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Editorial

At source of nanotechnology

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Nanotechnology is a broad field of modern science and also engineering, which creates, potentially, endless possibilities. This term is most often defined as the preparation and use of structures in which at least one dimension is expressed in nanometers. Usually, the dimensions of these structures are in the range from 1 to 100 nm (more often up to several hundred nm).The term nano-technology was used first time in 1974 by Japanese scientist Norio Taniguchi. He used the term to describe semiconductor processes. His definition of nano-technology was as follows: "Nano-technology mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule" [1].

Taniguchi considered nanotechnology as a technology of precision manufacture with nanometer tolerances. Such an approach implied from Tanguchi's background – he had studied the developments in machining techniques. The vision of nanotechnology, however, has deeper roots. The first ideas appeared several years earlier. On December 29, 1959, at California Institute of Technology, Feynman gave a lecture titled "There's Plenty of Room at the Bottom" [2]. In lecture, he considered the possibility of direct manipulation of individual atoms as a more powerful form of synthetic chemistry than those used at the time. Feynman also suggested that it should be possible, in principle, to make very tiny machines that are able to arrange the atoms the way we want, and do chemical synthesis by mechanical manipulation. At the end of his talk, Feynman announced two challenges and funded price for each one. The first task involved the construction of a very small motor, such small that would fit inside a cube 1/64 inches (0.4 mm) on each side. The second one was much more difficult – to find a way to scale down letters small enough so as to be able to take the information on a page of a book and put it on an area 1/20000 smaller in linear scale. The concepts, as well as tasks presented by Feynman were very abstractive at that time; nevertheless, they gave to researchers a strong motivation to work.

In November 1960, to Feynman's surprising, an electrical engineer William McLellan, presented an electric motor which size met posed assumptions. The motor was pure handcraft engineering. McLellan, to fabricate it, did not use any cut-edge apparatus but typical tools and his experience. Among his tools was a sharpened toothpick which pushed the miniature components into place - appropriately presaging the atom-fine tips of atomic-force microscopes [3]. To meet the second challenge took a little more time. In 1985, Tom Newman, a Stanford graduate student, successfully reduced the first paragraph of A Tale of Two Cities by 1/25,000, and collected the second Feynman prize [3].

The conceptual vision presented by Feynman inspired one of the most famous nowadays propagator of nanotechnology – Eric Drexler. Drexler not only followed the Feynman's concepts but he pushed the vision of nanotechnology much further. In 1986 Drexler

published a book Engines of Creation: The Coming Era of Nanotechnology [4] in which he used the first time the word nanotechnology in sense presented by Feynman. In the publication he presents a world where the entire Library of Congress can fit on a chip with the size of a sugar cube and where universal assemblers, tiny machines that can build objects atom by atom, will be used for everything from medical robots that help clear capillaries to environmental scrubbers that clear pollutants from the air. The author describe also the gray goo scenario - his prediction of what might happen if molecular nanotechnology were used to build uncontrollable self-replicating machines.

Nowadays, nanotechnology is an interdisciplinary field involving issues of precision mechanics, electronics, chemistry, physics, materials science, electromechanical systems as well as the use of bioengineering and biomedicine for gene therapy or drug application. Nanotechnology opens new ways of approaching desired goals. For that, both scientist and engineers as well use different methodology and tools. To distinguish with which approach we faced, the two terms has been introduce: top-down and bottom-up. Briefly, top-down refers to the methods of nano-objects fabrication for which macroscopic tools are hired, such as etching, deposition, machining, etc.; whereas bottom-up to methods where the structures are build up atom-by-atom or molecule-by-molecule.

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