Research Output of Institute of Minerals and Materials Technology India Indexed in Scopus during 2004-2013: A bibliometric analysis

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Abstract

This Paper presented the research output of Institute of Mineral and Material Technology India. it has been analyzed the yearly distribution of publication, growth rate, most productive authors, most preferential subject area, most favored document type, most productive journal, most frequent keywords, most productive institutions, most productive country, most favored source type, authorship pattern, degree of collaboration, multiple authors vs. single author, length of the publications, most cited authors etc. it is observed from the study that highest number of publication contributed in 2011 with 65(15.51%) publications, Average growth rate of publications is 7.43%, Parida, K. M. is the most productive author of this study with 107(25.54%)publications, Chemistry is the most favored subject area of the study with 144(34.37%) publications, Article is the most preferential document type with 365(87.11%) publications, Journal of Molecular Catalysis A Chemical is the most productive journal with 26(6.21%) publications, Keyword 'Article' used highest number of times with 82(19.57%) publications, Institute of Minerals and Materials Technology itself contributed 419(100%) publications, India is the most productive country with 419(100%) number of publications, Journal is the most favored source type with 383(91.41%), Domination of multiple authors on single author, Degree of collaboration is 0.98, Number of publication from pages 6-10 is highest with 258(61.58%) publications and Besra L., Liu M. are the most cited authors.

Keywords: Bibliometrics, IMMT, Scopus, Degree of Collaboration, Citation Analysis

1. Introduction

Bibliometric is a research methodology used to quantitative evaluation of the research output of the institutions/ organizations, journals, books, articles etc. it is often used in field of library and information science including webometrics and scientometrics. Citation analysis and content analysis these two terms are often used in bibliometric study. The term Bibliometrics was defined by Alan Pritchard in 1969 in a paper "Statistical Bibliography or Bibliometrics" as "the application of mathematics and statistical methods to books and other media of Communication".

Bibliometric analysis determined the impact of the articles, authors, institutions, geographical places, citation analysis, journal citation as well as makes comparatives statement among authorship pattern of publications, geographical distribution of publication, source wise distribution of publications, document type wise distributions of publications.

2. Institute of Minerals and Materials Technology India at a Glance

Institute of Minerals and Material Technology (IMMT) was established in the year 1964 in Bhubaneswar,Odisha by the council of scientific and industrial research (CSIR),New Delhi. it was previously known as Regional Research Laboratory, Bhubaneswar is an advanced research institute in

the area field of mineral and material engineering. the main focus research area of Institute of Minerals and Material Technology (IMMT) are mining and mineral/bio-mineral processing, process engineering, metal extraction and materials characterization, industrial waste management, marine and forest products development, pollution monitoring and control, colloids and materials chemistry and environmental sustainability. presently 140 scientist are working towards nation building programme under the supervision of Prof. Barada Kanta Mishra Director of the institution.

3. Literature Review

Sevukan, R., Sharma, J. (2008). Presented domination of two authored publications in the study. Thanuskodi, S. (2011). analyzed in the study that maximum number of publications contributed by single authored wit 83(52.17%). Ratha, B., Naidu, G.H.S. & Gawde,M. (2012). discovered in the study that Maximum number of article published in 2007. Baskaran, C. (2013). revealed that degree of collaboration is 0.96 and Material science is the most fovoured subject area.

Barik,N. & Jena, P. (2014). revealed that highest 169 publications contributed by two authored which is 43.89% of the total publications. Chaurasia, N. K. & Chavan, S.B.(2014). Analyzed that degree of collaboration is 0.96 and Article is the most favored document type. Ghosh, N.C. (2014) depicted that Leishmania was the major research area of CSIR-IICB, Kolkata contributing 223(29.89%) publications during 2001-2010. Nagarkar, S. (2014). shows the domination of multiple authors.

4. Objectives

» To study year wise distribution of publications.

» To analyze year wise growth rate of the publications.

» To analyze authorship pattern of the publications.

» To analyze degree of collaboration.

» To study single author vs. multiple authors.

» To identify most cited authors of this journal.

» To find out most prolific institution and organizations of the publications.

» To analyze ranking of the country in term of publications.

» To find out the most productive authors.

» To study average number of authors per paper.

» To study the subject area publications.

» To study Source wise distribution of publications.

» To study distribution of publications by Document Type.

» To study the key word used in publications.

» To study the Length of publications.

To study most cited authors.

5. Methodology

All the relevant data for the purpose of present research has been retrieved from the SCOPUS database using Affiliation city to Orissa then selected Institute of Minerals and Materials Technology (IMMT) selecting from the year 2004 to 2013. Basing on the objectives of the study retrieval data exported into excel sheet and organized in a well manner like distribution of publications in year wise, subject wise, affiliation wise, document type wise, authorships wise. Subsequently data has been ana-

lyzed and tabulated in excel sheet. All percentage calculation made on the basis of two digit after decimal.

6. Limitation

Present study is limited to the research output of Institute of Minerals and Materials Technology India (IMMT India) from the 2004 to 2013.

7. Data Analysis

7.1 Yearly Distribution of Publications

Table 1 shows that there are 419 number of publications has been published during 2004-2013. Out of them the highest 65 number of publications has been published in 2011 which is 15.51 % of total publications during the study followed by 61(14.56%) publications in 2009, 51(12.17%) publications in 2010 respectively.

Table 1: Yearly Distribution of Publications

Year	Number of Publications	%	Cumulative %
2013	26	6.21	6.21
2012	48	11.46	17.66
2011	65	15.51	33.17
2010	51	12.17	45.35
2009	61	14.56	59.90
2008	35	8.35	68.26
2007	38	9.07	77.33
2006	44	10.50	87.83
2005	24	5.73	93.56
2004	27	6.44	100.00
Total	419	100.00	

7.2 Increasing & Decreasing Mode of Publications

Table 2 analyzed the growth rate of the publications during the study. The average growth rate of IMMT from 2004-2013 is 7.43% and the average number of publications per year is 46.56. The highest growth rate occurred in 2012 with 22(84.62%) publications followed by 17(35.42%) publications followed by 10(19.61%) publications respectively. Highest number of publications decreased in 2005 with 20(45.45%) followed by 26(42.62%) in 2008 and 14(21.54%) in 2010 respectively.

Table 2: Increasing & Decreasing Mode of Publications

Year	Number of Publications	Increasing & Decreasing No. of Publications	Average Growth Rate %
2013	26		
2012	48	22	84.62
2011	65	17	35.42
2010	51	-14	21.54
2009	61	10	19.61
2008	35	-26	42.62
2007	38	3	8.57
2006	44	6	15.79
2005	24	-20	45.45
2004	27	3	12.50
Average	46.56		7.43
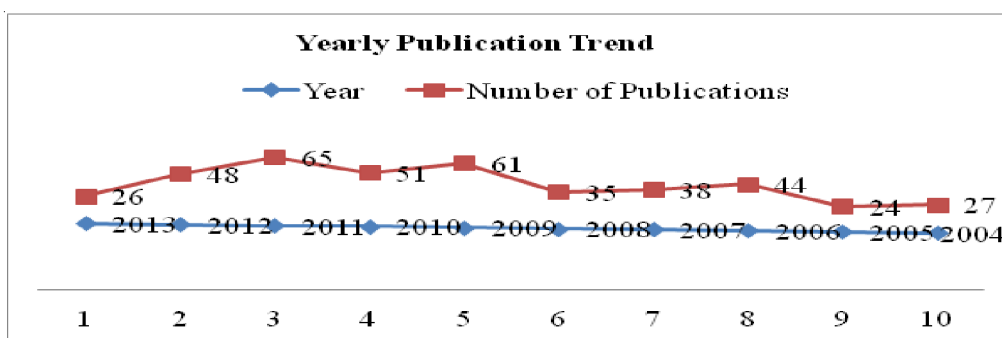
Figure 1: Increasing & Decreasing Mode of Publications

7.3 Subject Area of Research

Table 3 depicted that chemistry is the most interested subject area of research with 144 numbers of publications which is 34.37% of total publications followed by Material Science, Chemical Engineering and Engineering with 140(33.41%), 136(32.46%), 79 (18.85%) respectively.

Table 3: Subject Area of Research

Rank	Subject Area	Number of Publications(N=419)	%
1	Chemistry	144	34.37
2	Materials Science	140	33.41
3	Chemical Engineering	136	32.46
4	Engineering	79	18.85
5	Physics and Astronomy	72	17.18
6	Environmental Science	52	12.41
7	Earth and Planetary Sciences	44	10.50
8	Agricultural and Biological Sciences	32	7.64
9	Energy	27	6.44
10	Biochemistry, Genetics and Molecular Biology	21	5.01
11	Immunology and Microbiology	7	1.67
11	Medicine	7	1.67
11	Pharmacology, Toxicology and Pharmaceutics	7	1.67
12	Computer Science	6	1.43
13	Mathematics	5	1.19
14	Health Professions	4	0.95
15	Multidisciplinary	2	0.48
15	Social Sciences	2	0.48
16	Business, Management and Accounting	1	0.24
16	Neuroscience	1	0.24
16	Veterinary	1	0.24

7.4 Most Productive Journal

Table 4 revealed that highest 26(6.21%) number of publications contributed by researcher of IMMT in Journal of Molecular Catalysis A Chemical followed by Journal of Colloid and Interface Science and Industrial and Engineering Chemistry Research with 20(4.77%), 11(2.63%) publications contributed to the total number of publications respectively

Table 4: Most Productive Journal

Rank	Most Productive Journal	Number of Publications(N=419)	%
1	Journal of Molecular Catalysis A Chemical	26	6.21
2	Journal of Colloid and Interface Science	20	4.77
3	Industrial and Engineering Chemistry Research	11	2.63
4	Hydrometallurgy	10	2.39
5	Dalton Transactions	9	2.15
6	Applied Catalysis A General	8	1.91
6	Journal of Hazardous Materials	8	1.91
7	International Journal of Hydrogen Energy	6	1.43
7	Chemistry of Natural Compounds	6	1.43
7	Materials Letters	6	1.43
7	Korean Journal of Chemical Engineering	6	1.43
7	Catalysis Communications	6	1.43
7	Journal of the Indian Chemical Society	6	1.43
8	Transactions of the Institutions of Mining and Metallurgy Section C Mineral Processing and Extractive Metallurgy	5	1.19
8	World of Metallurgy Erzmetall	5	1.19
8	Materials Chemistry and Physics	5	1.19
9	Environmental Monitoring and Assessment	4	0.95
9	Chemical Engineering Journal	4	0.95
9	Transactions of the Indian Institute of Metals	4	0.95
9	TMS Light Metals	4	0.95
9	Applied Surface Science	4	0.95
9	TMS Annual Meeting	4	0.95
9	Separation and Purification Technology	4	0.95
9	International Journal of Mineral Processing	4	0.95
9	Catalysis Letters	4	0.95
9	Journal of Nanoscience and Nanotechnology	4	0.95
10	13 Journals 3 publications each	3	0.72
11	33 Journals 2 Publications each	2	0.48
12	88 Journals 1 Publications each	1	0.24

7.5 Distribution of Publications by Affiliation

Table 5 analyzed that there are 419 number of publications has been contributed by IMMT itself which is 100% of the total publications followed by Utkal University, Indian Institute of Technology Kanpur (IIT Kanpur), National Institute of Technology Rourkela(NIT Rourkela) contributed 17(4.06%), 12(2.86%) and 10(2.39%) number of publications collaborating with IMMT respectively.

Table 5: Distribution of Publications by Affiliation

Rank	Affiliation	Number of Publications(N=419)	%
1	Institute of Minerals and Materials Technology India	419	100.00
2	Utkal University	17	4.06
3	Indian Institute of Technology, Kanpur	12	2.86
4	National Institute of Technology Rourkela	10	2.39
5	Institute of Physics Bhubaneswar	9	2.15
6	National Metallurgical Laboratory India	8	1.91
7	Berhampur University India	7	1.67
7	Institute of Technical Education and Research of Siksha O Anusandhan University	7	1.67
8	Murdoch University	6	1.43
9	Sambalpur University	5	1.19
9	National Cheng Kung University	5	1.19
9	University of Witwatersrand	5	1.19
10	7 institutions 4 publications each	4	0.95
11	10 institutions 3 publications each	3	0.72
12	23 institutions 2 publications each	2	0.48
13	96 institutions 1 publications each	1	0.24

7.6   Most Renewed Authors

From the Table 6 it is cleared that Parida, K.M. is the most renowned authors of IMMT during the study by contributing highest number of publications with 107 which is 25.54% of the Total publications. followed by Anand, S. ,Mohapatra, M., Mishra, B.K. with 41(9.79%), 28(6.68%) and 24(5.73%) publications respectively.

Table 6: Most Renewed Authors

Rank	Most Productive Author	Number of Publications (N=419)	%
1	Parida, K.M.	107	25.54
2	Anand, S.	41	9.79
3	Mohapatra, M.	28	6.68
4	Mishra, B.K.	24	5.73
5	Sukla, L.B.	21	5.01
6	Das, D.P.	20	4.77
6	Mishra, B.K.	20	4.77
7	Parida, K.	19	4.53
8	Singh, S.K.	16	3.82
9	Mohapatra, B.K.	15	3.58
10	Besra, L.	14	3.34
10	Misra, V.N.	14	3.34
10	Mallick, S.	14	3.34
11	Das, R.P.	13	3.10
11	Martha, S.	13	3.10
11	Dhal, N.K.	13	3.10
12	Mishra, D.K.	12	2.86
13	Pradhan, N.	11	2.63
13	Singha, S.	11	2.63
14	Reddy, P.S.R.	10	2.39
14	Verma, H.C.	10	2.39
15	Dash, S.S.	9	2.15
15	Das, J.	9	2.15
15	Subbaiah, T.	9	2.15
16	6 Authors 8 Publications each	8	1.91
17	10 Authors 7 Publications each	7	1.67
18	16 Authors 6 Publications each	6	1.43
19	15 Authors 5 Publications each	5	1.19
20	30 Authors 4 Publications each	4	0.95
21	44 Authors 3 Publications each	3	0.72
22	15 Authors 2 Publications each	2	0.48

7.7 Distribution of Publication Country wise

Table 7 reveals the distribution of publications by different country during the study. it is cleared that India ranked 1st position contributing 419 number of publications to the total number of publications followed by United States, Australia contributed 10(2.39%) and 8(1.91%) number publications collaborating with India ranked 2nd and 3rd position respectively.

Table 7: Distribution of Publication Country wise

Rank	Country	Number of Publications(N=419)	%
1	India	419	100.00
2	United States	10	2.39
3	Australia	8	1.91
4	South Africa	7	1.67
4	Taiwan	7	1.67
5	Japan	5	1.19
5	South Korea	5	1.19
6	Germany	4	0.95
7	Canada	3	0.72
7	United Kingdom	3	0.72
8	Nigeria	2	0.48
9	Brazil	1	0.24
9	China	1	0.24
9	Italy	1	0.24
9	Netherlands	1	0.24
9	Slovenia	1	0.24
9	Sweden	1	0.24
9	Thailand	1	0.24

7.8 Distribution of Publication Keyword Wise

Table 8 denoted that researcher of IMMT used Article as Keyword 82 times during the study that means 82(19.57%) publications used Article as a Key-

word followed by Adsorption and X ray diffraction used as keyword in 69(16.47%) and 66(15.75%) publications respectively.

**Table 8: Distribution of Publication Keyword Wise**

Rank	Keyword	Number of Publications (N=419)	%
1	Article	82	19.57
2	Adsorption	69	16.47
3	X ray diffraction	66	15.75
4	Catalyst activity	44	10.50
5	XRD	35	8.35
6	Copper	34	8.11
7	Fourier transform infrared spectroscopy	32	7.64
8	Zinc	31	7.40
9	Transmission electron microscopy	30	7.16
10	PH	29	6.92
11	Priority journal	29	6.92
12	Iron	28	6.68
12	PH effects	28	6.68
13	Manganese	27	6.44
13	Leaching	27	6.44
13	Oxidation	27	6.44
14	Phenols	26	6.21
15	4 keyword 25 publications each	25	5.97
16	Controlled study	24	5.73
17	5 keywords 23 publications each	23	5.49

7.9 Authorship Pattern

Table 9 reveals the authorship pattern of publications contributed by Institute of Mineral and Material Technology, Orissa during 2004-2013. it is very clear that number of publications contributed by 3 authored is highest with 126(30.07%) followed by 4 authored and 2 authored with 90(21.48%) and 88(21%) respectively.

Table 9: Authorship Pattern

| Year	Number of Author						
	1	**2**	**3**	**4**	**5**	**>5**	**Total**
2013	Nil	4	6	8	5	3	26
2012	Nil	11	13	10	6	8	48
2011	1	7	22	15	6	14	65
2010	3	8	19	10	7	4	51
2009	3	11	19	13	8	7	61
2008	1	10	7	6	6	5	35
2007	Nil	15	7	9	5	2	38
2006	Nil	13	12	10	7	2	44
2005	Nil	5	9	3	6	1	24
2004	Nil	4	12	6	5	Nil	27
Total	8	88	126	90	61	46	419
%	1.91	21.00	30.07	21.48	14.56	10.98	100.00
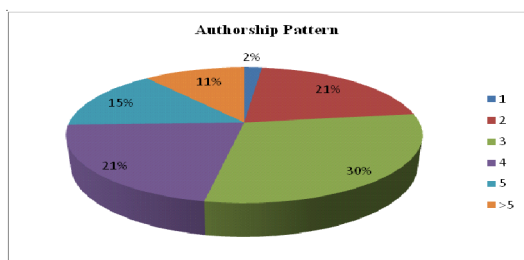
Figure-2

7.10 Single Author Vs Multiple Authors

Table 10 find out that out of total 419 number of publications 411 number of publications contributed by the multiple authors which is 98.09% of the total number of Publications. so it is clear that domination of multiple authors.

Table 10: Single Author Vs Multiple Authors

Year	Authorship		Total
	Single	**Multiple**	
2013	0	26	26
2012	0	48	48

2011	1	64	65
2010	3	48	51
2009	3	58	61
2008	1	34	35
2007	0	38	38
2006	0	44	44
2005	0	24	24
2004	0	27	27
Total	8	411	419
%	1.91	98.09	100.00
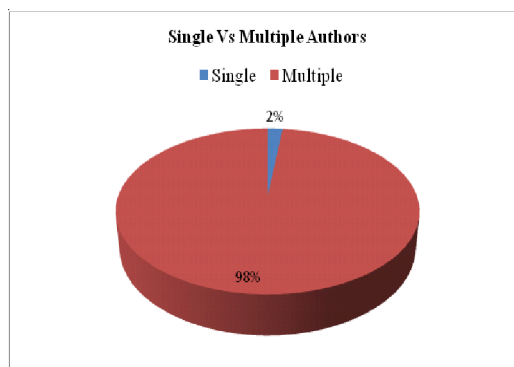
Figure-3

7.11 Degree of Collaboration

Table 11 depicted that average number of Degree of collaboration is 0.98 therefore the range for degree of Collaboration covered from 0.97 to 1.00. Maximum number of Degree of Collaboration occurred in 2004, 2005, 2006, 2007, 2012, and 2013 with 1.00 and lowest in 2010 with 0.94.

It has been prepared on the basis of K. Subramanyam's formula for Degree of Collaboration.

$$DC = \frac{M_n}{S_n + M_n} \quad \text{where}$$

DC = Degree of Collaboration;

S_n = Single Author;

M_n = Multiple Authors

$$DC = \frac{411}{8+411} = \frac{411}{419} = 0.98$$

Table 11: Degree of Collaboration

Year	Single(S_n)	Multiple(M_n)	S_n+M_n	Degree of Collaboration(C)
2013	Nil	26	26	1.00
2012	Nil	48	48	1.00
2011	1	64	65	0.98
2010	3	48	51	0.94
2009	3	58	61	0.95
2008	1	34	35	0.97
2007	Nil	38	38	1.00
2006	Nil	44	44	1.00
2005	Nil	24	24	1.00
2004	Nil	27	27	1.00
Total	8	411	419	0.98

7.12 Length of the Publications

Table 12 depicted that number of publication with pages from 6-10 is highest with 258(61.58%) followed by pages 1-5 with 99(23.63%) and pages 11-20 with 57 (13.60%) publications respectively.

Table 12: Length of the Publications

Range of Pages	Number of Publications	%
1-5	99	23.63
6-10	258	61.58
11-20	57	13.60
More than 20	5	1.19
Total	419	100.00

7.13 Contribution by Document Wise

Table 13 Examined that Article is the most favored Document type of publication contributing 365(87.11%) publications to the total number of publications followed by Conference Paper and Review with 37(8.83%) and 10(2.39%) respectively. Lowest number of publications contributed by Letter with only 1(0.24%) publication.

Table 13: Contribution by Document Wise

Rank	Document Type	Number of Publications(N=419)	%
1	Article	365	87.11
2	Conference Paper	37	8.83
3	Review	10	2.39
4	Book Chapter	4	0.95
5	Erratum	2	0.48
6	Letter	1	0.24
	Total	419	100.00

7.14 Source Type wise Distribution of Publication

Table 14 presented distribution of publication by source type during the study. Journals is the most favored source type contributing 383(91.41%) number of publications followed by conference proceedings and Books with 28(6.68%) and 4(0.95%) respectively. Trade Publications is the lowest source type contributing only 1(0.24%) number of publications.

Table 14: Source Type wise Distribution of Publication

Rank	Source Type	Number of Publications	%	Cumulative %
1	Journals	383	91.41	91.41
2	Conference Proceedings	28	6.68	98.09
3	Books	4	0.95	99.05
4	Book Series	3	0.72	99.76
5	Trade Publications	1	0.24	100.00
	Total	419	100.00	

7.15 Author Productivity

Table 15 shows the author productivity of Institute of Minerals and Materials Technology India during 2004 to 2013. Average number of authors per publication (AAPP) is 2.42 where as highest number of AAPP is 3.04 in 2013 and lowest number of AAPP is 2.08 in 2007 respectively.

Table 15: Author Productivity

Year	No. of Publications	No. of Authors	AAPP
2013	26	79	3.04
2012	48	117	2.44
2011	65	152	2.34
2010	51	119	2.33
2009	61	155	2.54
2008	35	94	2.69
2007	38	79	2.08
2006	44	99	2.25
2005	24	60	2.50
2004	27	59	2.19
Total	419	1013	2.42

7.16 Top 20 Citation Received Authors

Table 16 presents the most cited authored affilation to Institute of Mineral and Material Technology, orissa. Paper written by Besra L., Liu M. have got maximum citation with 507 followed by paper written by Das J., Patra B.S., Baliarsingh N., Parida K.M. with 148 and Das B., Prakash S., Reddy P.S.R., Misra V.N. with 139 citation respectively.

Table 16: Top 20 Citation Received Authors

Rank	Authors	Cited by
1	Besra L., Liu M.	507
2	Das J., Patra B.S., Baliarsingh N., Parida K.M.	148
3	Das B., Prakash S., Reddy P.S.R., Misra V.N.	139
4	Mohapatra M., Anand S., Mishra B.K., Giles D.E., Singh P.	138
5	Baral S.S., Das S.N., Rath P.	127
6	Parida K.M., Sahu N.	103
7	Pradhan N., Nathsarma K.C., Srinivasa Rao K., Sukla L.B., Mishra B.K.	96
8	Panda U.C., Sundaray S.K., Rath P., Nayak B.B., Bhatta D.	80
9	Singh B.P., Menchavez R., Takai C., Fuji M., Takahashi M.	78
10	Naik B., Parida K.M., Gopinath C.S.	74
10	Mohapatra P., Samantaray S.K., Parida K.	74
11	Parida K.M., Dash S.S., Das D.P.	73
12	Paramguru R.K., Rath P.C., Misra V.N.	72
13	Sundaray S.K., Nayak B.B., Lin S., Bhatta D.	69
14	Parida K.M., Sahu N., Biswal N.R., Naik B., Pradhan A.C.	66
15	Behera D., Acharya B.S.	63
16	Parida K.M., Naik B.	62
16	Sujana M.G., Pradhan H.K., Anand S.	62
17	Kar B.B., Datta P., Misra V.N.	59
18	Giles D.E., Mohapatra M., Issa T.B., Anand S., Singh P.	57
18	Pradhan G.K., Parida K.M.	57
18	Parida K.M., Reddy K.H., Martha S., Das D.P., Biswal N.	57
18	Pradhan N., Sukla L.B.	57
19	Parida K.M., Rath D.	55
20	Parida K.M., Pradhan A.C., Das J., Sahu N.	54

8. Conclusion and Findings

▸ Highest number of publication contributed in 2011 with 65(15.51%) publications.

▸ Average growth rate of publications is 7.43% during the study.

▸ Parida, K. M. is the most productive author of this study with 107(25.54%) publications followed by Anand, S. with 41(9.79%) and Mohapatra, M. with 28(6.68%) publications respectively.

▸ Chemistry is the most favored subject area of the study with 144(34.37%) publications followed by material science and Chemical Engineering with 140(33.41%) and 136(32.46%) publications respectively.

▸ Article is the most preferential document type with 365(87.11%) publications followed by conference Paper and Review with 37(8.83%) and 10(2.39%) publications as well as Document type Letter with only 1(0.24%) is the lowest publications respectively.

▸ Journal of Molecular Catalysis A Chemical is the most productive journal of the study contributing 26(6.21%) followed by Journal of Colloid and Interface Science with 20(4.77%) publications.

▸ Keyword 'Article' used highest number of times with 82(19.57%) publications followed Adsorption and X ray diffraction with 69(16.47%) and 66(15.75%) respectively.

▸ Institute of Minerals and Materials Technology itself contributed 419(100%) number of publications followed by Utkal University contributed 17(4.06%) publications collaborating with Institute of Minerals and Materials Technology India.

▸ India contributed highest 419(100%) number of publications followed by United states and Australia contributed 10(2.39%) and 8(1.91%) publication collaborating with India.

▸ Journal is the most favoured source type with 383(91.41%).

▸ 3 authored publication is highest with 126(30.07%) where as 1 authored publication is lowest with 8(1.91%).

▸ Domination of multiple authors on single author. Ratio between multiple authors and single author is 98:2.

▸ Degree of collaboration is 0.98.

▸ Number of publication from pages 6-10 is highest with 258(61.58%) and more than 20 pages' is lowest with 5(1.19%) respectively.

▸ Average number of Author productivity is 2.42.

▸ Besra L., Liu M. are the most cited authors .Paper written by them jointly cited 507 times.

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