APPLICATION OF NANOTECHNOLOGY IN ELECTRONICS

Definition

The term *nanoelectronics* refers to the use of nanotechnology in electronic components. These components are often only a few nanometers in size.

Nanoelectronics covers a diverse set of devices and materials, with the common characteristic that they are so small that physical effects alter the materials'properties on a nanoscale – inter-atomic interactions and quantum mechanical properties play a significant role in the workings of these devices.

The first transistors built in 1947 were over 1 centimeter in size; the smallest working transistor today is 7 nanometers long – over 1.4 million times smaller (1 cm equals 10 million nanometers). The result of these efforts are billion-transistor processors where, once industry embraces 7nm manufacturing techniques, 20 billion transistor-based circuits are integrated into a single chip.

Optoelectronics

Electronic devices that source, detect and control light – i.e. optoelectronic devices – come in many shapes and forms. Highly energy-efficient (less heat generation and power consumption) optical communications are increasingly important because they have the potential to solve one of the biggest problems of our information age: energy consumption.

Displays

Display technologies can be grouped into three broad technology areas; Organic LEDs, electronic paper and other devices intended to show still images, and Field Emission Displays.

Wearable, flexible electronics

The age of wearable electronics is upon us as witnessed by the fast growing array of smart watches, fitness bands and other advanced, next-generation health monitoring devices such as electronic stick-on tattoos.

If current research is an indicator, wearable electronics will go far beyond just very small electronic devices or wearable, flexible computers. Electronic textiles (e-textiles) will allow the

design and production of a new generation of garments with distributed sensors and electronic functions.

wearing single-walled carbon nanotube electronics on your skin", a "temporary tattoo to monitor glucose levels" or "graphene nanosensor tattoo on teeth monitors bacteria in your mouth").

APPLICATION OF NANOTECHNOLOGY IN ENERGY SCIENCE

Nanotechnologies provide the potential to enhance energy efficiency across all branches of industry and to economically leverage renewable energy production through new technological solutions and optimized production technologies.

Solar cells and super capacitors are examples of areas where nanoelectronics is playing a major role in energy generation and storage.

Energy sources

Nanotechnologies provide essential improvement potentials for the development of both conventional energy sources (fossil and nuclear fuels) and renewable energy sources like geothermal energy, sun, wind, water, tides or biomass.

Nano-coated, wear resistant drill probes, for example, allow the optimization of lifespan and efficiency of systems for the development of oil and natural gas deposits or geothermal energy and thus the saving of costs.

Further examples are high-duty nanomaterials for lighter and more rugged rotor blades of wind and tidepower plants as well as wear and corrosion protection layers for mechanically stressed components (bearings, gear boxes, etc.).

Energy conversion

The conversion of primary energy sources into electricity, heat and kinetic energy requires utmost efficiency.

Higher power plant efficiencies, however, require higher operating temperatures and thus heat-resistant turbine materials. Improvements are possible, for example, through nano-scale heat and

corrosion protection layers for turbine blades in power plants or aircraft engines to enhance the efficiency through increased operating temperatures or the application of lightweight construction materials (e.g. titanium aluminides).

Energy storage

Nanotechnologies can improve capacity and safety of lithium-ion batteries decisively, as for example through new ceramic, heat-resistant and still flexible separators and high-performance electrode materials.

APPLICATION OF NANOTECHNOLOGY IN MEDICINE

Drug Delivery

One application of nanotechnology in medicine currently being developed involves employing nanoparticles to deliver drugs, heat, light or other substances to specific types of cells (such as cancer cells). Particles are engineered so that they are attracted to diseased cells, which allows direct treatment of those cells. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease.

Diagnostic Techniques

Researchers at Worcester Polytechnic Institute are using antibodies attached to carbon nanotubes in chips to detect cancer cells in the blood stream. The researchers believe this method could be used in simple lab tests that could provide early detection of cancer cells in the bloodstream.

Antibacterial Treatments

Researchers at the University of Houston are developing a technique to kill bacteria using gold nanoparticles and infrared light. This method may lead to improved cleaning of instruments in hospital settings.

Wound Treatment

Researchers at the University of Wisconsin have demonstrated a bandage that applies electrical pulses to a wound using electricity produced by nanogenerators worn by the patient.

For trauma patients with internal bleeding another way to reduce the blood loss is needed. Researchers at Chase Western Reserve University are developing polymer nanoparticles that act as synthetic platelets. Lab tests have shown that injection of these synthetic platelets significantly reduces blood loss.