

Title of the Project: **Status of Nanotechnology in Indian Industry & Academia/ R&D Labs.**

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Implementing Agency: **National Foundation of Indian Engineers (NAFEN)**

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Executive Summary

ACADEMIC SIDE ANALYSIS

- The study intends to assess the latest and up-to-date status of nanotechnology in India in various academic institutes / R&D Labs. and industrial organizations engaged in the field.
- 152 experts from 77 Academic Institutes/ R&D Labs were surveyed; against this 122 (80%) experts from 65 (84%) Academic Institutes gave the required information. Total Number of Scientists/ Technologists working in 65 Academic Institutes/ R&D labs === 16782 Nos. and Scientists/ Technologists exclusively for Nanotechnology field === 1920 Nos. i.e. Approx. 11% of total Scientists/ Technologists are exclusively working for Nanotechnology related fields in the identified organizations.
- Present Investment in 65 academic institutes/ R&D labs in the field of Nanotechnology === Rs.14661 Million. Entire amount is not a direct funding amount from Government funding agencies.
- 183 Indian and 22 Foreign Patents have been applied. 49 Indian and 18 Foreign Patents have been granted. Country wise position of 18 foreign patents granted as USA (11), Japan (1), EU (2) Australia (2), South Korea (1) and Germany (1).
- Out of 122 respondents, 34 (28%) respondents have mentioned that the present equipment available with them for nanotechnology activities is adequate. 88 (72%) have mentioned that the infrastructure is not adequate and they require 687 additional Scientists/ Technologists and some new equipment.
- Out of 65 Academic Institutes/ R&D labs surveyed, 43 (66%) are offering courses in the area of nanotechnology at B.Sc./B.Tech./ M.Sc./ M.Tech & Ph.D. level.
- Respondents from balance 22 institutes / R&D Labs., mentioned that they will also introduce courses on nanotechnology at various levels in near future like Bachelor, Masters and Ph.D. To meet this objective they would need additional 574 Scientists/ Technologists and advanced equipped labs and Centres
- More than 59% of the respondents have mentioned commercialization and patenting as the criteria to assess the progress of present level of development of nanotechnology activities in India. This was followed, by publications (43%) and both commercialization and patenting (42%). (34%) have given emphasis on Industry - Institute partnership and (31%) have mentioned availability of trained human resources. (23%) have indicated clear definition of nanotechnology and (19%) have indicated public awareness regarding societal impact of nanotechnology. (Note: Multi-choice question)
- Out of 122 experts, 56 (46%) have stated that the various initiatives taken by the Government of India agencies are appropriate & sufficient. 66(54%) experts have stated that the initiatives are not sufficient and they have suggested remedial

measures to be taken by the Government of India. Some of the remedial measures suggested are as follows:-

- Govt. policy should be focused and clear
 - A network between teachers, scientists & technologists from academia and industry should be created.
 - Funding of projects should be enhanced and should be on transparent basis.
 - Courses on nanotechnology should be introduced even at the UG level
 - Industry should also come forward to fund projects for nanotechnology
- There are 45 National and 77 International collaborations with other organizations / institutes / R&D Labs.

INDUSTRY SIDE ANALYSIS

- 59 organisations from the industry side were surveyed and 41 (69%) organisations responded and gave the required information.
- Total Number of Scientists/ Technologists working in 41 organisations = 14609 Nos. Scientists/ Technologists exclusively working in 41 industrial organizations for Nanotechnology field === 446 Nos. i.e. 3% Scientists/ Technologists exclusively working for Nanotechnology related fields.
- Present Investment in 41 organisations in the field of Nanotechnology =Rs. 8692 Million
- 54 Indian and 77 Foreign Patents have been applied. 21 Indian and 32 Foreign Patents have been granted. Country wise position of 32 foreign patents granted as USA (12), UK (8), Japan (6), Germany (4), Others (2).
- Only 16 (39%) respondents mentioned that they have developed new technology in collaboration with other research institutes in India & abroad.
- 24 (59%) respondents have mentioned that the present equipment for nanotechnology activities are adequate. 17 (41%) have mentioned that it is not adequate. To meet their requirements they need 181 additional Scientists/ Technologists and some new machinery/ characterization equipment.
- Industries have indicated some future plans are as :-
- Developing alternative formulations with different profiles
 - Developing new formulations with higher bio availability
 - Developing new powder for floor coatings
 - Development of embryo research centre for sheep management.
 - Development of Automotive Clear paint coat and other coating products with excellent scratch resistance properties.
 - Development of Weather Resistant Wood Coating
 - Improve manufacture of oral dosage forms.
 - Development of high capacity of lead acid batteries
 - Development of Novel plastic blend alloy based Nanocomposites
 - To develop FC flow conveyors, MF chain conveyors and Coal feeders by using Nano particles
 - To develop new products for feminine hygiene like Sanitary napkins
 - To develop solutions for skin infections, soft tissue wounds, boils and fungal infections
 - To develop new techniques for energy conservation for various electric devices.
 - To meet these objectives, they need additional 295 Scientists/ Technologists and advanced equipped labs.

- 25 (61%) respondents indicated that initiatives taken by the Government of India are adequate. 16 (39%) have indicated as not adequate and following suggestions have been given:-
 - Create qualified nanotechnology manpower
 - Faster approvals from the regulatory authorities and create single window concept for regulatory mechanism
 - More incentives to be given for industries who want to work in the area of nanotechnology
 - Government R&D funding should be focused
 - Government should create specific goal oriented task forces for each area of nanotechnology
 - Reduce high R&D costs

- Out of 41 respondents, 18 (44%) experts agreed that the courses/ training programmes run in the academic institutions are adequate to meet the requirements of the industry. However, 23 (56%) mentioned that they are not adequate. They gave following major suggestions :-
 - Advanced courses in nanotechnology should be introduced starting from bachelor level onwards in Engg. Colleges like IITs and NIITs
 - Incorporation of basic aspects of Nano-technology at under-graduate level
 - More emphasis on research in academic curriculum
 - Sign Joint Ventures (JVs) with leading Universities/R&D labs from USA/Europe

- There are 17 National and 28 International collaborations with other organizations/ institutes/ R&D Labs.

- Project Investigator (PI) met number of prominent experts during the course of the study like Dr. T Ramasami, Secretary, Department of Science & Technology, Govt. of India; Mr. G. Madhavan Nair, Chairman, Indian Space Research Organization (ISRO) & Secretary, Department of Space, Government of India; Prof. U.R. Rao, Former Chairman, ISRO; Dr. Dr. S.K. Sikka, Scientific Secretary, Office of the Principal Scientific Adviser to the Govt. of India; Prof. A.K. Raychaudhuri, Head, S.N. Bose National Centre for Basic Sciences, Kolkata; Dr. Murali Sastry, Chief Scientist, Tata Chemical Ltd., Pune; Dr. V.K. Vinayak, President (R&D). Panacea Biotec, New Delhi; Mr. G.N.V. Satyanarayana, Director (Technical), Electronics Corporation of India Limited, Hyderabad; Prof. A.K. Sood, Chairman, Div. of Physical & Mathematical Sciences, Indian Institute of Science; Prof. N. Kumar, Homi Bhabha Distinguished Professor, Raman Research Institute, Bangalore; Prof. J. Kumar, Director, Crystal Growth Centre, Anna University, Chennai; Prof. A.K. Ghosh, Professor & Head, Indian Institute of Technology, Delhi. Gist of the discussions with these experts is as follows:-
 - Nanotechnology development at present is in its initial stages in India and intensive efforts are required both by Academia/ R&D labs and Industry, to make nanotechnology products available to the masses at a faster pace at competitive prices particularly in the areas like Water filtration systems and Health care.
 - Key sectors where nanotechnology and its applications will play major role are Energy applications, Water filtration Systems, Textiles, Drug Delivery, Pharmaceutical & Food Preservation and Packaging.
 - Paper publication by academia should be encouraged in such fields where technology can be expeditiously developed leading to patenting and commercialization.