"Young People must be Exposed to Opportunities in Scientific

Entrepreneurship"

Dr Swaminathan Sivaram, Director of National Chemical Laboratory (NCL), a unit of Council of Scientific and Industrial Research (CSIR) is a polymer chemist, mentor and science manager of distinction. Heading one of the largest publicly funded research and development laboratories devoted to chemical sciences, Dr Sivaram believes that publicly funded research institutions must have a clear focus on creating value through its science and benefiting the society at large. The leading scientist with clear thoughts about the Indian science and technology scenario expresses his views in a candid interview with K Jayadev of Nano Digest. Dr Sivaram has over forty years of experience in basic research, process/product R&D and S&T management, both, in industry and academia. He is widely recognised for his contributions to polymer science, technology development, institution building and management of innovation in publicly funded organisations. Excerpts from the interview:

Nano Digest: National Chemical Laboratory (NCL) has always been considered to as a research institute with industry-orientation. How did it get this brand image? Is it true that NCL is industry-oriented?

Dr Sivaram: You are right. NCL has had a long tradition of sustained collaboration with industries. In fact, the growth of NCL over the last sixty years closely parallels the growth of the Indian chemical industry since independence. To a large extent the credibility of NCL with the Indian industry has been due to its leadership who has had very strong technology orientation. The first two Indian Directors of NCL - Professor K Venkataraman and Professor BD Tilak came from the University Department of Chemical Technology (UDCT), Mumbai. UDCT has a strong tradition of research and partnership with industry. Both, Professor Venkataraman and Professor Tilak, although outstanding organic chemists in their own right, brought application orientation of research to NCL. Professor Venkataraman pioneered the research in dyestuff and colors. Professor Tilak built the process chemistry research in the area of fine chemicals and agro-chemicals. Subsequently we had Dr LK Doraiswamy and Dr RA Mashelkar as Directors of NCL, both of whom were distinguished scientists with a

background in chemical engineering. Dr Doraiswamy encouraged research in the area of generic low cost drugs in the early 1970s. He also built the foundation for research in the area of catalysis and polymer science. Dr Mashelkar brought to NCL a global view and promoted interaction of NCL with companies, both, within India and abroad with a strong culture of patenting. Subsequent leaderships of NCL have sustained these initiatives and continue to build on them. The fact that NCL was located in the city of Pune was also fortuitous. It so happened that Maharashtra and Gujarat became the hub of the fine chemicals, agro-chemicals, pharma as well as polymer industries. During the past decade NCL has pioneered the concept of public-private partnership and has developed several technologies that have been introduced into the market with great success. In keeping with the spirit of industrial orientation, NCL has encouraged both, knowledge creation (fundamental science) as well as technology development. NCL has been very successful in generating as well as licensing intellectual property. NCL today is counted as a respectable and credible partner with industry, with a high sense of professional ethics, ability to maintain confidentiality and create value out of its scientific competencies.

ND: Has this image been helpful to NCL?

Dr Sivaram: Yes, indeed, NCL distinguishes itself from academic research laboratories by the fact that it aggressively attempts to link knowledge to application. I believe that publicly funded research institutions must have a clear focus on creating value through its science and benefiting the society at large. Whereas knowledge generation is important and necessary there has to be continuing attention to create utility out of the knowledge an institution generates. NCL is focused not merely on solving a problem, but selling the solution to the relevant stakeholder be it either the society or industry. The credibility for NCL arises out of its ability to exploit the knowledge it creates.

NCL played a critical role in the development of Indian chemical industry, may it be, agro-chemicals, pharmaceuticals, fine chemicals, polymers or catalytic processes. The Indian industry continues to seek the association of NCL in addressing their future technology goals. The Directors of NCL have had, interestingly a balanced appreciation of both, academic as well as industrial research. Industries seek actively the participation of the leadership of NCL in many of the industry fora to discuss aspects of science, technology and

innovation. Industry leaders actively participate in our Research Council (RC) as well as in many of our research programmers aimed at technology development. Professor Tilak pioneered the idea of industry leaders peer reviewing technology development programmers at NCL to ensure that such programmers met the minimum needs of the industry before they are transferred.

ND: Does this tradition continue? Do you still have industry participating in review activities even today?

Dr Sivaram: This tradition continues but in a slightly modified manner. Leadership of industry as well as scientists participate actively in many of our Public-Private Partnership programmes aimed at technology development. They are also represented in the Research Council of the laboratory. We also involve them in brain storming sessions on future programmes which have a clear technology focus.

However, it is somewhat sad to note that we do not have too many visionary and respected science and technology leadership in the Indian chemical industry. At times we find it difficult to get diversified expertise from industry in several areas of interest to NCL for nomination in various peer review committees. This is a reflection of the less than optimum investment by industry in promoting and sustaining S&T led innovation in house.

ND: So does this mean we will not see much of industry people participating in activities…

Dr Sivaram: Nevertheless, we are seeking out actively as many professionals as possible from industry to participate in discussions, brain storming as well as research programmes in progress at NCL. Over the last several decades NCL has built a strong partnership model with Indian and global industry. We have flexible practices as well as

FACTFILE
Dr Swaminathan Sivaram
Education:
B Sc (Chemistry) - Year: 1965 from Madras University, Chennai.
M Sc (Chemistry) - Year: 1967 from Indian Institute of Technology, Kanpur.
Ph D in Organic Chemistry - Year: 1971 from Purdue University, USA.
Research Experience:
Research Associate, Institute of Polymer Science , The University of Akron, Ohio, USA
Research interests:
Polymer Synthesis, Controlled synthesis of polymers, surface modification of polymers, step growth polymers
Expertise:
R&D management and management of innovation
No. of granted patents:
42 granted
Publication:
Dr Sivaram has published over 200 papers in internationally reputed journals
The Journey:
Research Centre of Indian Petrochemicals Corporation Ltd, at Vadodara and rose to the position of Deputy General Manager (R&D).
In 1988, he joined NCL as Head of the Polymer Chemistry Division, and now is the Director of the Institute.

contractual agreement to accommodate the very special needs of every industry. In the end we seek to create a win-win relationship in which both the needs of NCL as well as that of the industry are satisfactorily met.

ND: What about nanotechnology? How is it going impact on the scientific community as well as the industry? How do you explain the Indian nanotech scenario vis-à-vis global scenario? What needs to be done to get on par?

Dr Sivaram: The nanotechnology scenario in India is rather weak at the present time compared to global benchmarks. Even China has made aggressive forays in the area of nanomaterials technology. Although there is substantial academic research in the area of nano-science, much of it is decoupled with frontier applications. To seize the initiative in this area there is a clear need to identify innovative market opportunities. We also have to create facilities/ infrastructure for converting the science into applications. World over "out of box" nanotechnology solutions have not come from R&D centers of large established industries. Much of the innovation has emerged out of SMEs, new ventures and start-ups. We have to create appropriate innovation eco-system in India for early scientific ideas in the area of nanoscience and technology to be spun off into ventures for value creation. Unless we encourage this process, we will have the unfortunate situation of Indian science creating wealth outside of India where scientific entrepreneurship, risk taking and new venture creations are more deeply embedded within their innovation systems.

ND: So China is posing a major threat…

Dr Sivaram: China is a threat to India in many areas of S&T. While we must be aware of this threat, there is nothing to fear from. India has immense unique opportunities which it can take advantage of.

ND: How do to look at the future of nanotech in India?

Dr Sivaram: Nano-technology holds great promises for India. The unique features of the Indian market are that they are very diverse in terms of product preferences, application and affordability. This implies enormous opportunities for innovation to address multiple segments of consumers. Take for example, health, water and energy. India needs a whole spectrum of solutions to meet its diverse needs. This is different from the more developed nations where a single solution addresses a substantial segment of the market. Consequently by focusing on different end segments, each with their unique price/performance matrix there is a great opportunity for value creation through nano-technology. India also needs more distributed manufacturing and production close to the consumers. Conventional wisdom which states that improved economies are achieved at higher scales needs to be re-examined. Manufacturing processes have to be rendered smaller, cleaner and affordable.

ND: What needs to done for all these to happen?

Dr Sivaram: For this to happen innovation must assume importance. Scientists and engineers in public institutions and academia must abandon the thinking that their job is to merely create good science and it is somebody else's responsibility to create value out of their science. Our peer recognition system must equally reward those who create applications of science which is accepted by the market. Young people must be taught in the universities and research laboratories that there is an alternative career path than merely doing a Ph D, pursuing a post doctoral research in some country abroad and then seek lifelong employment is a large industrial or government institution. Young people must be exposed to opportunities in scientific entrepreneurship and to the thought that they can create employment for others. There is a need to lower the barrier to entrepreneurship and encourage young people to a higher risk career opportunity with a larger pay off to society. There is too little of these initiatives in India.

ND: Till date what application developed in India have excited you and why? What are the major applications that you think will we all have to look forward from our scientists?

Dr Sivaram: Truly disruptive innovations have not come from cutting edge nanotechnology in India. This is not to say that nothing has happened. Catalysis for chemical processes are real life examples of nanomaterials in useful action. Several novel catalytic processes have been developed in India. There are several developments in the area of clean water which are built on the foundation of either nanoparticles or nanoporous materials. Nanoparticle based drug delivery is an advance technology practiced in India. Polymer nanocomposites have entered Indian markets.

However the promise is much larger, especially in health, diagnostics, communications and information technology, new energy resources, defense and national security.

ND: What are NCL's activities in nanotechnology?

Dr Sivaram: NCL has a strong research base in catalysis, polymers and advanced materials. NCL's focus is on new energy conversion systems, novel catalysts, and porous polymers for a diverse range of applications, controlled delivery of drugs as well as other active compounds and nanostructured materials. Polymers with controlled porosity in nanometer range have widespread applicability in water purification, as super-absorbent materials and as proton conducting membranes for application in fuel cell application. All these are areas of current research at NCL. Pore size control in inorganic materials and their use as catalysts for selective conversions and also as inorganic membranes is another area of our interest. Hybrids of polymers with inorganic nanomaterials, and nanomaterials with tunable band gaps are being studied for potential applications in solar energy conversion devices. NCL has broad and generic competencies in tailoring polymer structures capable of forming micro- and nano-capsules, useful in a variety of controlled delivery applications. Many of these concepts have been industrially exploited.

NCL has created an innovation ecosystem through the NCL Innovation Park and the associated Venture Center, a Section 25 company which houses a technology business incubator. Venture Center will provide to early stage entrepreneurs a wide range of services, which include company formation, assistance with IP, angel investment through a dedicated Lab2Mkt funding programme, support to MSMEs, and facilitating business plan preparation, new venture creation and their structuring and funding. I believe that this will be a very useful adjunct to NCL as it embarks on its mission to create new value out of the cutting edge science that will emerge out of its laboratories.

ND: Presently the excitement of nanotech seems to be amongst the training institutes, universities. Is this justifiable?

Dr Sivaram: Education is an important component in any emerging technology landscape. However, we need to distinguish between education and skill development. A large number of private institutions (and a few public universities too) have begun four year undergraduate course in Nanotechnology. To me this is unwarranted. Nanotechnology skills have no use since there are no large industries which use or need these skills. This is unlike biotechnology where some justification for an undergraduate course exists, since there are a large number of biotech industries which require technical personal just adequately skilled for a number of routine functions. An undergraduate in nanotechnology is unlikely to possess the depth of knowledge in either basic sciences or engineering to be useful as a professional in this area.

Nanoscience is a discipline born out of basic sciences and engineering. Anyone with grounding in chemistry, physics, mathematics, biology or any of the core engineering disciplines can become a nanoscience or technology professional in the long run. I would therefore encourage students to pursue a course in basic sciences or engineering if they wish to pursue advanced studies in this area. It is worth recognizing that man and nature have created materials across a diverse length and time scales. In that science, biology and material science is a continuum, from the scale of atoms to large ensemble comprising of many molecules. There is a deep relationship of the behavior of matter across these length and time scales. So to treat nanoscience as a separate scientific discipline is inappropriate. In my view nanoscience is a research discipline and anyone broadly trained in basic sciences or engineering can pursue it. Universities must embed the principles as well as our current understanding of behavior of matter in nanodimension within classical subjects such as structure, bonding and dynamics, statistical mechanics, thermodynamics, spectroscopy, colloid science, chemical synthesis, soft condensed matter theory, electrostatics and fluid mechanics. ■

Awards & Fellowships:

Padma Shri

Recipient of the Vishwakarma Medal (INSA)

Silver Medal of the Chemical Research Society of India

Millennium Medal of the Indian Science Congress Association

Distinguished Alumnus Award of IIT, Kanpur

Professor SR Palit Memorial Award of the Indian Association for Cultivation of Science

KG Naik Gold Medal of MS University, Baroda,

FICCI Award in Physical Sciences

Om Prakash Bhasin Award

JC Bose Fellowship of the Department of Science and Technology, Government of India for the period 2007-11

Fellow of Indian National Science Academy, Indian Academy of Sciences, National Academy of Sciences, Indian National Academy of Engineering and the Academy of Sciences for the Developing World, Trieste, Italy.

Dr Sivaram is a Member of the Board of Governors of National Institute of Pharmaceutical Education and Research (NIPER), Chandigarh, Indian Institute of Science Education and Research (IISER), Pune and Institute of Chemical Technology, Mumbai. Currently, he also serves as the Vice President of Indian Academy of Sciences, Bangalore. He also serves on the Board of Directors of Asian Paints India Limited, Apcotex Industries Limited and GMM Pfaudler Limited.