



## A Scientometric Analysis of Nanoparticles Research Publications in India

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### ABSTRACT

*This study analyzed the growth of Nanoparticles research publications in India. A total of 2831 records were downloaded from Web of science database. The findings revealed that Indian Institute of Technology and Bhabha Atomic Research centre were the major producers of Nanoparticles research in India. In the extent of International collaboration, that India has often collaborated South Korea, contributing to 82 records having a global citation score of 742. In analyzing the core research areas the maximum number of publications in comes from the area "Material Science", contributing to 1266 records. Further Contribution of journals, ranking of authors, preference of publication, frequency of keywords and funding agencies were also analyzed in this paper. The study also applied statistical tools such as Relative Growth Rate (RGR), Doubling Time etc.*

**KEYWORDS :** Nanoparticle, web of science, RGR, Doubling Time etc.

### 1. INTRODUCTION

In [nanotechnology](#), a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties. [Particles](#) are further classified according to diameter. A nanoparticle (or nanopowder or nanocluster or nanocrystal) is a microscopic particle with at least one dimension less than 100 nm. Nanoparticle research is currently an area of intense scientific research, due to a wide variety of potential applications in biomedical, optical, and electronic fields. "Quality" of science where emphasis is placed on investigations where the mechanisms of science are studied by statistical methods. This paper analyzes the core areas in the field of Nanoparticles research in India.

### 2. OBJECTIVES

- To determine the year wise publication of Nanoparticle research in India.
- To examine the growth rate of publications using RGR and Doubling Time.
- To find out the prolific authors in of Nanoparticle research in India.
- To analyze the document wise distribution of publication.
- To determine the extent of International collaboration
- To analyze the journal wise distribution of publication in Nanoparticle research in India.
- To identify keywords frequently used in Nanoparticle research in India.
- To identify the major institutions contributed to in Nanoparticle research in India.
- To analyze the core research areas in Nanoparticle research in India.
- To identify the funding agencies that supported Nanoparticle research in India

### 3. METHODOLOGY

The data for the study were retrieved from web of science database which is a scientific and indexing service maintained by Thomson Reuters. The Nanoparticles research productivity of India was analyzed. The following search strategy has been used to extract data for the BRIC countries.

TITLE-ABS-KEY ("Nanoparticles") AND PUBYEAR (All years) AND LIMIT-TO (AFFILCOUNTRY "India").

The bibliographic details such as authors, document types, collaboration etc were analyzed using Histcite which is a software package used for bibliometric analysis and information visualization.

### 4. ANALYSIS

A total of 2831 records were published in Nanoparticles research in

India. The research output was analyzed using various scientometric indicators.

### 4.1. YEARWISE PUBLICATIONS

**Table 1: year wise distribution of Nanoparticle research output in India**

S.NO	PUBLICATION YEAR	RECS	PERCENT	TLCS	TGCS
1	1992	1	0.0	0	9
2	1995	5	0.2	4	90
3	1996	4	0.1	4	33
4	1997	5	0.2	0	46
5	1998	2	0.1	1	64
6	1999	5	0.2	2	80
7	2000	8	0.3	4	125
8	2001	17	0.6	7	249
9	2002	24	0.8	15	649
10	2003	37	1.3	99	2450
11	2004	61	2.2	52	1122
12	2005	57	2.0	66	915
13	2006	106	3.7	105	2537
14	2007	139	4.9	102	3033
15	2008	174	6.1	97	3118
16	2009	180	6.4	113	3411
17	2010	257	9.1	154	3537
18	2011	315	11.1	125	3387
19	2012	359	12.7	104	2552
20	2013	417	14.7	83	1738
21	2014	436	15.4	48	639
22	2015	222	7.8	5	34
	TOTAL	2831	100	1190	29818

Table 1 shows the year wise distribution of research output in the field of Nano Particles in India. A total of 2831 records were published by the Indian researchers. The highest number of publications is in the year 2014 with 436 records, having a Global citation score of 639 and a Local citation score of 48, followed by 417 records in the year 2013 with a Global citation score of 1738 and a Local citation score of 83. The year 2010 has scored the maximum global citation score of 3537 with 257 publications. It is also noticed that, even minimum numbers of records have scored higher global citation scores. The table clearly shows that Nano Particles research output in India is increasing every year, which indicates a healthy trend.

### 4.2. GROWTH OF PUBLICATIONS

Relative Growth Rate and Doubling Time are the two parameters used to measure the growth of publications. The Relative Growth Rate and Doubling Time model was developed by Mahapatra (1985).

**4.2.1. RELATIVE GROWTH RATE (RGR)**

The Relative Growth Rate (RGR) is the increase in number of articles or pages per unit of time. It is calculated using the following formula.

$$\text{Relative Growth Rate (RGR)} = \frac{\text{Log } e^{2W} - \text{Log } e^{1W}}{2T - 1T}$$

**4.2.2. DOUBLING TIME**

Generally, doubling time is the period of time required for a quantity to double in size or value. Doubling time and Relative Growth Rate have a direct relation between them. If the number of articles or pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be logarithm of the number 2. If natural logarithm is used this difference has a value of 0.693. Thus the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the formula:

**Doubling Time (DT) = 0.693/R**

**Table 2: Relative Growth Rate and Doubling Time of publications**

YEAR	PUBLICATIONS	CUMULATIVE TOTAL	LOG <sub>e</sub> W <sub>1</sub>	LOG <sub>e</sub> W <sub>2</sub>	RGR	DOUBLING TIME (DT)
1992	1	1		0		
1995	5	6	0	1.79	1.79	0.39
1996	4	10	1.79	2.30	0.51	1.36
1997	5	15	2.30	2.71	0.41	1.69
1998	2	17	2.71	2.83	0.12	5.76
1999	5	22	2.83	3.09	0.26	2.67
2000	8	30	3.09	3.40	0.31	2.23
2001	17	47	3.40	3.85	0.45	1.54
2002	24	71	3.85	4.26	0.41	1.69
2003	37	108	4.26	4.68	0.42	1.65
2004	61	169	4.68	5.12	0.44	1.58
2005	57	226	5.12	5.42	0.30	2.31
2006	106	332	5.42	5.81	0.39	1.78
2007	139	471	5.81	6.15	0.34	2/04
2008	174	645	6.15	6.47	0.32	2.17
2009	180	825	6.47	6.71	0.24	2.89
2010	257	1082	6.71	6.99	0.28	2.48
2011	315	1397	6.99	7.24	0.25	2.78
2012	359	1756	7.24	7.47	0.23	3.01
2013	417	2173	7.47	7.68	0.21	3.30
2014	436	2609	7.68	7.87	0.19	3.65
2015	222	2831	7.87	7.95	0.08	8.67

Table 2 shows the Relative growth Rate and Doubling time of Nano Particles research in India. It is clearly seen from the table RGR is decreasing considerably, whereas Doubling Time shows a fluctuating trend. The RGR is highest in the year 1995 with 1.79 and lowest in the year 2015 with 0.08. The Doubling time is highest in the year 2015 with 8.67 and lowest in the year 1996 with 0.39.

**4.3. RANKING OF AUTHORS**

Table 3: Ranking of top ten authors by number of publications in Nanoparticle research in India

S.NO	Author	Recs	Percent	TLCS	TGCS
1	Khanna PK	42	1.5	68	773
2	Das S	34	1.2	12	277
3	Kumar A	31	1.1	22	437

4	Mishra S	30	1.1	62	227
5	Singh AK	29	1.0	35	344
6	Kumar R	27	1.0	4	126
7	Tyagi AK	26	0.9	6	256
8	Kumar S	25	0.9	25	292
9	Kumar V	25	0.9	13	186
10	Rajendran V	24	0.8	10	90

Table 3 depicts the ranking of top ten authors in Nano Particle research in India. It was found out that totally 6361 authors contributed to Nano Particle research output in India. It is clearly noticed from the table that Khanna PK has published the maximum number of publications with 42 records, having a global citation score of 773 and a Local citation score of 68, followed by Das S and Kumar A with 34 and 21 records, having global citation scores of 277 and 437 respectively.

**4.4. CONTRIBUTION OF JOURNALS**

**Table 4: Contribution of Journals to Nanoparticle research in India (Top 10)**

S.NO	JOURNAL	RECS	PERCENT	TLCS	TGCS
1	JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY	82	2.9	27	454
2	JOURNAL OF ALLOYS AND COMPOUNDS	70	2.5	34	876
3	MATERIALS LETTERS	69	2.4	63	1005
4	MATERIALS CHEMISTRY AND PHYSICS	55	1.9	42	1027
5	RSC ADVANCES	53	1.9	5	120
6	CERAMICS INTERNATIONAL	44	1.6	13	396
7	JOURNAL OF MATERIALS SCIENCE-MATERIALS IN ELECTRONICS	40	1.4	1	140
8	BULLETIN OF MATERIALS SCIENCE	38	1.3	12	227
9	JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS	37	1.3	32	477
10	ASIAN JOURNAL OF CHEMISTRY	36	1.3	1	25

Table 4 reveals the contribution of top ten journals to Nano Particles research output in India. The study found out the total research output of Nano Particles research in India, comprising of 2831 records was published in 644 journals. It is clearly seen from the table that Journal Of Nanoscience And Nanotechnology stands first with 82 records, having a Global citation score of 454 and a Local citation score of 27 followed by Journal Of Alloys And Compounds with 70 records, having a Global citation score of 876 a Local citation score of 34.

**4.5. CONTRIBUTION OF INSTITUTIONS**

**Table 5: Contribution of Institutions to Nanoparticle research output in India (Top ten)**

S.NO	INSTITUTION	RECS	PERCENT	TLCS	TGCS
1	Indian Inst Technol	394	13.9	264	6319
2	Bhabha Atom Res Ctr	107	3.8	54	962
3	CSIR	105	3.7	30	897
4	Indian Inst Sci	99	3.5	42	1632
5	Natl Inst Technol	85	3.0	27	604
6	Anna Univ	69	2.4	23	803
7	Natl Chem Lab	65	2.3	78	1940
8	Banaras Hindu Univ	56	2.0	14	416
9	Jadavpur Univ	55	1.9	23	504
10	Natl Phys Lab	52	1.8	34	737

This table presents the contribution of top ten Institutions to Nano Particle research output in India. It is clearly seen from the table that Indian Inst Technology has the maximum number of publications with 394 records having a global citation score of 6319 and a local citation score of 264, followed by Bhabha Atomic Research Centre with 107 publications, having a global citation score of 962 and a local citation score of 54. It is also noted that institutes with minimum publications have scored highest global citation score.

**4.7. RESEARCH AREAS**

**Table 7: Top ten Research areas of Nanoparticle research in India**

RESEACH AREAS	RECS	PERCENTAGE
MATERIALS SCIENCE	1266	44.719 %
CHEMISTRY	909	32.109 %
PHYSICS	847	29.919 %
SCIENCE TECHNOLOGY OTHER TOPICS	415	14.659 %
ENGINEERING	361	12.752 %
POLYMER SCIENCE	166	5.864 %
METALLURGY METALLURGICAL ENGINEERING	160	5.652 %
ELECTROCHEMISTRY	115	4.062 %
ENERGY FUELS	71	2.508 %
OPTICS	66	2.331 %

Table 7 depicts the top ten research areas of Nano Particle research in India. It is clearly seen from the table that maximum number of publications in comes from the area "Material Science", contributing to 1266 records which is followed by the area "Chemistry" and "Physics" with 909 and 847 records respectively.

## 5. SUMMARY AND CONCLUSION

A scientometric analysis was undertaken in this study to show the present state of Nano particles research in India. The study found out that a total of 2831 records were published by the researchers. Indian Institute of Technology and Bhaba Atomic Research centre were the major producers of Nanoparticles research in India. In the ranking of authors, Khanna PK has published the maximum number of publications with 42 records, having a global citation score of 773 and a Local citation score of 68, followed by Das S and Kumar A with 34 and 21 records, having global citation scores of 277 and 437 respectively. In the contribution of journals, Journal Of Nanoscience And Nanotechnology stands first with 82 records, having a Global citation score of 454 and a Local citation score of 27 followed by Journal Of Alloys And Compounds with 70 records, having a Global citation score of 876 a Local citation score of 34. In the extent of International collaboration, that India has often collaborated South Korea, contributing to 82 records having a global citation score of 742. In the frequency of keywords used, the word "Nano" has been used in 1141 records by the researchers with a Global citation score of 11824 and a Local citation score of 665, followed by the word "Synthesis" in 569 records with a global citation score of 6746 and a Local citation score of 311. In analyzing the core research areas the maximum number of publications in comes from the area "Material Science", contributing to 1266 records. In analyzing the contribution of funding agencies, that Council of Scientific and Industrial Research (CSIR) stands first with 317 funding supported papers followed by Department of Science and technology (DST) and University grants commission (UGC) with 272 and 219 funding supported respectively. Finally, It is concluded that the growth of Nanoparticles research publications in India is increasing every year at a considerable rare which indicates a healthy trend.

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