
NANO SCIENCE AND TECHNOLOGY — THE INDIAN SCENE

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WHAT HAVE WE DONE SO FAR?

- **Basic Research in nanomaterials was being promoted as part of institutional and extramural support by all funding agencies**
- **In October 2001, DST launched a Nano Science and Technology Initiative (NSTI) under the leadership of Prof. CNR Rao.**
- **DST has also promoted some activities under bilateral international programmes**

NSTI — launched in October 2001

Broad Objectives:

- **Support priority areas of research in Nano Science & Technology**
- **Strengthen characterization and infrastructural facilities at National level**
- **Generate trained Manpower in the area**
- **Have interface between educational institutions and industry for applications**

Thrust of the Programme

- **Research Areas (Synthesis & Assembly)**
- **Characterization Facilities (Routine & Advanced measurements)**
- **Education (To Train Manpower)**
- **Industry (Linkages with Industry)**

Thrust of the Programme contd.

1. Research Areas

(a) **Synthesis and Assembly**

Ceramic nanoparticles, Nanotubes, Nanowires, Nanoporous solids, DNA chips, Nanostructured alloys, etc.

Main focus on chemical methods / routes to synthesize these materials

(b) **Characterization**

i) **Less expensive pieces of equipment for routine characterization for individual research workers (e.g. ordinary STM/AFM, Light scattering etc.)**

ii) **Facilities / equipments for advanced measurements**
A few centers to be established with major facilities (eg. Combined AFM-STM-SEM Instrument, Near Field Microscopy, Optical Tweezer)

Thrust of the Programme contd.

(c) Applications

- i) Nanolithography & Nanoelectronics
- ii) Drugs / Gene targeting, DNA Chips
- iii) Nanotubes
- iv) Nanostructured high strength materials
- v) Quantum structures

2. Education

- Advanced Schools
- International / National symposium
- Postdoctoral Fellowships in Nanoscience & Technology

3. Industry

Interaction with Industry

Nanopowder / Nanoparticle production

Nanoelectronics

Surface processing

Drug Delivery

Initial discussions held with Confederation of Indian Industry

PRESENT STATUS

- **80 R&D Projects funded**
- **9 Regional Centres/Units on Nanoscience funded with state-of-the-art facilities**
- **6 Centres on Nanotechnology to be funded soon.**
- **One International and One National Conference organized focusing on different aspects of Nano Science & Technology**
- **Two Advanced Schools organized**
- **Postdoctoral Fellowships initiated – 10 per year**
- **Investments made so far ~ \$ 20M**

Some Areas of Research Work

- ❖ Application of SWCNT in fluid flow measurements
- ❖ Synthesis and properties of nanotubes and nanorods of transition metal oxides, chalcogenides, III-V semiconductor nanowires
- ❖ Template synthesis of nanowires
- ❖ Synthesis and applications of nanocomposites
- ❖ Metallurgical routes to engineer the hardness of bulk nanocomposites
- ❖ Applications of nanoparticles, particularly in targeted drug delivery, pigment paints and engineering materials, novel sensors, etc.
- ❖ Biosynthesis of nanomaterials
- ❖ Functional, nanostructured films
- ❖ etc.

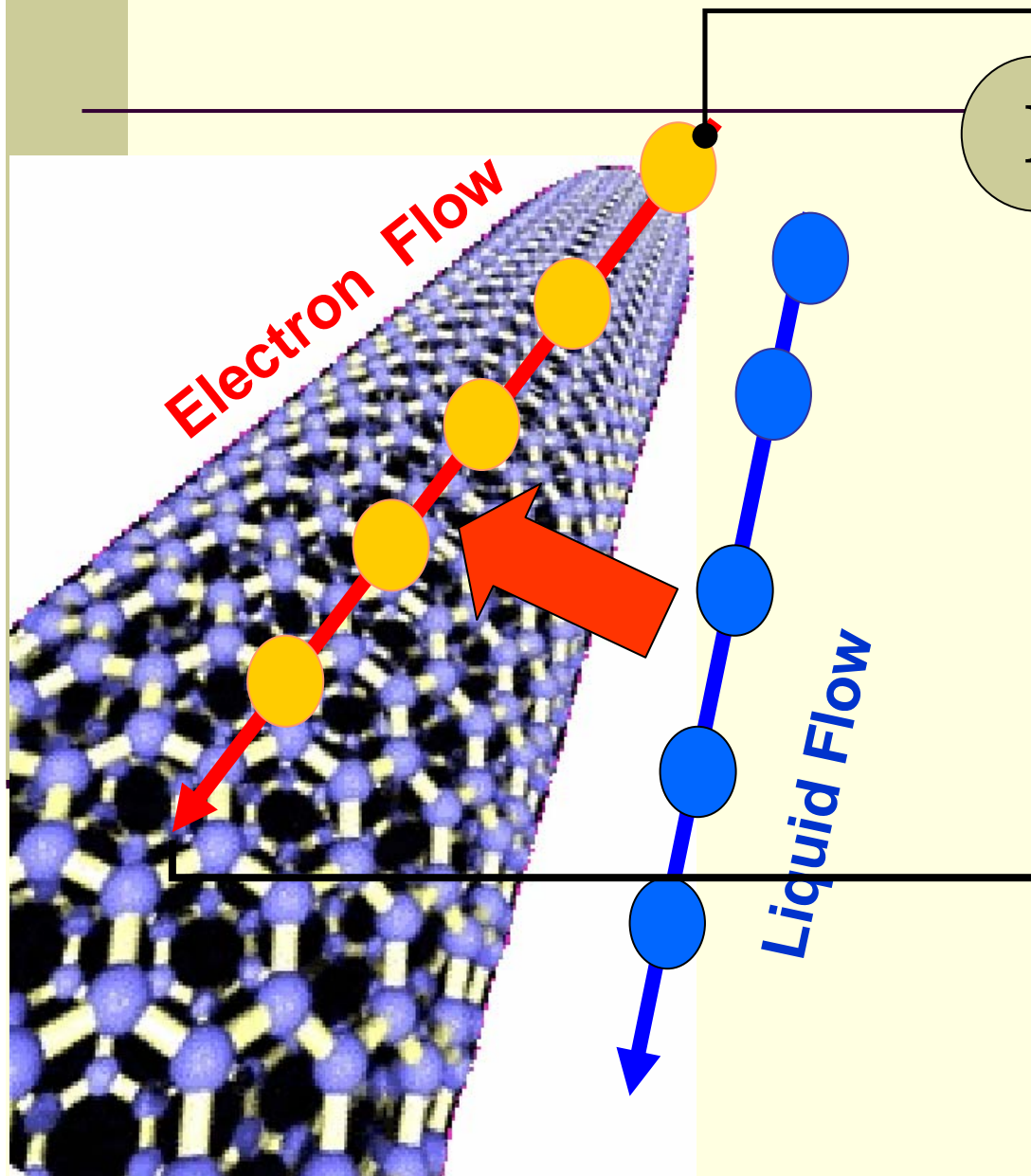
Flow induced electrical signals in SWNT

Key Result:

Voltage and Current are generated by flow of liquid on nanotubes.

*S. Ghosh, A.K. Sood and N. Kumar: **Science** 299, 1042 (2003).*

US Patent Number : 6,718,834



- SWNT are 1D systems: Narrow lanes for carriers.

- Momentum transfer to the carriers either by direct or indirect processes causes electrons (holes) to scatter only in forward or backward directions along the tube.

Nano-biology

Design of Nanoparticles as Non-Viral Vectors (fat nanoparticles) for gene delivery to eukaryotic cells.

Use of inorganic nanoparticles for drug delivery for ocular applications.

Institutions Supported

- Indian Institute of Science, Bangalore
- Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore
- National Chemical Laboratory, Pune
- National Physical Laboratory, New Delhi
- Indian Association for the Cultivation of Science, Kolkata
- Saha Institute of Nuclear Physics, Kolkata
- Indian Institutes of Technology
 - - Delhi
 - - Bombay
 - - Kanpur
 - - Kharagpur
 - - Guwahati
 - - Madras
 - - Roorkee
- National Metallurgical Laboratory, Jamshedpur

Institutions Supported Contd.

Central Universities

- **University of Delhi**
- **Banaras Hindu University**
- **University of Hyderabad**

Other Universities

- **Anna University**
- **Madras University**
- **Pune University**
- **Vidyasagar University**
- **North Maharashtra University**
- **Madurai Kamaraj University**
- **Osmania University**

SOME ACTIVITIES UNDER BILATERAL INTERNATIONAL PROGRAMMES

□ Indo-US Efforts

Some DST-NSF projects funded:

**Indian institutions: NPL, Osmania, RRL
Trivandrum, IISc, IITK, CEERI, etc.**

**US institutions: UoPennsylvania, PennStateU,
UoFlorida, UoMinnesota, UoRhodelsland, etc.**

5 Indo-US Conferences held since Nov 2001

- a variety of topics covered

SOME ACTIVITIES UNDER BILATERAL INTERNATIONAL PROGRAMMES (contd..)

- **DST-NSF Materials Network**
to involve larger number of Indian and US institutions on projects of mutual interest in the area of Materials Science including Nanomaterials

- **Indo-German Efforts**

Indo-German Workshop on Nanomaterials
INDO-GERMAN RESEARCH TRAINING GROUP (IGRTG)
on Engineered Functional Nanocomposites to start (IITK,IITM,ARCI – Darmstadt,Karlsruhe,Saarbrucken,Ulm)
- to focus on magnetic properties, magnetic interactions, gas-solid interactions including catalysis, etc.

SOME ACTIVITIES UNDER BILATERAL INTERNATIONAL PROGRAMMES (contd..)

□ Indo-Italian Efforts

SINP, Kolkata & INFM, Genoa

(patterned glass and patterned GeAs and SiC)

Uo Hyderabad & Uo Trento

(metallic and semiconducting nanoparticles in rare earth activated glassy matrix for photonic applications)

□ Indo-EU Efforts

□ Indo-Taiwan Efforts

THE CENTRE FOR NANOMATERIALS AT ARCI, HYDERABAD

- Pilot-scale facilities for producing nanopowders**
- Facilities for producing CNTs**
- Facilities for agglomeration of nanopowders**
- Compaction and sintering of nanopowders for producing nanostructured components and shapes**
- Engineering coatings**
- Development of CNT reinforced ceramic and polymer composites**
- Use of nanopowders for water and air purification, etc.**

WHAT DO WE NEED TO DO NOW?

- **Increase investments – obvious**
- **However, we need to invest on larger number of researchers and not only focus on increased investments on the same population of workers – this calls for a vibrant Manpower Development Programme**
 - A. Large number of fellowships to tap ever increasing number of researchers – a sizable portion of it should go to technology and product developers
 - B. Large number of Nanotechnology Chairs to ensure continued involvement of researchers in Nanotechnology
- **Promote entrepreneurship and start-ups**

Future Plans

1. Interaction with Industry to evolve joint projects in following areas

Nanoparticle production

Drug delivery

Nanoelectronics

Surface Coatings

- 2. Possible collaboration with other countries in areas of mutual interest**
- 3. Take up multi-disciplinary studies on safety aspects of nanomaterials**

LAUNCH OF NANOSCIENCE & TECHNOLOGY MISSION

- **Some possible guiding principles:**
 - A. Areas of national interest and priorities like energy, drinking water, health care, etc.
 - B. Areas where national S&T strength exists
 - C. Areas with commercial potential
- **FOUR POSSIBLE APPLICATION AREAS:**
 - Surface Coatings/Engineering with Nanopowders
 - Energy Saving and Storage Applications
 - Drug Delivery
 - Sensors, devices etc.
- **Approx. US \$ 250m for next 5 Years**



**THANK
YOU!**