NANOSCIENCE AND TECHNOLOGY : MAPCO ENGINEERING COLLEGE, SIVAKASI

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Ladies and Gentlemen,

I understand you had an exciting three days of deliberations on nanoscience and technology. I wish to compliment the organizers for putting together an impressive programme capable of assembling so many of you here. Nanotechnology has special relevance to the city of Sivakasi, the global capital of the fireworks industry. Pyrotechnics and explosives are related to particle sizes and nanoscale aluminum has orders of magnitude greater energy release potential than ordinary aluminum powder, so ubiquitous in a firework. In fact nanocrystals of aluminum react explosively with molybdenum trioxide. The thermite reaction – and are used for military ordnance applications and are being developed as rocket fuels.

This evening, I intend to briefly touch upon two aspects of nanoscience and technology, that could be of some interest to you. Befitting a valedictory speech, I hope, my talk will provoke you to think more deeply about this fascinating area, as you wind back home this evening.

The two aspects, I wish to focus on is:

1. Why is this field of science so exciting and is being so talked about

2. What is the nature of this science and technology? Where are its boundaries? How do you teach such a discipline? What are the tools of this research? What is the cost of R&D?

Let me take the first question – why is nanoscience considered so exciting? The first part of 20th Century was dominated by a revolution in physics. Albert Einstein had become an icon and the bizarre world of quantum mechanics had grabbed much public attention. The latter part of the century, however, was overtaken by biology, thanks to the unfolding of the structure of DNA by Crick and Watson. Gene came to dominate our ideas about biology and medicine. As we step into the 21st century, nanotechnology is emerging as a buzz word of our age. The area is attracting vast quantities of Government support, in terms of funding. The industry is cautiously, but seriously watching the emerging developments. But why all the excitement? The only defining characteristic of nanotechnology is dimension. Nanotechnology cuts across discipline without a thought. From physics we have tools that allow us to see and manipulate matter at unprecedented small scales. From chemistry we have methods for synthesizing and assembling molecules. From material science, we know that matter in nanometer scales can exhibit novel and unusual properties. And from biology, we know that this is also the scale of the cell.

The single and the most important reason why nanotechnology is causing so much excitement is the potential to bring together all these disciplines to address a scientific problem. The integration of sciences, the interdisciplinary of approach and the ability as well as opportunity to unite disparate fields is the distinguishing hallmark of this science and the cause for so much excitement.

Nanomaterials are not new to mankind. Nature has provided us with a wide variety of exquisite nanomaterials. The Romans used clustered of gold nanoparticles in glass to produce vivid colors. Nanoparticles of metals found routinely into formulations of traditional medicines (Chinese, ayurveda, homeopathy etc.). Carbon black and fumed silica have been around for over 100 years. So what is new?

The current excitement is nanoscience centers around the principle of synthesis coupled with an ability to organize/assemble/fabricate them into useful entities, with a range of chemical and physical properties. Nanoparticles are the equivalent of atoms in molecular sciences. When atoms are assembled into molecules, useful properties result. Similarly, only when nanoparticles are assembled into organized structures that new properties emerge. Examples are nanotubes, nanowires, nanowhiskers, nanobelts, nanoshells, nanosprings, nanorods, nanocrystals, nanobrush, nanofluid and the like. Such assemblies lead to potential objects such as nanomotors, nanorobots, nanomachines, nanoscale electronics, nanodevices etc.

I am somewhat disappointed to say that in our country, while there is considerable efforts on synthesis of nanomaterials, there is very little work on issues related to assembly on study of nanoobjects.

To explore the nanoworld, you also need nanotools and to assemble nonmaterial you need nanofabrication methods. Several nanotools are available today, eg. STM, AFM, HRTEM, Optical Tweezers, Quantum Confinement devices, etc. Yet everyone of these tools have limitations (AFM surface relief no chemical comp, STM- phenomenal resolution but cond.systems. Several nanomanufacturing techniques are being explored namely nanolithography, self assembly techniques, microfluidics, nano-chemical-electrical-mechanicals manufacturing systems etc.

Let me know briefly examine the second aspect – i.e. research education in nanoscience and technology. Over the years, several attempts have been made to integrate disciplines. In the early eighties, material science began to emerge as an interface discipline between physics, chemistry, metallurgy and engineering. Later in the nineties biotechnology emerged as an interface discipline, encompassing, chemistry, biology, chemical engineering and computational science. A similar situation is now emerging with several departments of nanoscience and technology as well as curricula in the subject in the offing.

However, I must caution against compartmentalizing an integrative discipline such as nanoscience and technology. More than any other discipline, this area requires very strong foundation in chemistry, physics, mathematics and biology. It is my considered opinion that to build an edifice of knowledge of nanoscience and technology on weak foundations of fundamental science can be dangerous. To some extent, we are today reaping the outcomes of what happened when we created vast educational curriculum for biotechnology. Many who came out of these programs had poor foundations on molecular biology, chemistry and mathematics. The result is that we produced more of doers than thinkers. While in biotechnology, this could be condoned as it needed people for employment in industry, nanoscience and technology is just a research discipline. It will remain so for another decade or so, even in the world. So, the people we need to train are not technicians, but researchers, who are capable of pushing the frontiers of science and technology in nanoscale.