

A SCIENTOMETRIC MAPPING OF RESEARCH PERFORMANCE ON NANOTECHNOLOGY: THE INDIAN PERSPECTIVE

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Abstract

This research work attempts to analyze quantitatively the growth and development of Nanotechnology Research in India in terms of publication output as reflected in Web of Science Database (SCI) for the period 1998 to 2006. The researchers have published a total of 79 papers on Nanotechnology during this period. The study reveals that Nanotechnology research in India is still in its infancy.

Index Terms: Nanotechnology, Scientometric mapping

1. INTRODUCTION

Scientometric mapping describes the output traits in terms of organizational research structure, resource inputs and outputs, develops benchmark to evaluate the quality of information output. Scientometric studies characterize the disciplines using the growth pattern and other attributes [1]. These studies have potential particularly in assessing the emerging disciplines. Thus, Scientometric study of research performance of Nanotechnology has potential and enables the users to get an understanding the structure of it.

Nanotechnology refers broadly to a field of Applied Science and Technology whose unifying theme is the control of matter on the atomic and molecular level in scales smaller than 1 micrometre, normally 1 to 100 nanometers, and the fabrication of devices within that size range. It is a highly multidisciplinary field, drawing from fields such as Applied Physics, Materials Science, Colloidal Science, Device Physics, Supramolecular Chemistry, and even Mechanical and Electrical Engineering [2]. Much speculation exists as to what new science and technology may result from these lines of research. Nanotechnology can be seen as an extension of existing sciences into the nanoscale, or as a recasting of existing sciences using a newer, more modern term.

2. SCOPE OF THE STUDY

The present study attempts to find out the publication pattern of researchers of Nanotechnology. This study is based on the references and aims to analyze quantitatively the growth and development of Nanotechnology in India in terms of publication output as reflected in Web of Science Database during 1998-2006 [3]. Web of Science is the largest abstract and citation database of research literature and quality web-only journals. It is designed to enable not only the researchers for accessing scientific information but also provide the information scientists to study the literature for different information analyses purposes, quick, easy, and comprehensive. Web of Science provides superior support of the literature research process.

3. OBJECTIVES

The main objective of the study is to present the growth of literature and make the quantitative assessment of status of researchers of Nanotechnology in India by analyzing the various features. The specific objectives are

- 1 To measure year-wise growth of publications in terms of input of records
- 2 To measure domain-wise contributions
- 3 To measure authorship pattern in the publications
- 4 To measure source of publications
- 5 To measure format of publications

4. METHODOLOGY

The study entitled “Scientometric Mapping of Research Performance on Nanotechnology: The Indian Perspective” is a case study encompassing records output on Web of Science (SCI) [4]. The present study aims at analysing the research output of India in the field of Nanotechnology. The growth rates of output in terms of both at absolute level and relative level are analysed from 1998 to 2006. The authorship pattern and the author productivity are examined to identify the pattern of research contribution in the field of Nanotechnology [5]. The area-wise research performance is analysed to identify the emerging area of research. The study is mainly exploratory in nature in identifying research output of Indian Nanotechnology researchers.

5. RESULTS AND DISCUSSION

5.1 Year-wise Distribution of Research Output

Nanotechnology research output of National level is mainly mentioned in the table 1. The table given below indicates the total output made by the Indian researcher during 1998-2006. The number of publication is accounted to 1 in 1998 and it was raised upto 26 in 2006. The publication output in 2006 was noted to be the highest productivity of 32.91 per cent output over the study period. From the discussion, it could be deduced that there was a gradual growth trend noted in terms of publication output made by the Indian researchers. In the present study, the total output has been observed to 79 for 9 years and no research output in 1999 and 2000.

Table 1 Year-wise Distribution of Indian Researchers on Nanotechnology

Publication Year	Research Output	Percentage	Cumulative %
2006	26	32.91	32.91
2005	19	24.05	56.96
2003	13	16.45	73.41
2004	10	12.66	86.07
2002	8	10.13	96.20
2001	2	2.53	98.73
1998	1	1.27	100.00
Total	79	100.00	

5.2 Institution-wise Nanotechnology Research Output

Table 2 indicates Institution-wise Nanotechnology research productivity. It is noted that Indian Institute of Technology and National Chemical Laboratory ranks first in order by contributing 15.19 per cent of total research output. Indian Institute of Technology and National Chemical Laboratory have well established infrastructure facility. The second place in order is recorded by Indian Institute of Science, Bangalore also having well established infrastructure facility which shares 10.13 per cent, Saha Institute of Nuclear Physics contributing 5.06 per cent of total scientific research output of the specified institution takes third place in order. The other 58 Institutions have given less than 5 per cent of share in total research output.

Table 2 Institutions-wise Research Output

Institution Name	Record Count	% of 79
Indian Institute of Technology	12	15.19
National Chemical Lab	12	15.19
Indian institute of Science	8	10.13
Saha institute of Nuclear physics	4	5.06
Bhabha Atom Research Centre	3	3.80
Cent elect Engineering research institute	3	3.80
Tohoku University	3	3.80
Caltech	2	2.53
CSIR	2	2.53
Government India	2	2.53
Indian Assoc Cultivation Science	2	2.53
Int inst information technology	2	2.53

Institution Name	Record Count	% of 79
Jawaharlal Nehru Ctr adv Science Research	2	2.53
University Hyderabad	2	2.53
Abasaheb Garware college	1	1.27
Alagappa University	1	1.27
All India Inst Med Science	1	1.27
Armed forces med college	1	1.27
Asian Institute of technology	1	1.27
Banaras Hindu University	1	1.27
BARC	1	1.27
Bharati vidhyapeeths College Engn Womens	1	1.27
Cent Electrochem Research Institute	1	1.27
Cent glass & Ceram Res inst	1	1.27
Cent sci instrument org	1	1.27
Ctr mat elect technology	1	1.27
Def inst adv technology	1	1.27
Ganpat University	1	1.27
Georgia inst technology	1	1.27
Govt higher secondary scheme	1	1.27
Guru Gobind Singh Indraprastha University	1	1.27
Indian petrochem corp Ltd	1	1.27
Indian sch mines	1	1.27
IGCAR	1	1.27
Inst life science	1	1.27
Inst phys	1	1.27
Inst Theoret & Angew phys	1	1.27
Ja College women	1	1.27
Jai Narain Vyas University	1	1.27
Japan Science & Technology agcy	1	1.27
Karunya Inst technology & Science	1	1.27
Kurukshetra University	1	1.27
Madurai Kamaraj University	1	1.27
Maharaja Sayajirao University Baroda	1	1.27
Max Planck inst met Research	1	1.27
National phys lab	1	1.27
Niper	1	1.27
Nmssvn College	1	1.27
Postgrad Inst Med Educ & Research	1	1.27
PT Ravishankar Shuklar	1	1.27
PZT Ctr	1	1.27
Raja Rammohun Roy Mahavidyalaya	1	1.27
Shivaji University	1	1.27
Sree Chitra Tirunal inst med Science & technology	1	1.27
Tech University Clausthal	1	1.27
University Arkansas	1	1.27

University Aveiro	1	1.27
University British Columbia	1	1.27
University Illinois	1	1.27
University Potsdam	1	1.27
University Stuttgart	1	1.27
Vishwakarma Institute of technology	1	1.27

5.3 Author-wise Distribution of Research Output

The objective of the study of authorship pattern is to bring out the research pattern in a discipline. The extent of research contribution by the Indian researchers is explained in the analysis of authorship pattern. It is well known that nowadays research is carried out by group of researchers rather than by a single researcher. The total contributions published by Indian researchers are calculated to 79 over the study period.

It could be noted that two authored papers rank first in the order sharing 29.11 per cent of the total research output. The one-authored papers follow the second in the order taking 24.05 per cent of the total research contributions. The three-authored contributions take the third in the order sharing 16.46 per cent of the total scientific research output during the study period. Four authored papers rank next in the order reporting 8 contributions results in 10.13 per cent of total Nanotechnology research output.

Table 3 Author-wise Distribution of Research output

No of Authors	No of Contribution	Percentage	Cumulative %
1	19	24.05	24.05
2	23	29.11	53.16
3	13	16.46	69.62
4	8	10.13	79.75
5	5	6.33	86.08
6	4	5.06	91.14
7	5	6.33	97.47
8 and Above	2	2.53	100.00
Total	79	100.00	

5.4 Country-wise Collaborative Distribution of Research Output

During 1998–2006, India produced a total no. of 79 publications.

Table 4 Country-wise Collaborative Research output

Country/Territory	Record Count	% of 79
India	79	100.00
USA	5	6.33
Germany	3	3.80
Japan	3	3.80
Canada	1	1.27
Portugal	1	1.27
Thailand	1	1.27

More than 5 (6.33%) collaboration with USA, 3 (3.80%) collaboration each with Germany and Japan, 1 (1.27%) collaboration each with Canada, Portugal, and Thailand respectively. It is well known that nowadays research is carried out by group of researchers rather than by a single researcher.

5.5 Document Type-wise Distribution

During 1998–2006 India produced a total no. of 79 publications. The highest numbers of publications were 67 (84.81%) Journal articles, 7 (8.86%) Reviews, 4 (5.06%) Editorial Materials and 1 (1.27%) Letter.

Table 5 Document-wise Research output

Document Type	Record Count	% of 79
Article	67	84.81
Review	7	8.86
Editorial Material	4	5.06
LETTER	1	1.27
Total	79	100.00

5.6 Subject Domain-wise Distribution

During 1998–2006 India produced a total no. of 79 publications which have contributed significantly to the following main domains broadly grouped as:

- Materials Science, Multidisciplinary
- Physics, Applied
- Chemistry, Multidisciplinary
- Chemistry, Physical
- Multidisciplinary Sciences
- Nanoscience & Nanotechnology
- Physics, Condensed Matter
- Chemistry, Inorganic & Nuclear
- Engineering, Multidisciplinary
- Pharmacology & Pharmacy
- Physics, Multidisciplinary
- Biochemistry & Molecular Biology
- Biophysics
- Biotechnology & Applied Microbiology
- Crystallography
- Materials Science, Biomaterials
- Materials Science, Coatings & Films
- Computer Science, Theory & Methods
- Engineering, Chemical
- Engineering, Electrical & Electronic
- Engineering, Industrial
- Physics, Atomic, Molecular & Chemical
- Polymer Science
- Telecommunications

There were 16 (20.25%) publications in Materials Science domain followed by 15 (18.99%) in Applied Physics, 13 (16.46%) publications in Chemistry, 12 (15.19%) publications in Physical Chemistry and Multidisciplinary Sciences, 10 (12.66%) Publications in Nanoscience & Nanotechnology and others less than 5 in different disciplines and growth of publications in each domain is given below.

Table 6 Subject-wise Research Output

Subject Category	Record Count	% of 79
Materials Science, Multidisciplinary	16	20.25
Applied Physics	15	18.99
Multidisciplinary Chemistry	13	16.46
Physical Chemistry	12	15.19
Multidisciplinary Sciences	12	15.19
Nanoscience & Nanotechnology	10	12.66
Physics, Condensed Matter	10	12.66
Inorganic & Nuclear Chemistry	4	5.06
Engineering, Multidisciplinary	4	5.06
Pharmacology & Pharmacy	4	5.06
Physics, Multidisciplinary	4	5.06
Biochemistry & Molecular biology	3	3.80
Biophysics	3	3.80
Biotechnology & Applied Microbiology	3	3.80
Crystallography	3	3.80
Materials Science, Biomaterials	3	3.80
Materials Science, Coatings & Films	3	3.80
Computer Science, Theory & Methods	2	2.53
Engineering, Chemical	2	2.53
Engineering, Electrical & Electronic	2	2.53
Engineering, Industrial	2	2.53
Physics, Atomic, Molecular & Chemical	2	2.53
Polymer Science	2	2.53
Telecommunications	2	2.53
Chemistry, Analytical	1	1.27
Chemistry, Applied	1	1.27
Chemistry, Organic	1	1.27
Engineering, Biomedical	1	1.27
Food science & Technology	1	1.27
Management	1	1.27
Medicine, General & Internal	1	1.27
Operations Research & Management Science	1	1.27
Physics, Fluids & Plasmas	1	1.27
Physics, Mathematical	1	1.27
Physics, Nuclear	1	1.27
Total	79	100.00

5.7 Source-wise Distribution of Research Output

During 1998–2006, India has produced a total no. of 79 publications in the field of Nanotechnology. More than 67(84.81%) papers were published on only the specific

area of Nanotechnology. The highest number of publications were 7(8.86%) on Current Science and 4(5.06%) followed by Synthesis and Reactivity in Inorganic Metal-Organic. Nano-Metal Chemistry and other journals having less than 3 publications.

Table 7 Source-wise Research Output

Source Title	Record Count	% of 79
Current Science	7	8.86
Synthesis and reactivity in inorganic metal-organic and Nano-metal Chemistry	4	5.06
Journal of Nanoscience and Nanotechnology	3	3.80
Pramana-Journal of Physics	3	3.80
Advances in Computer Systems Architecture, Proceedings	2	2.53
Chemistry-A European Journal	2	2.53
Colloids and surfaces B-Biointerfaces	2	2.53
Current Applied Physics	2	2.53
IETE Technical Review	2	2.53
Indian Journal of Engineering and Materials Sciences	2	2.53
Journal of Applied Physics	2	2.53
Journal of Computational and Theoretical Nanoscience	2	2.53
National Academy Science Letters-India	2	2.53
Proceedings of the Indian academy of sciences-chemical sciences	2	2.53
Thin Solid Films	2	2.53
Angewandte Chemie-International Edition	1	1.27
Applied Surface Science	1	1.27
Biological & Pharmaceutical Bulletin	1	1.27
Biomacromolecules	1	1.27
Biophysical Journal	1	1.27
Biotechnology Progress	1	1.27
Bulletin of Materials Science	1	1.27
Catalysis Today	1	1.27
Chemical Physics Letters	1	1.27
Chemistry of Materials	1	1.27
Clinical Pharmacokinetics	1	1.27
Critical Reviews in Biotechnology	1	1.27
Crystal Growth & Design	1	1.27
Crystengcomm	1	1.27
Defence Science Journal	1	1.27
European Physical Journal-Applied Physics	1	1.27
Hyperfine Interactions	1	1.27
Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science-Part A	1	1.27
International Journal of Pharmaceutics	1	1.27
Journal of Applied Polymer Science	1	1.27

Journal of Biomedical Materials Research part B-applied Biomaterials	1	1.27
Journal of Drug Targeting	1	1.27
Journal of Materials Chemistry	1	1.27
Journal of Molecular Structure	1	1.27
Journal of Photochemistry and Photobiology A-Chemistry	1	1.27
Journal of Physical Chemistry B	1	1.27
Journal of Physics D-Applied Physics	1	1.27
Journal of Scientific & Industrial Research	1	1.27
Langmuir	1	1.27
Molecular Crystals and Liquid Crystals	1	1.27
Nanotechnology	1	1.27
National Medical Journal of India	1	1.27
Nucleic Acids Research	1	1.27
Physical Review B	1	1.27
Physical Review E	1	1.27
Process Biochemistry	1	1.27
Pure and Applied Chemistry	1	1.27
Sadhana-Academy Proceedings in Engineering Sciences	1	1.27
Technovation	1	1.27
Thermochimica Acta	1	1.27
Total	79	100.00

6. CONCLUSION

This paper has highlighted quantitatively the contributions made by the Indian Nanotechnology researchers during 1998-2006 as reflected in the Web of Science Database. During 1998 – 2006, Indian contributions in terms of number of publications are not significant. A comparison of Indian output in relation to the world output (India 79 and International 3928) may help in understanding the contribution in a better angle. Though the records available in the Web of Science Database reveal a small number, it is important that the Web of Science covers only the peer-reviewed journals. If a broader coverage database is available, it may provide a reasonable number of papers. It is suggested for tracking citation record of papers so that the impact of publications in Nanotechnology may be visible.

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