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Future of nanomaterials and nanostructures

Present challenges and future solutions via nanobiotechnology and nanobiosciences exist for electronics, environment and energy.World-wide situation appears extremely difficult and only at the nanoscale we can hope to embark on such undertaking with some degree of success, while keeping the environment and the earth viable and growing in the process. Energy is strongly interlinked with power generation, automation and environment, while similarly is happening (at the nanoscale) for really intelligent hardware, being strongly interlinked to communication, defence and environment. Indeed the risk of upcoming ecological disasters, including global warming, can be reduced or avoided with the development of new energy sources nanotechnology-based from sun, wind and hydrogen. The far reaching effects will be beneficial for the entire humanity and for the survival and growth of earth. It seems that when the peak of world oil production will be reached by 2030 there will be furthermore an irreversibly declining resource facing an increasing demand for energy which could not be met. Other routes must then identified for Energy, Electronics and Environment. Five new developments in nanomaterials and nanostructures have gained interest by an industrial point of view and our applications to energy, environment and electronics are here exemplified: (A) Nanotechnology for energy devices. Energy-oriented components, as intended in this paper, are elements designed in a power supply context, designed for the generation or the storage of energy in electrical form. Nanotechnology can help in the synthesis of materials with particular characteristics to make them suitable for the use in the energy field, particularly for the photovoltaic power generation and for the construction of parts of batteries, both object of this review. The constant development of highly integrated electronic devices is leading circuits to very small dimensions. The power supply must provide enough energy for the proper functionality of these structures, so it should be based on materials with high energy efficiency to limit the weight and the volume of the device. For energy storage purposes, lithium-ion electrolytic cells for batteries are nowadays considered the best dealing with these characteristics. For what concerns energy conversion from renewable sources, solar systems based on non-standard construction techniques, like CISG (Cadmium Indium Gallium (di) Selenide) cells or dye sensitized solar cells (also known as Gratzel Cells); (B) Mass Spectrometry and Protein Array for Biodiesel production, where mass spectrometry results evidenced the enzyme action of separating plastic oligomers of Poly (ε-Caprolactone) and of hydrolysing further the oligomers previously detached. The degradation of PCL occurred by three fungal lipases from Mucormiehei, Candida rugosa and Rhizhopusarrizhus in a solvent- free systemutilizing olive oil as substrate. Mucormiehei lipase proved to be the best biocatalystmatching catalytic activity for biodiesl productionbeing strongly enhanced when the enzyme is immobilized on a glass surface in up to five monolayers. (C) QCM_D Biosensor for Environment, based on an innovative conductimetric biosensor has been implemented coupling Quartz Crystal Microbalance with Dissipation Monitoring nanogravimetry and an innovative protein cell-free expression system named Nucleic Acid Programmable Protein Arrays (NAPPA) that allow us to immobilize on the QC surface, as sensing molecule, any kind of proteins. The NAPPA spots have been imprinted utilizing both traditional technology and a new technology, called NanoProbeArrays, based on piezoelectric liquid dispensing for non-contact printing and probing, that allows the realization of protein arrays for protein analysis with as little as a few nanoliters of sample. Here we present the results so far obtained employing our biosensor to monitor protein-protein and enzyme drug interactions and its future application to environmental analysis. Our conductimetric biosensor - as exploiting its capability to monitor reaction in real-time - proposes as an answer to the demands of fast-and cost-effective analytical techniques to monitor the increasing number of potentially harmful pollutants in the environment. (D) Conductive Polymers forCO2 Sensors, based on Poly(o-methylaniline) (POTO) and nanocomposite based on both multi-walled MWNTs)