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Nanotechnology turns fifty

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On December 29, 2009, we celebrated the golden jubilee of Nanotechnology. It was on this day, fifty years ago Professor Richard P. Feynman (Nobel Laureate, 1965) delivered the celebrated talk, 'There's plenty of room at the bottom,' which predicted the era of nanotechnology — the technology of nanometre scale objects. He proposed a new kind of technology by assembling things atom by atom, in today's terms, 'molecular nanotechnology'. The terminology, nanotechnology itself came into being in 1974, due to Professor Norio Taniguchi.

Feynman talked about writing the entire Encyclopaedia Britannica on the tip of a needle; he envisioned that one day the entire information of the world could be contained in an envelope!

He forecasted that little motors could move within blood vessels and do surgeries, as if the surgeon has gone. No talk was talked about so extensively as this one in the history of science, except probably the 'Candle light lectures' of Faraday.

The predictions of Feynman, to a large extent, have been realised today. Since 1991, we arrange atoms one at a time to create well-defined structures. Feynman said, "The principles of physics, as far as I can see, do not speak against the possibility of manoeuvring things atom by atom." A new methodology to see and place atoms called scanning tunnelling microscopy came in 1981 and numerous modifications of this tool revolutionized all branches of science.

It is possible to direct tiny diagnostic and therapeutic objects into the body and even into specific cells. Although such 'surgeons' do not travel through the blood vessels as of now, diagnostic and therapeutic agents do. Single elements of electronic storage are now in nanoscale so that entire libraries can be written in hand-held devices. Molecules have

been shown to store information.

The evolution

It is now possible to see the evolution in size, shape and properties of pieces of matter, atom by atom – as the object is made. As a result, we can probe questions such as the electrical conductivity of a single DNA strand or strength of single chemical bonds.

When one looks at matter closely, new phenomena are discovered. For example, one can make gold emitting light in all colours — from blue to red! New phenomena have made natural sciences most exciting.

Global nanotechnology research budget is substantial. In the U.S. alone, the projected budget for FY 2010 is $1.6 billion. A sum of $10.1 billion was spent in this area in the U.S. during 2001-2009. Indian efforts have been small, the government started a Nano Mission two years ago with an investment of Rs.1,000 crores in five years.

Nanotechnology is expected to produce goods and services worth $2.6 trillion in the year 2014 globally. A total of about 400,000 research papers and 100,000 patents have already come out in the area. Annual research publications are nearly 59,000 in 2009. It grew five fold in 2000-2009.

Another peak?

What would nano do to the world? Will it be another peak in the unending chain of scientific excitements? Nanotechnology implies the power to manipulate matter at the atomic level. It is the power of the creator, as all are constructed with atoms. Once this capability is comprehended fully, nothing that matter can deliver is impossible. Naturally, promises are plenty. It may appear like science fiction when topics such as single cell therapy are proposed. It is possible to repair the molecular machinery of life and thereby control, prevent and extend biological functions.

Materials can be made super tough, super light, etc; after all carbon is the toughest and still quite light. It may one day be possible to harvest all the energy needed for the planet from the sun and if more is needed, there is the reaction between hydrogen and oxygen forming water. The world may be clean and green again. Well, nanotechnology does give hopes.

Thinking of such possibilities, this is what is going on in nature. All the carbohydrate which plants cook in their leaves, to keep us going, is made atom by atom, from carbon dioxide and water, using sunlight.

In the way we convert that food to energy and then to work, very little wastage occurs. If biological machinery were to be as inefficient as our motors, the food we produce cannot even sustain one-tenth of the population. Thus, biology is nanotechnology in perfection.

Similarly best chemistry is nanotechnology. It converts atoms to molecules in a clean and green manner, chemists say with high atom efficiency. All physics is ultimately that is done at the atomic level. This convergence of disciplines at the nanometre level is probably one of the biggest benefits of nanotechnology.