron nanoparticle additives to biodiesel and diesel fuels have also shown a decrease in fuel consumption and volumetric emissions of hydrocarbons by 3-6%, carbon monoxide by 6-12% and nitrogen oxides by 4-11% in one study.