

A Scientometric Analysis of Graphite Research in India: 1989–2014

Khaiser Nikam, Hydarali*

Department of Studies Library and Information Science, Manasagotri, Mysuru, Karnataka, India

Abstract

The present study is an attempt to examine the mosaic of the literature of graphite using scientometric as research tool. The data are collect for period of 25 years, spanning from the year 1989 through 2014. The main objective of the study is to identify the form of literature; institution affiliation; journal ranking and prolific authors. The findings reveal that the journal papers account for 98.08% (3168). The most ranking journals are “Carbon” and “RSC Advances”. The highest productivity of graphite literature is from all the Indian institute of technology (IIT's) in India; Prof. RN Goyal and Prof. CNR Rao are the most prolific authors in this discipline. The study is the highly relevant as graphite is becoming very popular, as it is economically feasible to use in industrial processes.

Keywords: Scientometric, bibliometric, graphite, research growth, India

****Author for Correspondence*** E-mail: hydaralimisc@gmail.com

INTRODUCTION

Graphite, a grey crystalline allotropic form of carbon which occurs as a mineral in some rocks and can be made from coke. It is used as a solid lubricant, in pencils, and as a moderator in nuclear reactors. According to “The Online Etymology Dictionary (OED)” the word graphite or “black lead”, was coined in 1789 by German mineralogist Abraham Gottlob Werner (1750–1817). Bibliometrics is a set of research methods used to quantitatively analyze scientific and technological literature. It utilizes quantitative analysis and statistics to describe patterns of publication within a given field or body of scientific literature [1].

BACKGROUND OF THE STUDY

Background of the study describes in brief an account of what has been published in relation to the topic of the research, Tian *et al.* conducted a bibliometric analysis to evaluate global scientific production of geographic information system (GIS), using papers from 1997 to 2006 in science citation index [2]. Sudhier and Kumar examined the scientific research contained in doctoral dissertations produced at the University of Kerala, India [3]. Gupta and Karisiddappa who have worked in the field of theoretical population genetics for the period from 1907–1980, by applying

different growth models, concluded that power model is observed to be the only model among the models viz., exponential logistics [4]. Karki and Garg have studied the activity and growth of organic chemistry research in India during the years of 1971–1989 using chemical abstracts as source database [5]. Bonilla-Calero described a scientometric analysis of a sample of research output in physics taken from the institutional repository of the University of Strathclyde called “Strathprints” [6]. The documents in this sample were authored over the period 2000–2005 but were deposited in the repository during the period from publication up to 2007. Haritash *et al.* have attempted a study to map various S&T concerns of the Indian parliament by analyzing questions raised in three of its 1992 sessions [7].

OBJECTIVES OF STUDY

The main objectives of the study are as follows;

- To measure the year-wise growth of publications of the India;
- To identify the most prolific author;
- To rank the Universities and research institutes;
- To study the subject-wise distribution;
- To identify the source of publications;
- To identify the funding agency.

SCOPE AND METHODOLOGY

The present study is based on graphite research output in India which indexed in WOS database (www.webofknowledge.com) [8], covering 3230 publications, during 1989–2014.

The data was downloaded from the web of science database. Most of the bibliometric studies have used web of science (WOS) to obtain citation data [9]. By using suitable strategy related to literature produced in graphite research, the bibliographic details for each record included number of authors, authors' affiliation, title, type of document, source of publication, year of publication and country of input, have been collected. Further all the bibliographic details have been

transferred to a spreadsheet. Later the data was analyzed as per the objectives of the study [10].

DATA ANALYSIS AND INTERPRETATION

The present study analyzes the publication output on the topic 'Graphite research' as found in the web of science citation database. Further, data analysis and interpretation was done.

Table 1 shows the types document published. Here most of items were published in form of articles and it counts to 98.08% (3168), followed by conference proceedings scores 5.45% and review score 1.92%.

Table 1: Form Wise Distribution.

Sl No	Forms	TP (n=3230)	% of 3230
1	Articles	3168	98.08
2	Conference Proceedings	176	5.45
3	Reviews	62	1.92

Table 2: Year-wise Growth of Publications.

Sl. No	Year	TP	%	Sl. No	Year	TP	%
1	2014	465	14.40	14	2001	59	1.83
2	2013	404	12.51	15	2000	62	1.92
3	2012	289	8.95	16	1999	71	2.20
4	2011	261	8.08	17	1998	79	2.45
5	2010	214	6.63	18	1997	65	2.01
6	2009	206	6.38	19	1996	71	2.20
7	2008	168	5.20	20	1995	57	1.77
8	2007	137	4.24	21	1994	56	1.73
9	2006	114	3.53	22	1993	50	1.55
10	2005	89	2.76	23	1992	51	1.58
11	2004	68	2.11	24	1991	39	1.21
12	2003	73	2.26	25	1990	13	0.40
13	2002	54	1.67	26	1989	15	0.46
Total						3230	100

Key: TP: Total Publications.

Table 2 presents the year-wise growth of publications which shows that during the period 1989–2014 a total of 3230 articles were published in India [11]. There were more number of contributions of 465 (14.40%) articles in 2014, followed by 404 (12.51%)

articles in 2013, 289 (8.95%) articles in 2012, 261 (8.08%) articles in 2011, 214 (6.63%) papers in 2010 and 206 (6.38%) articles in 2009; and least were published in the year 1989, i.e. 15 (0.46%) articles.

Table 3: Most Prolific Authors.

Sl. No.	Authors	TP (n=3230)	% of 3230	Sl. No.	Authors	TP (n=3230)	% of 3230
1	Goyal RN	121	3.75	11	Kumar M	29	0.9
2	Rao CNR	62	1.92	12	Kumar N	29	0.9
3	Singh AK	41	1.27	13	Kumar R	28	0.87
4	Kumar S	39	1.21	14	Chatterjee S	25	0.77
5	Ramaprabhu S	39	1.21	15	Govindaraj A	25	0.77
6	Narayanan SS	38	1.18	16	Jain R	25	0.77
7	Prasad BK	38	1.18	17	Noel M	24	0.74
8	Kumar A	36	1.12	18	Mathur RB	23	0.71
9	Sampath S	36	1.12	19	Prasad BB	23	0.71
10	Gupta VK	32	0.99	20	Das S	22	0.68

Key: TP: Total Publications.

Table 3 shows the top 20 authors from graphite research for their highest productivity. Of these 20 authors; RN Goyal occupies the first rank with 121 articles, followed by CNR

Rao, with 62 articles, AK Singh, with 41 articles, and least were published by S Das, i.e. 22 articles.

Table 4: Institution-wise Publications.

Sl. No.	Organizations	TP (n=3230)	% of 3230
1	Indian Institute of Technology (IITs)	719	22.26%
2	Council of Scientific Industrial Research (CSIR) India	695	21.52%
3	Indian Institute of Science, Bangalore	209	6.47%
4	Bhabha Atomic Research Center	183	5.67%
5	Banaras Hindu University	122	3.78%
6	Jawaharlal Nehru Center for Advanced Scientific Research	88	2.72%
7	Central Electrochemical Research Institute India	86	2.66%
8	National Physics Laboratory India	85	2.63%
9	Indira Gandhi Centre for Atomic Research	70	2.17%
10	University of Roorkee	65	2.01%
11	Indian Association for the Cultivation of Science	57	1.77%
12	University of Delhi	54	1.67%
13	University of Madras	52	1.61%
14	National Institute Technology, Tiruchirappalli	47	1.46%
15	Jadavpur University	44	1.36%
16	Indian Institute of Chemical Technology	43	1.33%
17	Kuvempu University	40	1.24%
18	National Chemistry Laboratory, Pune	39	1.21%
19	University of Pune	33	1.02%
20	PSG College of Technology	32	0.99%

Key: TP: Total Publications.

Table 4 shows the ranking of top 20 organizations of India for their highest productivity. Indian institute of technology (IIT's) contributed the highest publications, i.e. 719 articles with 22.26% of total output,

followed by council of scientific industrial research with 695 articles (21.52%), Indian institute of science with 209 articles (6.47%), Bhabha atomic research center with 183 articles (5.67%), Banaras Hindu university

with 122 articles (3.78%), Jawaharlal Nehru center for advanced scientific research with 88 articles (2.72%), central electrochemical research institute, India, with 86 articles

(2.66%), National physics laboratory, India, with 85 articles (2.63%) and least were published by PSG college of technology with 22 articles (0.99%).

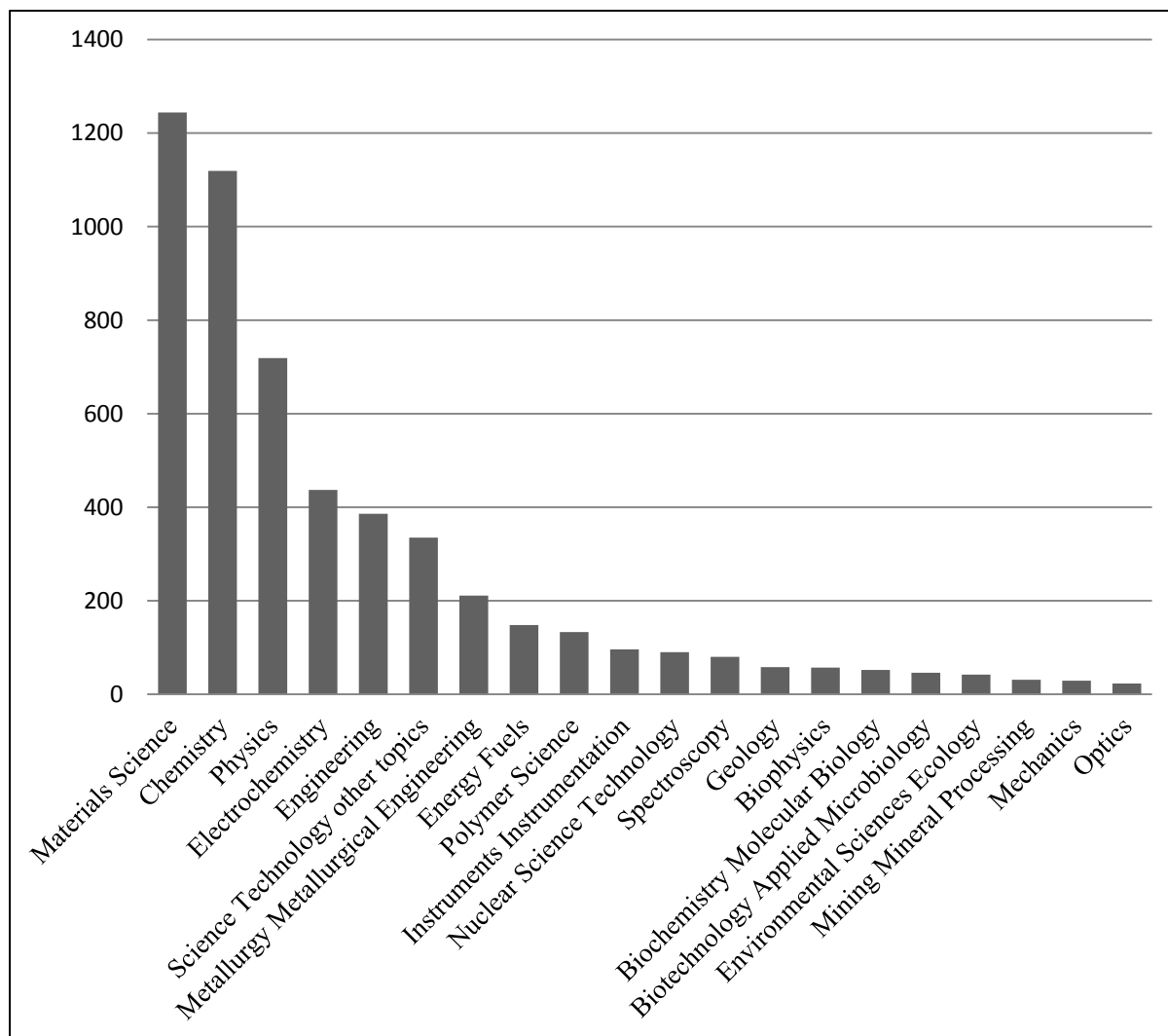


Fig. 1: Research Area-wise Distribution of Publication.

Figure 1 represents the research areas of research output of India during 1989–2014. The highest number of articles published are in the area of materials science with 1244 (38.51%), followed by chemistry (1119), physics (719), electrochemistry (437), engineering (386), science technology other topics (335), metallurgy metallurgical engineering (211), energy fuels (148), polymer science (133) articles and least were published in optics which accounts to 23 articles.

Table 5 shows the ranking of top 20 journals ranked in order of their productivity. Some of the most productive journals are Carbon 68 (2.11%) articles, RSC Advances 67 (2.07%)

articles, Materials Design 50 (1.55%) articles, Electrochimica Acta 49 (1.52%) articles, Sensors and Actuators B Chemical 47 (1.46%) articles, Electroanalysis 45 (1.39%) articles, Journal of Power Sources 42 (1.30%) articles, Transactions of the Indian Institute of Metals 42 (1.30%) articles, Journal of Physical Chemistry C 41 (1.27%) articles, Indian Journal of Chemistry Section A Inorganic Bio Inorganic Physical Theoretical Analytical Chemistry 38 (1.18%) articles, Wear 37 (1.15%) articles, Journal of Applied Physics 35 (1.08%) articles, Talanta 34 (1.05%) articles and International Journal of Hydrogen Energy 32 (0.99%) articles.

Table 5: Journal-wise Publications.

Sl. No.	Name of the Journal	TP (n=3230)	% of 3230
1	Carbon	68	2.11%
2	RSC Advances	67	2.07%
3	Materials Design	50	1.55%
4	Electrochimica Acta	49	1.52%
5	Sensors and Actuators B Chemical	47	1.46%
6	ElectroAnalysis	45	1.39%
7	Journal of Power Sources	42	1.30%
8	Transactions of the Indian Institute of Metals	42	1.30%
9	Journal of Physical Chemistry C	41	1.27%
10	Indian Journal of Chemistry Section A Inorganic Bio Inorganic Physical Theoretical Analytical Chemistry	38	1.18%
11	Wear	37	1.15%
12	Journal of Applied Physics	35	1.08%
13	Talanta	34	1.05%
14	International Journal of Hydrogen Energy	32	0.99%
15	Materials Science and Engineering A Structural Materials Properties Microstructure And Processing	32	0.99%
16	Journal of Electroanalytical Chemistry	31	0.96%
17	Bulletin of Electrochemistry	30	0.93%
18	International Journal of Electrochemical Science	30	0.93%
19	Bulletin of Materials Science	28	0.87%
20	Applied Surface Science	27	0.84%

Key: TP: Total Publications.

Table 6: Funding Agencies-wise Contribution to Graphite Research.

Sl No	Funding Agencies	TP (n=3230)	% of 3230
1	Council of Scientific and Industrial Research (CSIR) New Delhi	317	9.81
2	Department of Science and Technology New Delhi	284	8.79
3	University Grants Commission New Delhi	119	3.68
4	IIT'S	38	1.18
5	DRDO	37	1.15
6	National Research Foundation of Korea	26	0.80
7	BRNS	16	0.50
8	National Science Council	9	0.28
9	Converging Research Center Program, The Ministry of Science, ICT, Future Planning	8	0.25
10	Department of Atomic Energy, Board of Research in Nuclear Sciences	5	0.15

Key: TP: Total Publications.

Table 6 shows the ranking of top 10 funding agencies. Council of scientific and industrial research, New Delhi, contributed the highest

publications, i.e. 317 articles with 9.81% of total output, followed by department of science and technology, New Delhi, with 284

articles (8.79%), University grants commission, New Delhi with 119 research output (3.68%), IIT's with 38 articles (1.18%), DRDO with 37 articles (1.15%), national research foundation of Korea with 26 articles (0.80%), BRNS with 16 articles (0.50%), national science council with 9 articles (0.28%), converging research center program the ministry of science ICT future planning with eight articles (0.25%) and dept. of atomic energy board of research in nuclear sciences with five articles (0.15%).

FINDINGS OF THE STUDY

Major findings of the study "A Bibliometric analysis of Graphite research in India: 1989-2014" are presented here:

- Majority of the publications published were in the form of articles i.e. 3168 (98.08%).
- There is more number of contributions of 465 (14.40%) articles in 2014 and least published in the year 1989. i.e. 15 (0.46%) articles.
- The top 20 authors from graphite research for their highest productivity. Of these 20 authors, RN Goyal occupies the first rank with 121 articles and least published by S Das i.e. 22 articles.
- The Indian institute of technology IITs contributed the highest publications, i.e. 719 articles with 22.26% of total output and least were published by PSG College of technology with 22 articles (0.99%).
- The highest numbers of articles published are in the area of materials science with 1244 (38.51%).
- The top 20 journals ranked the most productive journal with highest publications as 'Carbon' 68 (2.11%) articles.
- The council of scientific and industrial research, New Delhi contributed the highest funding towards publications in graphite research and dept. of atomic energy board of research in nuclear sciences with five articles (0.15%).

CONCLUSIONS

Although, scientometrics studies are more than two decades old, they have remained evergreen methods of carrying out research in

library and information science. The present study is a humble attempt to find out the vistas of research in the discipline graphite. The results of the study were interesting and have expelled the facts about the quantum of the journal research literature, most prolific authors, productive institutions and the area most researched with in the subject.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

1. Henderson M, Shurville S, Fernstrom K. The Quantitative Crunch: the Impact of Bibliometric Research Quality Assessment Exercises on Academic Development at Small Conferences. *Campus-Wide Information Systems (CWIS)*. 2009; 26(3): 149–167p. <http://en.wikipedia.org/wiki/Bibliometrics>
2. Tian Y, Wen C, Hong S. Global Scientific Production on GIS Research by Bibliometric Analysis from 1997 to 2006. *J Informetr*. 2008; 2: 65–74p.
3. Sudhier K, Kumar V. Scientometric Study of Doctoral Dissertations in Biochemistry in the University of Kerala, India. *Library Philosophy & Practice (LPP)*. 2010; 1–16p.
4. Gupta BM, Karisiddippa CR. Modeling the Growth of Literature in the Area of Theoretical Population Genetics. *Scientometrics*. 2002; 49(2): 321–355p.
5. Karki MMS, Garg KC, Sharma P. Activity and Growth of Organic Chemistry Research in India during 1971–1989. *Scientometrics*. 2000; 49(2): 279–288p.
6. Bonilla-Calero AI. Scientometric Analysis of a Sample of Physics-Related Research Output Held in the Institutional Repository Strath Prints (2000–2005). *Library Review*. 2008; 57(9): 700–721p.
7. Haritash N, Gupta B, Davis M, *et al*. Mapping of S&T issues in Indian Parliament: A Scientometric Analysis of Questions Rose in Both the Houses of Parliament. *Proceedings of the 8Th International Conference on*

- Scientometrics and Informetrics*. 2001; 211–224p.
8. *Online Etymology Dictionary*. (n.d.). Retrieved Nov 4, 2015.
 9. Dutt Bharvi, Khaizer Nikam. A Scientometric Overview of Collaboration Pattern in Global Solar Cell Research. *ALIS*. 62: 157–67p. Print.
 10. Dutt Bharvi, Khaizer Nikam. Scientometrics of Collaboration Pattern in Solar Cell Research in India. *ALIS*. 61(1): 65–73p. Print.
 11. Dutt Bharvi, Khaizer Nikam. Solar Cell Research in India: A Scientometrics Profile. *ALIS*. 60(2): 115–27p. Print.

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APPENDIX

Sl. No	Countries	TP	% of 80513
1	USA	16210	20.13
2	Peoples R China	13994	17.38
3	Japan	10069	12.51
4	Germany	6588	8.18
5	France	4762	5.92
6	Russia	4192	5.21
7	England	3646	4.53
8	South Korea	3522	4.37
9	India	3230	4.01
10	Spain	2670	3.32
11	Italy	2452	3.05
12	Canada	2171	2.70
13	Taiwan	1720	2.14
14	Brazil	1710	2.12
15	Australia	1651	2.05
16	Poland	1464	1.82
17	Sweden	1445	1.80
18	Iran	1369	1.70
19	Switzerland	1050	1.30
20	Singapore	1003	1.25