

The Era of Nanotechnology

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They pretend to unlock the mysteries of what is invisible to the human eye. The search for applications, that can be used to treat cancer, purify contaminated water and minimize contraband, even for the design of new devices that can store more information, the creation of reconfigurable micro antennas and find methods that can maximize the storage of energy.

Of course we are speaking about Nanotechnology: the study, design, reaction, synthesis, manipulation and application of materials, apparatus and functional systems through the control of materials at a nano scale.

“Nanotechnology focuses on making useful things with materials which are organized on a scale of more than a billion times smaller than a meter. These are extremely small dimensions which are invisible to the human eye and the majority of the telescopes”, explained Dr. Miguel Castro of the Chemistry Department at the Mayagüez campus of the University of Puerto Rico (UPRM).

In the opinion of Dr. Arturo Hernández Maldonado of the Chemical Engineering Department at UPRM the “beauty” of nanotechnology is the capacity it offers the scientist to “functionalize” or change the function of a material to molecular scale.

On the other hand, Dr. Félix Fernández of the Physics Department at UPRM emphasized that the idea to manipulate and control very small objects to obtain revolutionary applications was expressed in the decade of the fifties by the Physics Nobel Prize winner, Richard P. Feynman.

This last decade has specifically marked the revolution in this area of research since it has perfected the scientific instruments it achieve it, pointed out Hernández Maldonado.

As a matter of fact, Dr. Samuel Hernández of the Chemistry Department, who has spent a decade in this field, agrees that “during this time, nanotechnology has changed from a research area in laboratories to a branch of the sciences and engineering with palpable applications and within the general public’s reach”.

Therefore according to Dr. Carlos Rinaldi of the Department of Chemical Engineering, the word nanotechnology has already become a familiar word for society in general” even it they do not necessarily know what it implies. “At present in research this is one of the most important fields. We are in the nanotechnology era.”

Dr Arturo Hernández Maldonado pointed out that the Federal Government invested almost a billion dollars in 2005 in research related to this field. He added that at present the inversion is approximately more than four billion dollars. And we expect that by 2015 nanotechnology will represent a trillion dollars of the global economy and will offer jobs for a million employees, added Rinaldi.

Of the 50 states and territories of the United States, already 41 of them, including Puerto Rico are immersed in the study and development of applications of nanotechnology. On the island, “El Colegio” (UPRM), is one of the most important centers in the generation of research associated with this discipline, according to the professors.

Precisely one of the significant aspects of the nano scale science is its interdisciplinary nature. At UPRM more than twenty professors from the departments of Chemical Engineering, Mechanical, Electrical, and from Science and Material as well as Chemistry, Physics, and Biology study the different applications of nanotechnology.

“Due to the fact that nanotechnology does not define a specific discipline, but represents a new way (or scale), of doing research and engineering, it is a field of activity that is intrinsically interdisciplinary”, maintained Rinaldi.

Managers of New Solutions

The scientists at UPRM use nanotechnology to create materials, apparatus and new systems that will have a great impact on industry, health and medicine.

“From the point of view of research, the importance of nanotechnology falls on a new paradigm of observation, manipulation, design and construction of materials and products using atoms or molecules as the basic elements. This creates an opportunity to study new phenomena and achieve applications that would not be possible on another scale”, affirmed Rinaldi.

At the moment they have in their laboratories various projects in the area of foundations and applications of magnetic nano particles. Among them are the development of sensors based on nano particles, the creation of nano fibers for the application to contraband and the evaluation of magnetic nano particles for the treatment of cancer.

“In the cancer treatment project they expect to elucidate on the mechanism by which the particles induce cellular death on various types of cancerous tissue, including colon and breast cancer cells. These initial experiments open the doors for pre-clinical test, evaluating the efficiency of the treatment in animals, and eventually on patients”, he explained.

In the case of Hernandez Maldonado, in his laboratory they dedicate their time to the synthesize, characterization and application of nonporous materials. He explained that they can be visualized as tiny “filters” capable of separating a pair of molecules.

“The expectations of our projects include: create efficient methods to prepare absorbent materials at molecular scale; synthesize selective and efficient materials (“filters”), that will be resistant to different conditions and that can be regenerated with little effort and find solutions to problems that involve energy resources and potable water”, he specified.

He commented, for example, that many of the pharmaceutical drugs that consumers take return to bodies of water. As he explained, at the moment these are present in very small quantities. Never the less it’s been observed that there is a significant increase in the consumption of drugs due to the rapid increase in population.

“At some time they will be above the levels of detection and the question is what does this mean for societies health in general? I always tell a joke: “well when you drink water you will not get a head ache because you already have Tylenol, but, what if it is an antibiotic?” he stated.

In his laboratory they study materials at nano scale that can function as an absorbent filter for the waste from the pharmaceutical drugs.

Other Nanometric Initiatives

In the case of Dr. Oscar Perales Pérez from the Department of Engineering and Materials Science his projects are related to the preparation of manganese and zinc nano crystals for magnetic caloric applications, such as the control of properties at nano metric scale in materials for the storing of information.

On the other hand, Hernández’s projects in Chemistry range from the development of sensors based on nano particle applicable to defense and national security to the detection of microorganisms that can be used in bacteriological warfare.

Meanwhile, Drs. Pablo G. Cáceres and Rick Valentín from Mechanical Engineering also carry on research associated with the synthesis of nano tubes and nano fibers.

Dr. Nelson Sepulveda, from Electrical Engineering is developing reconfigurable micro antennas the size of a human hair. He is also studying nano resonators that are mechanisms that can be used in computers.

In the Physics Department there are various professors working in the field of nanotechnology, said Fernandez. “One of the projects is centered on materials that exhibit a substantial change in their optic and electric properties once illuminated with pulses of ultra short light. These materials and their nanostructures are of interest for future applications of optic devices and optoelectronics with faster response than those that exist today.”

On the other hand, Castro from the Chemistry Department expressed that they are working on methods which would permit to lead the organization of the materials to make functional structures as Nanometric scale such as the manufacturing of electric devices and will permit in the near future the reduction of space in cars, planes and space ships.

To create these laboratories, research concepts, obtain materials and instruments, the professor submit proposals to different scientific agencies. The Professors at UPRM have successfully obtained very competitive funds for the study of nanotechnology.

Some of the entities that subsidize these projects are The National Science Foundation, NSF-EPSCoR of Puerto Rico, and Partnership for Research and Education in Functional and Nanostructured Materials, The American Chemical Society Petroleum Research Fund and The Department of Defense, among other agencies.

Another aspect that the professors emphasized is the educative component of nanotechnology. “The students are the nanotechnologist of the future. They are the cornerstone of our efforts”. concluded Perales.