

Scholarly Output of Material Science Research in India: A Scientometric Analysis

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Abstract - Material Science is a discipline which elevates the properties of matter and its applications to various areas of science and engineering. This science investigates the relationship between the structure of material and its properties. The researcher has made an attempt to highlight quantitatively and qualitatively the growth and development of scholarly publications by Indian Scientists and researchers on Materials Science during 2009-2018 as reflected in Scopus. This study describes and focuses the various factors such as chronology wise distribution; country wise distribution; ranking of highly cited authors; ranking of highly cited institutions; highly cited journals on Material Science; and predominant funding agencies. The results revealed that the highest number of (16.7%) papers published in 2018 and Journal of Materials Science Materials in Electronics is the predominantly used source for the scholarly publication in Material Science research in India. Indian Institute of Science, Bangalore has the highest number of publications in the Material Science research.

Keywords: Scientometric analysis, Material Science, Scholarly Publications

I. INTRODUCTION

Material Science is one of the thrust areas in the field of Engineering and Technology. Materials science is associated with properties and its applications. Material Science research strive to provide a forum of scientific researchers to share findings on all aspects of material Science and Engineering and to disseminate innovative and relevant practices followed in the material science horizon. Materials science is an amalgamated discipline hybridizing metallurgy, ceramics, solid-state physics, and chemistry. It is the first example of a new academic discipline emerging by fusion rather than fission. Materials science is an important part of forensic engineering and failure analysis and investigates materials, products, structures or components which fail or do not function as intended, causing personal injury or damage to property. “The interdisciplinary field of materials science, also commonly termed materials science and engineering is the design and discovery of new materials, particularly solids”

Scientometrics is one of the purport metric tools by which the state of science and technology can be observed by means of overall scientific publications at a given level of specialization. It indicates that for situating a country in association with the world, an institution or organization in

association with a country, and even an individual researcher or scientists in association with their own communities. This study reveals the answer for the status of material science research in India during 2009-2018 as reflected in Scopus Citation database. This study also highlights the journals rating parameters such as SJR, Citescore and SNIP.

II. REVIEW OF LITERATURE

Kochhar *et al.*, (1996) have analyzed research output from Indian institutions in seven categories of materials, namely metals and alloys, aluminum, ceramics, composites, glass, polymers, and wood as per the database developed by Indian National Scientific Documentation Centre (INSDOC) through funding from Technology Information Forecasting and Assessment Council (TIFAC) during 1980–1989.

Kademani *et al.*, (2011) have studied the research and impact of materials science in India as per Web of Science for the period 1999–2008. In this paper, they have highlighted the growth of publications and citations, relative growth rate and doubling time, domain-wise distribution of publications and citations, activity index, national and international collaboration, highly productive institutions, highly productive authors, channels of communication, impact factor wise distribution of publications and highly cited publications.

Lalit *et al.*, (2010) have highlighted quantitatively the growth and development of Indian research in the field of nanoscience and nanotechnology in terms of publication output as reflected in Science Citation Index (SCI) during 1982–2008.

III. OBJECTIVES OF THE STUDY

The main purpose of this research is to identify the growth of Material Science research in India during the period of 2009-2018. The other key objectives are chronology wise distribution, country wise distribution, Ranking of Highly cited authors, Ranking of Highly cited institutions, highly cited journals on Material Science, and document wise distribution.

IV. MATERIALS AND METHODS

For the purpose of this research Scopus database has been chosen for the data collection. The Scopus Core Collection database has been used to retrieve the data by the keyword i.e. 'Material Science' and it is limited to India for the period of 2009-2018.

Total of 12, 648 scholarly publications were done by the Indian material science researchers during the mentioned period. The study has some limitations such as; the study covers the national and international publications only and excludes the publications in regional language. It does not cover literature output from newspapers or magazines and the scholarly communications other than Material Science.

V. ANALYSIS AND RESULTS

Table I inferred that the year wise distribution of contributions on Material Science in India during the period from 2009 to 2018.

It represents that out of 12648 research papers, the highest number i.e. 2101 (16.6%) papers were published in 2018 and had ranked first and followed by 1948 (15.4%) articles which were published in 2017.

TABLE I CHRONOLOGY WISE DISTRIBUTION

S. No.	Year	No of Publication	Percentage (%)
1.	2018	2101	16.65
2.	2017	1948	15.44
3.	2016	1646	13.04
4.	2015	1481	11.74
5.	2014	1277	10.12
6.	2013	1200	9.51
7.	2012	952	7.54
8.	2011	879	6.97
9.	2010	587	4.65
10.	2009	547	4.34

TABLE II TOP 30 PREDOMINANT AUTHORS IN MATERIAL SCIENCE RESEARCH

S. No.	Author	Institution	Publication	Citation	H-Index
1.	Choudhary, R.N.P.	Siksha O Anusandhan University, Department of Physics	81	9103	45
2.	Das, P.R.	Sri Sivasubramaniya Nadar College of Engineering, Chennai	33	9568	45
3.	Thomas, S.	Mahatma Gandhi University, Kottayam	32	29192	80
4.	Manikandan, A.	Bharath Institute of Higher Education and Research (BIHER), Department of Chemistry	22	2395	31
5.	Awana, V.P.S.	National Physical Laboratory India	21	3401	27
6.	Kotnala, R.K.	National Physical Laboratory India	20	4646	33
7.	Solomon, S.	Mar Ivanios College, Thiruvananthapuram, Department of Physics	20	857	16
8.	Basu, B.	Materials Research Centre, Laboratory for Biomaterials, Bengaluru, India	19	6902	43
9.	Thomas, J.K.	Mar Ivanios College, Thiruvananthapuram, Department of Physics	19	759	16
10.	Badapanda, T.	C. V. Raman College of Engineering, Department of Physics	18	840	17
11.	Parida, B.N.	Central Institute of Technology, BTAD	18	470	12
12.	Ahmad, S.	Jamia Hamdard Faculty of Pharmacy, Department of Pharmacognosy and Phytochemistry	17	1512	20
13.	Bhadauria, B.S.	Babasaheb Bhimrao Ambedkar University, Department of Applied Mathematics	17	1284	22
14.	Jayavel, R.	Anna University	17	5353	37
15.	Omanwar, S.K.	Sant Gadge Baba Amravati University, Department of Physics	16	1240	18
16.	Padhee, R.	Sambalpur University, School of Physics	16	421	11
17.	Rai, R.	Eternal University	16	779	16
18.	Tiwari, A.	National Institute for Materials Science Tsukuba, International Center for Materials Nanoarchitectonics	16	2745	28
19.	Iyer, N.R.	Academy of Scientific and Innovative Research	15	1018	14
20.	Kumar, P.	Hanyang University, Department of Civil & Environmental Engineering	15	3855	31
21.	Panigrahi, S.	National Institute of Technology Rourkela, Department of Physics and Astronomy	15	1700	23

22.	Ramasamy, P.	Sri Sivasubramaniya Nadar College of Engineering, Chennai	15	9568	45
23.	Dhoble, S.J.	Rashtrasant Tukadoji Maharaj Nagpur University, Department of Physics	14	4615	29
24.	Kumar, A.	Indian Institute of Technology, Kanpur, Department of Biological Sciences and Bioengineering	14	7171	41
25.	Raj, B.	National Institute of Advanced Studies, Bangalore	14	11290	51
26.	Reddy, B.M.	Indian Institute of Chemical Technology	14	9296	50
27.	Jadhav, K.M.	Dr. Babasaheb Ambedkar Marathwada University, Department of Physics	13	2904	31
28.	Kanagesan, S.	Universiti Putra Malaysia, Materials Synthesis and Characterization Laboratory	13	483	12
29.	Kumar, M.	University of Pennsylvania, Department of Earth and Environmental Sciences	13	4533	32
30.	Sagadevan, S.	University of Malaya, Nanotechnology & Catalysis Research Centre (NANOCAT)	13	448	11

Table II shows the predominant author in the field of Material Science. Choudhary, R.N.P. from Siksha O Anusandhan University has the highest number of publications (81); H-index 45 followed by Das, P.R. from SSN College of Engineering, Chennai (33) with the H-index of 45. Moreover authors working in Southern part of institutions are having good number of publications in the field of Material Science.

Table III clearly highlights the document wise distribution in the field of Material Science research for the period of study. 75 % of the publications are articles published in various journals. Conference papers and Book chapters are 8.05, 7.08 respectively. It shows that the researchers of material science concentrated more on the journal publications than that of reviews, books and editorials.

TABLE III DOCUMENT WISE DISTRIBUTION

S. No.	Document Type	No. of Publication	Percentage (%)
1.	Article	9479	75.12
2.	Conference Paper	1016	8.05
3.	Book Chapter	893	7.08
4.	Review	740	5.86
5.	Article in Press	198	1.57
6.	Book	190	1.51
7.	Erratum	51	0.40
8.	Editorial	24	0.19
9.	Short Survey	10	0.08
10.	Note	8	0.06

TABLE IV TOP 30 PREDOMINANT SOURCE OF PUBLICATION IN MATERIAL SCIENCE RESEARCH

S. No.	Name of the Source	Cite Score	SJR	SNIP	No. of Publication
1.	Journal of Materials Science Materials In Electronics	2.16	0.503	0.811	1008
2.	Bulletin of Materials Science	1.01	0.310	0.524	306
3.	Journal of Materials Science	2.83	0.807	1.064	259
4.	Journal of Superconductivity and Novel Magnetism	1.05	0.320	0.572	240
5.	Journal of Clinical And Diagnostic Research	0.82	0.352	0.670	224
6.	Journal of Krishna Institute of Medical Sciences University	0.08	0.117	0.057	192
7.	Silicon	1.25	0.355	0.832	144
8.	Journal of Chemical Sciences	1.15	0.352	0.466	141
9.	Journal of Sol Gel Science And Technology	1.70	0.477	0.642	135
10.	Journal of Nanoparticle Research	1.93	0.528	0.603	129
11.	Journal of Materials Science Materials In Medicine	2.65	0.647	0.916	124
12.	Advanced Materials Research	0.08	0.121	0.183	119
13.	Journal of Pharmacy and Bioallied Sciences	1.08	0.338	0.664	111
14.	Journal of The Brazilian Society of Mechanical Sciences And Engineering	1.47	0.362	0.866	104
15.	Journal of Porous Materials	1.84	0.500	0.697	103
16.	Matec Web of Conferences	0.25	0.151	0.340	102
17.	European Physical Journal	1.20	0.430	0.596	100
18.	Transport in Porous Media	2.42	0.728	1.241	100

19.	Sadhana Academy Proceedings in Engineering Sciences	0.86	0.209	0.554	97
20.	Journal of Datta Meghe Institute of Medical Sciences University	0.00	0.100	0.00	96
21.	Journal of Inorganic and Organometallic Polymers and Materials	1.53	0.402	0.459	96
22.	Electronic Materials Letters	2.15	0.704	1.031	94
23.	Pramana Journal of Physics	0.56	0.214	0.320	94
24.	Journal of Natural Science Biology and Medicine	1.13	0.380	0.901	92
25.	Journal of Computational Electronics	1.35	0.274	0.716	73
26.	Asian Journal of Transfusion Science	0.90	0.350	0.026	72
27.	Indian Journal of Engineering and Materials Sciences	0.71	0.233	0.567	72
28.	Applied Biochemistry and Biotechnology	2.02	0.571	0.800	69
29.	Journal of Polymer Research	1.37	0.403	0.520	69
30.	Indian Journal of Physics	0.97	0.308	0.671	68

TABLE V TOP 30 PREDOMINANT INSTITUTIONS IN MATERIAL SCIENCE RESEARCH

S. No.	Institution	No. of Publication	Percentage (%)
1.	Indian Institute of Science, Bangalore	301	2.38
2.	Council of Scientific and Industrial Research India	255	2.02
3.	Anna University	245	1.94
4.	Indian Institute of Technology, Kharagpur	232	1.83
5.	Indian Institute of Technology Delhi	206	1.63
6.	Banaras Hindu University	204	1.61
7.	Bhabha Atomic Research Centre	188	1.49
8.	Indian Institute of Technology Madras	175	1.38
9.	Vellore Institute of Technology	174	1.38
10.	Jadavpur University	159	1.26
11.	University of Delhi	150	1.19
12.	All India Institute of Medical Sciences, New Delhi	144	1.14
13.	Indian Institute of Technology Roorkee	143	1.13
14.	National Physical Laboratory India	142	1.12
15.	Indian Institute of Technology, Bombay	136	1.08
16.	Indian Institute of Technology, Kanpur	134	1.06
17.	National Institute of Technology Rourkela	130	1.03
18.	SRM Institute of Science and Technology	129	1.02
19.	Manipal Academy of Higher Education	129	1.02
20.	Siksha O Anusandhan University	128	1.01
21.	University of Hyderabad	106	0.84
22.	Indian Institute of Technology Indian School of Mines, Dhanbad	102	0.81
23.	Indian Institute of Technology, Guwahati	102	0.81
24.	Aligarh Muslim University	101	0.80
25.	Datta Meghe Institute of Medical Sciences	100	0.79
26.	Indian Institute of Technology Banaras Hindu University	94	0.74
27.	Panjab University	92	0.73
28.	Jamia Millia Islamia	90	0.71
29.	Thapar University	85	0.67
30.	Savitribai Phule Pune University	85	0.67

Table IV shows the predominant source to publish the articles in material science research. Journal of Materials Science Materials in Electronics has 1008 publication for the period of study with the Cite Score value of 2.16, Bulletin of Materials Science as 306 publications with the Cite score 1.01; Journal of Materials Science has the Cite Score value of 2.83 with 259 publications. It has recommended the material science researcher to publish their intellectual output based on the Cite Score, SJR and SNIP for the top most journals in the Material Science.

Table V depicts the premier institution in India in the field of material science research. Indian Institute of Science, Bangalore has secured the top position having 301 publication in its credits followed by Council of Scientific and Industrial Research India (255) and Anna University, Chennai 245 publications. Almost all the IITs are contributing the good number of publications in material science research. As a private Institution, SRM Institute of Science and Technology, Vellore Institute of Technology are also having a plenty number of publications in material science.

TABLE VI TOP 30 PREDOMINANT FUNDING AGENCIES IN MATERIAL SCIENCE RESEARCH

S. No.	Funding Sponsor	No. of Publication	Percentage (%)
1.	University Grants Commission (UGC)	504	3.98
2.	Council of Scientific and Industrial Research (CSIR)	467	3.69
3.	Department of Science and Technology, Ministry of Science and Technology (DST)	379	3.00
4.	Department of Science and Technology (DOST)	255	2.02
5.	Science and Engineering Research Board (SERB)	118	0.93
6.	Department of Science and Technology, Government of Kerala	99	0.78
7.	Työ- ja Elinkeinoministeriö (TEM)	85	0.67
8.	Council for Scientific and Industrial Research (CSIR)	71	0.56
9.	Indian Institute of Technology Bombay (IITB)	68	0.54
10.	Defence Research and Development Organisation (DRDO)	60	0.47
11.	Ministry of Coal, Government of India	57	0.45
12.	Schizophrenia Research Fund (SRF)	55	0.43
13.	Illinois Institute of Technology (IIT)	53	0.42
14.	Board of Research in Nuclear Sciences (BRNS)	52	0.41
15.	Department of Biotechnology, Government of West Bengal (DBT-WB)	49	0.39
16.	National Research Foundation of Korea (NRF)	46	0.36
17.	Indian Council of Medical Research (ICMR)	44	0.35
18.	Department of Biotechnology, Ministry of Science and Technology (DBT)	43	0.34
19.	Ministry of Human Resource Development (MHRD)	43	0.34
20.	Department of Atomic Energy, Government of India (DAE)	39	0.31
21.	Department of Science and Technology, Government of West Bengal (DST)	37	0.29
22.	Indian Institute of Science (IISc)	36	0.28
23.	Banaras Hindu University (BHU)	35	0.28
24.	UGC-DAE Consortium for Scientific Research, University Grants Commission (UGC-DAE CSR)	34	0.27
25.	Indian Council of Agricultural Research (ICAR)	32	0.25
26.	All India Council for Technical Education (AICTE)	31	0.25
27.	National Physical Laboratory (NPL)	31	0.25
28.	Ministry of Education, Science and Technology (MEST)	27	0.21
29.	Bhabha Atomic Research Centre (BARC)	26	0.21
30.	Kerala State Council for Science, Technology and Environment (KSCSTE)	25	0.20

Table VI clearly highlights the topmost funding agencies in the field of material science research. University Grants Commission (UGC) funded for 304 publications, Council of Scientific and Industrial Research (CSIR), 467 and Department of Science and Technology, Ministry of Science and Technology (DST) for 369 publications. SERB, DRDO, IIT, AICTE, ICAR, IISc, DAE, ICMR are also the other funding agencies which are predominant in material science research in India.

TABLE VII TOP 20 COLLABORATIVE COUNTRIES IN MATERIAL SCIENCE RESEARCH

S. No.	Collaborated Countries	No of Publication	Percentage (%)
1.	United States	500	3.95
2.	South Korea	262	2.07
3.	Saudi Arabia	202	1.60
4.	United Kingdom	163	1.29
5.	Japan	147	1.16
6.	Germany	141	1.11
7.	Malaysia	135	1.07
8.	China	112	0.89
9.	Australia	105	0.83
10.	France	86	0.68
11.	Canada	80	0.63
12.	South Africa	69	0.55
13.	Italy	66	0.52
14.	Russian Federation	61	0.48
15.	Taiwan	61	0.48
16.	Portugal	58	0.46
17.	Brazil	51	0.40
18.	Spain	48	0.38
19.	Poland	38	0.30
20.	Sweden	38	0.30

Any field which requires a peak development, there should be a collaborative work. Especially in the field of research collaboration with other institutions turned to the highest visibility and matured growth rate in the field of research.

Table VII shows the collaborative countries with India for the material science research. In this United States have the major contribution 500 publication with India, followed by South Korea (262) and Saudi Arabia (202) publications.

VI. FINDINGS AND SUGGESTIONS

1. Technological expansion drastically changed the growth of literature in the field of material science research, 2018 has the highest number of publications compared to all other period of study.
2. Choudhary, R.N.P. from Siksha O Anusandhan University, Department of Physics is the predominant author in the field of material science research in India with the publications of 81.
3. Journal articles are published more in number (9479) in the field of material science research in India.
4. Journal of Materials Science Materials In Electronics is the predominant source of publications 1008 publications in material science research in India.
5. IISc, Bengaluru, Council of Scientific and Industrial Research India and Anna University are the predominant institutions in India which are producing good number of publications in material science.
6. UGC and DST are the predominant funding agencies in India for material science research. United States, South Korea and Saudi Arabia are the collaborative countries in Indian material science research output.

VII. CONCLUSION

Material Science is a field which is applied with every engineering discipline as well as applied science and technology. This study gives clear glimpses on the growth of literature in the field of material science in the recent days with the support of several government funding agencies and the initiatives by the government. Research in material science develops the face value of India by the collaborative work with other countries with other parameters such as journal metrics and institutional ratings. This is in need of the exponential growth over the period of Engineering and Technology and Applied Sciences.

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