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Mapping of Literature on Nanotechnology: A Bibliometric Study

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Hugar, Dr. Jayaprakash G., "Mapping of Literature on Nanotechnology: A Bibliometric Study" (2020).
Library Philosophy and Practice (e-journal). 3777.
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Mapping of Literature on Nanotechnology: A Bibliometric Study

Dr. Jayaprakash G Hugar

Abstract

This study aims to analyse the research output performance on the Nanotechnology subject. A total of 11825 research articles published in Web of Science database were analyzed to find the performance of Nanotechnology related scientists from all over the world in terms of growth during the period 2013-2017 (last five years). Annual growth rate, global publication share, and ranking among ten countries of the world, a prolific author in the field, high productive Institutions, Journals, etc. are studied in this article. This study reveals that the maximum numbers of funding agencies are from China. The average number of publications per year is 2365; more number of articles are published during 2016. In the country-wise contribution of documents, the USA contributed the highest 27.39% of the total publication. Among journals, ACS Nano journal ranked first with 2% of articles and among the funding agencies, the National Natural Science Foundation of China stands first with 8.1% funding.

Keywords: Bibliometric, Nanotechnology, Funding, Trend, Publications

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1. Introduction:

The word “Nanotechnology” refers to high resolution lithographic technology while others use it to refer to almost any research where some critical size is less than a micron (1000 nanometers). Increasing number of scientific publications points to quick developments in the field of nanoscience and nanotechnology. Nanotechnology offers potentials of unimaginable proportions. Innovative possibilities present themselves in many areas of human activity.

2. Review of Literature:

2.1 Bakthavachalam Elango, Periyaswamy Rajendran, Lutz Bornmann (2013) studied and assessed the Nano tribology research output at global level using scientometric tools. The SCOPUS database was used to retrieve records related to the Nano tribology research for the period 1996–2010. Publications were counted on a fractional basis. The level of collaboration and its citation impact were examined. The performance of the most productive countries, institutes and most preferred journals is assessed. Various visualization tools such as the Sci2 tool and Ucinet were employed. The USA ranked top in terms of number of publications, citations per paper and h-index, while Switzerland published a higher percentage of international collaborative papers. The most productive institution was Tsinghua University followed by Ohio State University and Lanzhou Institute of Chemical Physics, CAS. The most preferred journals were Tribology Letters, Wear and Journal of Japanese Society of Tribologists. The result of author keywords analysis reveals that Molecular Dynamics, MEMS, Hard Disk and Diamond like Carbon are major research topics.

2.2 Karmen (2016) assessed interactions between nanotechnology and agriculture in his article on “Presence of nanotechnology in agriculture: bibliometric approach. With co-word analysis in particular, they examined aspects of agro-nano applications related to plant protection. In order to analyze and map the structure of knowledge, they employed selected terms from a general citation database Web of Science (WOS) as well as specialized bibliographic database CAB Abstracts which covers life sciences with a special emphasis on agriculture. Thematic maps (visualization) present some principal themes and relations among them. Pesticides, biosensors and detection are the main keywords in the network of words from article titles and network of the KeyWords. Analysis of controlled terms (descriptors, classification codes) from CAB Abstracts in connection with pesticides shows two important directions of research: pollution and environmental topics and topics related to human health, experimental animals and related.

2.3 Maria Karaulova, Abdullah Go, Oliver Shackleton and Philip Shapira (2016) they studied the influence of path dependencies on the development of an emerging technology in a transitional economy. And focused the development of nanotechnology in Russia in the period between 1990 and 2012. By examining outputs, publication paths and collaboration patterns, identified the series of factors that help to explain Russia’s limited success in leveraging its ambitious national nanotechnology initiative. The analysis highlights four path-dependent tendencies of Russian nanotechnology research: publication pathways and the gatekeeping role of the Russian Academy of Sciences; increasing geographical and institutional centralization of nanotechnology

research; limited institutional diffusion; and patterns associated with the internationalization of Russian research. They also discussed the policy implications related to path dependence, nanotechnology research in Russia and to the broader reform of the Russian science system.

3. Objective:

The following are the objectives of the study, to find out the year wise publication;

- 1.1 To analyze the authorship pattern of contribution.
- 1.2 To find out author productivity in Nanotechnology literature in LIS field in last five years.
- 1.3 To examine the chronological-wise distribution of articles/publications.
- 1.4 To study the most prolific contributions of journal.
- 1.5 To investigate the geographical distribution of articles;
- 1.6 To find out the communication channels used by the authors.

4. Methodology:

Database analysis is the major techniques employed by the investigator for the present study. The data was collected from the Web of Science database in the month of May 2017. All the articles published on Nanotechnology from last five years of (2013 to 2017) analyzed and presented in the tabular format. It includes the information regarding the pattern of authorship, year of publication, geographical location of the author and their affiliated institutes, name of the journal, languages of publication and type of articles. These data were analyzed and presented in different tables and figures as shown below.

5. Data Analysis and Interpretation

Table No. 5.1 Types of Documents

| Document Types | Records | % of 11825 |
|-----------------------|----------------|-------------------|
| Article | 8552 | 72.32 |
| Review | 2615 | 22.11 |
| Editorial Material | 445 | 3.76 |
| Proceedings Paper | 158 | 1.33 |
| Meeting Abstract | 120 | 1.01 |
| Book Chapter | 60 | 0.50 |
| News Item | 37 | 0.31 |
| Book Review | 29 | 0.24 |
| Correction | 13 | 0.10 |
| Letter | 11 | 0.09 |

We have different type of communications in different publications; Table No. 5.1 reveals that, type of documents cited in this Nanotechnology literature. It can be noted that out of 11825 research output, majority 72.32% of the output is in the form of articles in the journals, followed by Reviews (22.11%), Editorial Material (3.76%), Proceedings Paper (1.33%), and Meeting

Abstracts (1.01%) Whereas, Book Chapter, News items, Book Reviews, Correction and Letters output is less than 1% in this field of study. Articles holds first place as usual compared to other type of documents cited in journals.

Table No. 5.2 Language wise Distribution of Publications

| Languages | Records | % of 11825 |
|------------------|----------------|-------------------|
| English | 11606 | 98.14 |
| Chinese | 61 | 0.51 |
| Portuguese | 38 | 0.32 |
| Spanish | 36 | 0.30 |
| French | 22 | 0.18 |
| German | 19 | 0.16 |
| Japanese | 13 | 0.10 |
| Polish | 12 | 0.10 |
| Czech | 5 | 0.04 |
| Russian | 4 | 0.03 |

For any communication language is important. Table No.5.2 shows that majority of the articles published in English language (98.14%), followed by Chinese language publications with 0.51% and Portuguese with 0.32%. Remaining languages such as Spanish, French, German, Japanese, Polish, Czech and Russian contribution to this Nanotechnology study is less than 0.30%. Again it is proved that English is the universal language of the world.

Table 5.3 Prolific Author wise Distribution of Publications

| Authors | Records | % of 29866 |
|----------------|----------------|-------------------|
| Zhang Y | 229 | 0.76 |
| Wang J | 179 | 0.59 |
| Wang Y | 171 | 0.57 |
| Li Y | 161 | 0.53 |
| Li J | 140 | 0.46 |
| Wang L | 139 | 0.46 |
| Liu Y | 138 | 0.46 |
| Zhang L | 128 | 0.42 |
| Kim J H | 120 | 0.40 |
| Wang X | 115 | 0.38 |

Ranking list of authors help professionals in many ways, example for deciding popularity, to select reading materials, to decide acquisition policy of the library and so on. To find out the experts in the field of Nanotechnology, we have top ten authors in the Table No. 5.3 author Zhang Y got the first rank with 229 (0.76%) articles. Wang J got second rank with 179 (0.59%) articles, Wang Y got the third rank with 171 (0.57%) articles, Li Y and Li J got fourth and fifth rank with 161 (0.53%) and 140 (0.46%) articles. Wang L, Liu Y, published 0.46% articles. Whereas, Zhang L, Kim J H and Wang X published 0.42% , 0.40% and 0.38% articles respectively on Nanotechnology.

Table No. 5.4 Top Institution wise Contribution of Publications

| Organizations | Records | % of 11825 |
|---------------------------------------|----------------|-------------------|
| Chinese Academy of Science | 340 | 6.73 |
| Harvard University | 158 | 3.13 |
| National University of Singapore | 128 | 2.53 |
| Massachusetts Institute of Technology | 117 | 2.31 |
| Islamic Azad University | 110 | 2.17 |
| Tsinghua University | 97 | 1.92 |
| Nanyang Technological University | 94 | 1.86 |
| Georgia Institute of Technology | 85 | 1.68 |
| King Abdul Aziz University | 84 | 1.66 |
| CNR | 83 | 1.64 |

Table No. 5.4 presents data on the number of documents on Nanotechnology subject contributed by various universities and different R&D organizations in the world. Out of the total of 11825 contributions, the highest number i.e., 340 (6.73%) were contributed by Chinese Academy of Science, followed by Harvard University with 158 (3.13%). National University of Singapore secured 3rd rank by publishing 128 (2.53%) articles. Massachusetts Institute of Technology came in 4th place by publishing 117 (2.31%) articles, 5th rank goes to Islamic Azad University with 110 (2.17%) articles. Tsinghua University, Nanyang Technological University, Georgia Institute of Technology, King Abdul Aziz University and CNR output is less than 2% in the nanotechnology field.

Further, it is observed that 671 (13.29%) publications are published from different universities and occupied first place in the study, 542 (10.73%) publications on Nanotechnology are from various R&D organizations in the world.

Table No.5.5 Top Funding Agency wise Distribution of Publication

| Funding Agencies | Nations | Records | % Of 11825 |
|---|----------------|----------------|-------------------|
| National Natural Science Foundation Of China | China | 963 | 8.13 |
| National Science Foundation (NSF) | USA | 561 | 4.73 |
| National Institute Of Health (NIH) | USA | 374 | 3.15 |
| National Basic Research Program Of China | China | 215 | 1.80 |
| Fundamental Research Funds For The Central Universities | China | 131 | 1.10 |
| European Union | Europe | 94 | 0.79 |

Figure No. 5.5

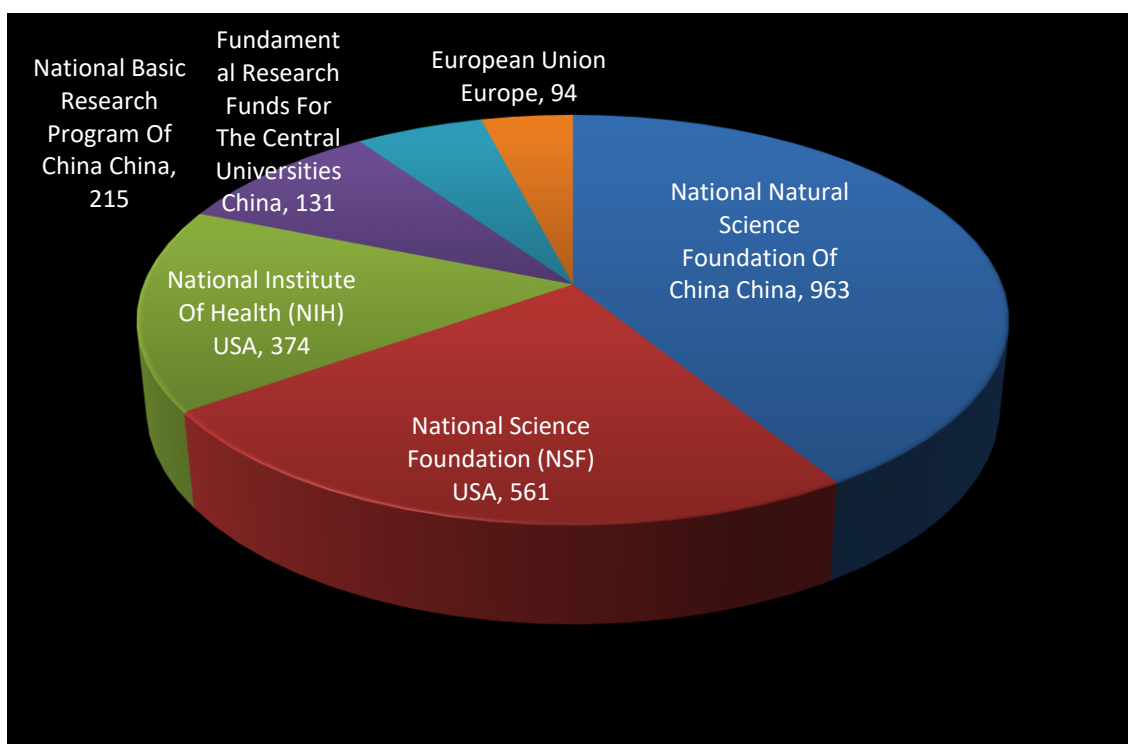


Table and Figure No. 5.5 indicate that the National Natural Science Foundation of China leads the table by funding 8.13% of publications, followed by the National Science Foundation (NSF) with 4.73% publications and National Institutes of Health (NIH) with 3.15% of the publications. National Basic Research Program of China and Fundamental Research Funds for the Central Universities published 1.80% and 1.10% respectively. Remaining agencies like European Union funded less than 1%.

It is noted here that, China originated funding agencies are leading in funding the Nanotechnology and its related study as majority 1309 (11.03%) articles and followed by USA with 935 (7.88%) articles funded by respective countries.

Table No. 5.6 Country wise Distribution of Publications

| Countries | Records | % of 11825 |
|---------------------------|---------|------------|
| USA | 3240 | 27.39 |
| Peoples Republic of China | 1976 | 16.71 |
| India | 1027 | 8.68 |
| Italy | 676 | 5.71 |
| Germany | 674 | 5.69 |
| England | 636 | 5.37 |
| South Korea | 508 | 4.29 |
| Spain | 493 | 4.16 |
| Iran | 475 | 4.01 |
| Brazil | 432 | 3.65 |

Figure No. 5.6

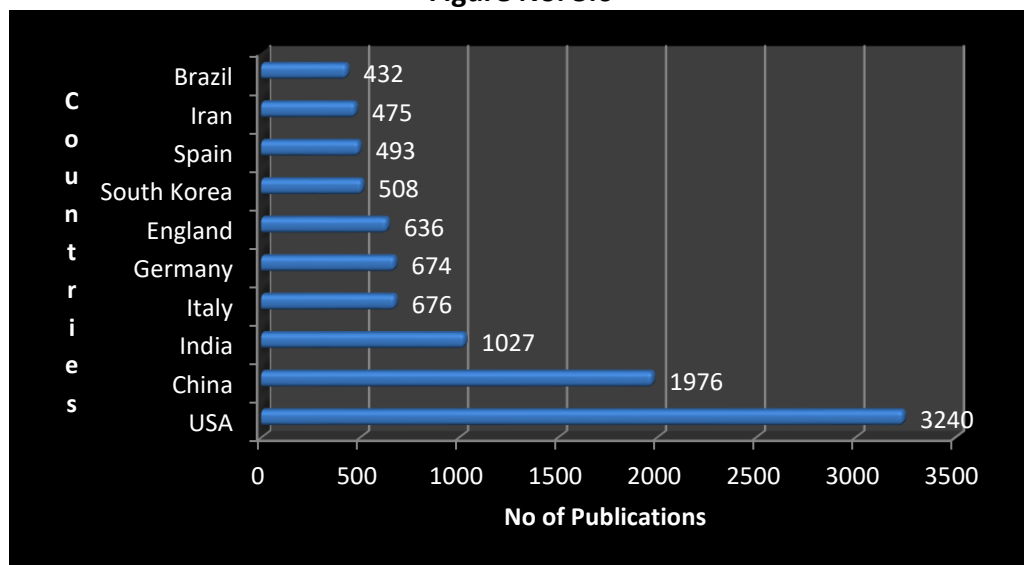


Table and Figure No. 5.6 analysed that the country wise distribution of the articles and reveals that out of ten nations, USA is leading with 27.39% of the articles, followed by Peoples Republic of China and India with 16.71% and 8.68%. Italy, Germany and England published 5.71%, 5.69% and 5.37% of the articles respectively on Nanotechnology subject. South Korea, Spain and Iran published 4.29%, 4.16% and 4.01%. Brazil published lowest number of articles 3.65% in the field of Nanotechnology subject.

Table No. 5.7 Top Journal wise Ranking of Publications

| Source Titles | Records | % of 11825 |
|---|---------|------------|
| ACS Nano | 263 | 2.22 |
| RSC Advances | 181 | 1.53 |
| International Journal Of Nanomedicine | 174 | 1.47 |
| Nanoscale | 164 | 1.38 |
| Journal Of Nanoscience And Nanotechnology | 160 | 1.35 |
| Nanomedicine | 135 | 1.14 |
| Journal Of Nanoparticle Research | 130 | 1.09 |
| Angewandte Chemie International Edition | 126 | 1.06 |
| Scientific Reports | 125 | 1.05 |
| Nanotechnology | 111 | 0.93 |

It is important for the faculty members to publish their article in a journal which is having more visibility and impact, so they will get more and more citations also. Ranking of the journals based on their research output on Nanotechnology subject for the year 2013-2017 is provided in Table No. 5.7 ACS Nano journal holds the first rank with 2.22% and published the majority number of articles compared to any other journals, in the field of Nanotechnology. 2nd rank got by RSC Advances and International Journal of Nanomedicine took 3rd rank.

Table No. 5.8 Ranking of Top Books

| Book Series Titles | Records | % Of 11825 | Rank |
|---|---------|------------|------|
| Advances in Experimental Medicine And Biology | 12 | 0.04 | 1 |
| Topics in Current Chemistry | 8 | 0.02 | 2 |
| International Review Of Neurobiology | 6 | 0.02 | 3 |
| Advances in Polymer Science | 6 | 0.02 | |
| Progress in Molecular Biology And Translational Science | 3 | 0.01 | 4 |
| Annual Review Of Chemical And Biomolecular Engineering | 3 | 0.01 | |
| Annual Review Of Analytical Chemistry | 3 | 0.01 | |
| Annals of The New York Academy Of Sciences | 3 | 0.01 | |
| Structure and Bonding | 2 | 0.007 | 5 |
| Methods in Enzymology | 2 | 0.007 | |

Books are very important to know the depth of any subject and getting retrospective information on a particular subject. Ranking of books based on their research output on Nanotechnology field during the year 2013 to 2017 is given in Table No. 5.8 Advances in Experimental Medicine and Biology Book holds the first rank by contributing 12 (0.04%) articles compared to any other books, in the field of Nanotechnology. 2nd rank got by Topics in Current Chemistry, followed by International Review of Neurobiology and Advances in Polymer Science books shared and got 3rd rank. Whereas, four books i.e.: Progress in Molecular Biology and Translational Science, Annual Review of Chemical and Biomolecular Engineering, Annual Review of Analytical Chemistry and Annals of the New York Academy of Science got 4th rank by contributing 3 articles each, Structure and Bonding and Methods in Enzymology books got 5th rank by contributing two articles each on Nanotechnology subject.

Table No. 5.9 Subject wise Distribution of Articles

| Subjects | Records | % Of 11825 |
|-------------------------------------|---------|------------|
| Nanoscience Nanotechnology | 2818 | 55.82 |
| Chemistry Multidisciplinary | 2655 | 52.59 |
| Materials Science Multidisciplinary | 2577 | 51.05 |
| Applied Physics | 1470 | 29.12 |
| Physical Chemistry | 1266 | 25.07 |
| Pharmacy Pharmacology | 1180 | 23.37 |
| Physics Condensed Matter | 657 | 13.01 |
| Biotechnology Applied Microbiology | 598 | 11.84 |
| Materials Science Biomaterials | 513 | 10.16 |

| | | |
|--------------------------------|-----|------|
| Biochemistry Molecular Biology | 503 | 9.96 |
|--------------------------------|-----|------|

Table No. 5.9 depicts the subject wise distribution of articles. 55% of the articles are published in the subject of Nano-science Nanotechnology, next place is taken by Chemistry Multidisciplinary and third place is taken by the Material Science Multidisciplinary with 52% and 51%. Applied Physics, Physical Chemistry, Pharmacy Pharmacology got 4th, 5th and 6th rank by publishing 29%, 25% and 23% of publications respectively. Other categories such as Physics Condensed Matter, Biotechnology Applied Microbiology, Materials Science Biomaterials and Biochemistry Molecular Biology got 7th to 10th place by publishing 13%, 11%, 10% and 9% respectively.

Table No.5.10 Year wise distribution of publications and citations

| Publication Years | records | % of 11825 |
|-------------------|---------|------------|
| 2016 | 2979 | 25.19 |
| 2015 | 2759 | 23.33 |
| 2014 | 2591 | 21.91 |
| 2013 | 2466 | 20.85 |
| 2017 | 1030 | 8.71 |

Table No. 5.10 presents the growth of the Nanotechnology research publications during 2013–2017. In the year 2016 is the highest 2979 (25.19%) number of articles are published, followed by 2015 with 23.33% are the more productive years in relation to the number of publications. The less productive years are 2013–2014 with 21% and 22% publications. It appears that, from 2013 onwards awareness on Nanotechnology is more, because more and more number of publications started appearing in the journals. On an average 2365 articles are published per year during the study period.

6. Findings

- 6.1 It is revealed from the study that, out of 11825 contributions, the highest number of articles i.e., 340 (6.73%) were contributed by Chinese Academy of Science in the Nanotechnology field during the study period.
- 6.2 Majority of the articles are published in the English language (98.14%).
- 6.3 National Natural Science Foundation of China funded 8.13% of publications in this Nanotechnology field.
- 6.4 It can be noted that out of 11825 research output, majority 72.32% of publication is in the form of articles in the journals.
- 6.5 Country wise distribution of the articles reveals that out of ten nations, USA is leading with 27.39% of the articles.
- 6.6 Most prolific author in the field of Nanotechnology is ZhangY and got the first rank by contributing 229 (0.76%) articles in the last five years.
- 6.7 Highest 2979 (25.19%) number of articles are published on Nanotechnology in the year 2016.
- 6.8 ACS Nano journal holds the first rank with 2.22% and published the majority number of articles compared to any other journals in the field of study.

- 6.9 56% of the articles are published in the subject of Nano-science Nanotechnology.
- 6.10 Advances in Experimental Medicine and Biology Book holds the first rank among the books by contributing 12 (0.04%) articles compared to any other books, in the field of Nanotechnology during the study period.
- 6.11 671 (13.29%) publications are from different universities and occupied first place in this study, 542 (10.73%) publications on Nanotechnology are from various R&D Centers in the world.

7. Suggestions

- 7.1 It is suggested to publish more and more articles on Nanotechnology subject in India as India is in third place listed in the top ten productive nations on this subject.
- 7.2 Funding by the Government of India should be increased in this subject, as study showed that, funding agencies are more in china and maximum amount is provided for the Nanotechnology research and accordingly more articles are published in the field.
- 7.3 Since Nanotechnology is very much useful for the human being India should invest more money in this area of research in different universities and R&D centers.

8. Conclusion

The result of the study helps the librarians in selection and in acquisition of journals in the field of Nanotechnology. It also helps them in proper organisation and management of this literature for better use by the scholars in the field of study. In general, the study reveals the growth and trend in Nanotechnology field during last five years.

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