of various mechatronic elements, diagnostics can increase the life of the various mechatronic elements, which in turn will enhance the life of the product or system. Such inputs in mechatronics can be best given by the manufacturers of hi-tech machines and manufacturing systems. In fact, the machine tool manufacturers are now being called upon to offer a total manufacturing for solution in production, by the customers, rather than supply of just the stand-alone machines. This trend is already evident in many of the advanced countries. Evidently, the design and manufacturing of future products will involve a combination of precision mechanical and electronic systems and mechatronics will form the core of all activities in products and production technology.

3 TYPES OF MECHATRONIC DEVICES.

The types of mechatronic devices is used such as switches, relay, solenoid, power diode, power transistor, thyristor, gate controller switch, rectifier, chopper, transducer and others [5].

References:

1. http://www.yaskawa.com/site/products.nsf/staticPagesNewWindow/mechatronics.html.
2. http://en.wikipedia.org/wiki/Mechatronics.
3. http://ru.scribd.com/doc/34853325/INTRODUCTION-OF-MECHATRONIC-DEVICE.
4. Tata McGraw-Hill Education, 1998. Machine-tools. 461 pages.
5. http://www.ukessays.com/essays/information-technology/mechatronics-for-manufacturing-cells-information-technology-essay.php.

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Nanotechnologies in the Electrical Energy Sector

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Nanotechnology is an interdisciplinary field of basic and applied science and technology, which deals with the accumulation of theoretical basis and practical methods of investigation, analysis and synthesis, as well as methods of manufacture and use of products with a given atomic structure by controlled manipulation of individual atoms and molecules.

Nanotechnologies are worldwide regarded as key technologies for innovations and technological progress in almost all branches of economy. Nanotechnologies refer to the target-oriented technical utilization of objects and structures in a size in the range of 1 and 100 nm. They are less seen as basic technologies in the classical sense with a clear and distinct definition, since they describe interdisciplinary and cross-sector research approaches, for example in electronics, optics, biotechnology or new materials, using effects and phenomena which are only found in the nano-cosmos.

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. In the long run, essential contributions to sustainable energy supply and the global climate protection policy will be achieved. Here, nanotechnological innovations are brought to bear on each part of the value-added chain in the energy sector.

Low-Loss Power Supply through Nanomaterials.

Considerable progress was made in the development of high-temperature superconductors in the last years through the production of yttrium-barium copper oxide (YBCO) on metallic carriers (so-called Coated Conductors, CC), which significantly extended the processability and applicability of this material class. Cable lengths of over 600 m could already be realized. Superconductors will play a growing role in energy technology for low-loss wired power supply, in coil windings and bearings of electric engines as well as in residual current circuit breakers in high-voltage grids. The most important challenge is the production of all deposited layers (superconducting and buffer protection layers) by chemical means from low-cost precursor to decrease costs to an economically attractive value. Nanotechnologies provide toeholds for the control of the microstructure in layer formation, for example through specific insertion of nanoparticles in the form of particle inclusions in the lattice structure. Currently, superconductive nanostructured systems from sol-gel precursors are being developed in a project supported by the German Federal Ministry of Education and Research (BMBF). In the long run, cables of carbon nanotube composites as high-efficient conductors could be an alternative for a low-loss power supply line in high-voltage grids. This, however, would require further significant progresses with regard to more efficient production methods and technologies for the production of long CNT-fibers with uniform structure.

Nanostructured Insulation Materials for High-Voltage Power Lines.

Efficiency of power transfer in high-voltage power lines increases with increasing amperage. In Europe, current is usually conducted at approx. 400 kV, while in extensive countries like China and India high-voltage grids with up to 1500 kV are aspired. Due to increased voltages and the required current compaction as a result of the feeding of decentralized power generators and the supply of huge metropolitan areas, the electrical and mechanical strains on high-voltage power lines are growing. Hence, a central task of high-voltage technology is the further development of electric insulation systems, for example through the application of nanomaterials. The material design on the nanoscale enables the optimization of electric insulation properties like breakdown voltage, for example, through the application of nanostructured metal oxide powder in varistors as protection elements against overvoltages in power lines. Multifunctional, non-linear and auto-adaptive insulation systems are in development, the mechanical and electrical properties of which change with field strength, temperature or mechanical stress and adjust optimally to the power demand.

Nanotechnologies within Smart Grids.

The worldwide increasing liberalization of the electricity market will significantly increase the future demand on the flexibility of the power grids. Trans-European power trading requires efficient energy distribution even over long distances, a flexible adjustment to temporarily strongly fluctuating demands and a quick controllability of the power flow to limit the extent of grid failures and the risk of extensive blackouts. The existing power distribution grid encounters limits even regarding the growing decentral power supply from fluctuating renewable sources. The future power distribution requires grids which enable a dynamic load and failure management as well as a demand-driven energy supply with flexible price mechanisms. Nanotechnologies could contribute essentially to the realization of this vision, for example through nanosensoric and power electronic components, which could cope with the extremely complex control and monitoring of such grids. Here, miniaturized magnetoresistive sensors on the basis of magnetic nanolayers provide potentials to enable an area wide online-metering of current and voltage parameters in the grid.

Efficient Application of Wireless Nanocrystals.

Use of wireless technologies refers to the perspective trends characterizing the modern stage of the scientific and technological development. In particularly, the tendency is rapidly evolving in the energy sector involving energy distribution and transmission, and nanotechnologies provide solutions to a variety of urgent problems in this area.

A wireless nanodevice that functions like a fluorescent light – but potentially far more efficiently – has been developed in a joint project between the National Nuclear Security Administration's Los Alamos and Sandia national laboratories. The experimental success efficiently causes nanocrystals to emit light when placed on top of a nearby energy source, eliminating the need to put wires directly on the nanocrystals.

The energy source is a so-called quantum well that emits energy at wavelengths most easily absorbable by the nanocrystals. The efficiency of the energy transfer from the quantum well to the nanocrystals was approximately 55 percent – although in theory nearly 100 percent transfer of the energy is possible and might be achieved with further tweaking. The work is another step in creating more efficient white-light-emitting diodes – semiconductor-based structures more efficient and endurable than the common tungsten light bulb.

Reduction of lighting costs is of wide interest because on a world scale, lighting uses more electrical energy per year than any other human invention. Nanocrystals pumped by quantum wells generate light in a process similar to the light generation in a fluorescent light bulb.

There, a captive gas permeated by electricity emits ultraviolet light that strikes the phosphor-coated surface of the bulb, causing the coat to emit its familiar, overly white fluorescent light. The current work shows that the nanocrystals can be pumped very efficiently by a peculiar kind of energy transfer that does not require radiation in the usual sense. The process is so efficient because unlike the fluorescent bulb, which must radiate its ultraviolet energy to the phosphor, the quantum well delivers its ultraviolet energy to the nanocrystal very rapidly before radiation occurs.

Because the emissions of nanocrystals (a.k.a. quantum dots) can be varied merely by controlling the size of the dot rather than by the standard, cumbersome process of varying the mix of materials, no known theoretical or practical barriers exist to pumping different-sized quantum dots that could individually emit blue, green, or red light, or be combined to generate white light.

The quantum well, about three nanometers thick, is composed of a dozen atomic layers. It coats a wafer two inches in diameter and is composed of indium gallium nitride. The film is not fabricated but rather grown as crystal, with an energy gap between its different layers that emits energy in the ultraviolet range at approximately 400 nm.

In this proof-of-principle work, the energy in the quantum well was delivered with a laser. Although the difficulties of inserting energy into the quantum well using an electrical connection rather than laser light are significant, it is considered to be feasible.

So, In view of a globally increasing energy demand, threatening climatic changes due to continuously increasing carbon dioxide emissions, as well as the foreseeable scarcity of fossil fuels, the development and provision of sustainable methods for power generation belong to the most urgent challenges of mankind. Massive effort at political and economical level is required to basically modernize the existing energy system. Growing efficiency and new methods through nanotechnological know-how may play a key role for the required innovation in the energy sector.

Nanotechnological components provide potentials for the more efficient utilization of energy reserves and the more economical development of renewables. Nanostructured insulation materials are to be implemented in smart grids and, as a result, they will contribute to the dynamic load and failure management as well as a demand-driven energy supply with flexible price mechanisms. Introduction of wireless nanocrystals is seen as a productive step in creating more efficient white-light-emitting diodes that will allow to reduce lighting costs.

To sum up, the design of a future energy system requires new long-term investments in research activities based on realistic potential assessments and careful adaptation of the individual supply chain components based on cutting-edge nanotechnologies.

References:

1. http://www.hessen-nanotech.de/mm/NanoEnergy_web.pdf.
2. http://www.bakerinstitute.org/programs/energy-forum/research/research/riceenergyprogram/nanotechnology.html.
3. http://www.photonicsonline.com/doc/wireless-nanocrystals-efficiently-radiate-vis-0002.

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Poisoning the reactor with Samarium

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There are two types of poisoning the reactor Fission poisoning and liquid poisoning. The first type is natural and the second one is manmade. The liquid poisoning type is used to prevent the accidents in the reactor and to decrease the consequences. But in this presentation we will consider the fission poisoning (referred to as poisoning).

Poisoning the reactor – the process of formation short-lived products of fission in the working reactor, which involved in unproductive capture of neutrons and thereby lowering the reactivity margin in their accumulation and increasing it when they decay.

Slagging of fuel – is the process of accumulation stable and long-lived fission products in the working reactor which involved in unproductive capture of thermal neutrons and thus lowering the reactivity margin reactor.

The element Samarium-194 is a strong slag of the first group. Its half-life is 13,84 years, it means that it's almost stable. But why do we say about poisoning rather than slagging the reactor?.

Yes, Samarium is a slag but its accumulating in fuel elements of the reactor has some peculiarities which make the process of changes in Samarium concentrating similar in quality to poisoning the reactor with Xenon. In difference to other slags, Samarium can not only be accumulated in a working reactor but can be bombarded by neutrons. Thus, losses of reactivity connected with Samarium accumulating can be either increased or decreased due to its intensive bombarding at high levels of the reactor power. That's why the process of Samarium accumulating was named poisoning rather than slagging.

Samarium isn't practically formed as a product of fission in the reactor. In this case almost all its formation is connected with beta-decay of another product of fission – Promethium-149. This element as a direct fragment of fission is also formed in small amounts. A basic source of its formation is beta -decay of Neodymium-149. Thus, the processes of formation and decreasing fission products can be shown as following.

References:

1. Мерзликин Г.Я. Основы теории ядерных реакторов. Курс для эксплуатационного персонала АЭС. Севастополь: СИЯЭиП, 2001. 341 с.