Annals of Library and Information Studies
Vol. 58, June 2011, pp. 151-160

Research publications of National Metallurgical Laboratory during the year 2001-2010 - A study on citation patterns

A.K. Sahu[1], N.G. Goswami[2] and B.K. Choudhary[3]

[1]Technical Officer and [2] Scientist G, Information Management & Dissemination Centre, CSIR-National Metallurgical Laboratory, Jamshedpur – 831 007, Jharkhand, India, Email: aksahu@nmlindia.org

[3] Visiting Professor, Department of Library & Information Science, Sambalpur University, Orissa, India.

R&D publication growth, its characteristics, research impact, quality, citation value, category of journals, core research areas, characteristics of productive authors with reference to the National Metallurgical Laboratory, an R&D organisation under CSIR, India is analysed. Based on data obtained from the Science Citation Indices, it was found that the highest number of 120 papers was published by the laboratory in the year 2010, out of which 28 papers received 62 citations during the same year for the papers published by the laboratory whereas the highest citation received was 738 from 88 out of 107 papers published in 2006 as on April 2011. The average number of publications per year was 88.1 for the period under consideration and the average citation per paper was 5.02. The analysis shows that the majority of the authors of this laboratory published their research work in joint authorship (96.48%). The authors mostly prefer to publish their research findings in reputed international journals rather than Indian journals. 72.95 percent citing authors are from foreign countries and only 27.05 percent are Indians. Therefore, the R&D contributions made by scientists of CSIR-NML had a global impact in the field of metallurgy and materials science. High citations received were in the areas of materials science, metallurgical engineering, nanoscience & nanotechnology and environmental engineering over the last decades as observed during the period 2001-2010. The h-index of the last decade was 25.

Introduction

The scientific community takes the support of bibliometric data, including citation counts of articles, impact factors of journals, circulation volume and mode (print/online) etc. in their subject areas for selecting the preferred journals for research paper/scholarly communications. The citation pattern plays a key role whenever "citations" are used as indicators to evaluate scholarly communication. Although authors may have good reasons to cite their own works, these citations do not necessarily reflect the importance of their work or its impact on the rest of scientific community unless relevancy applies. Similarly, the research publication date and citation year also contribute to the citation pattern of a scholarly communication and these are needed to be studied in details to understand the research productivity of an organisation.

The National Metallurgical Laboratory (NML), Jamshedpur, a constituent unit of CSIR, India was established in 1950 as a response to the needs of Indian industries in the area of minerals, metals and materials. Since its inception, the laboratory has grown in its size and reach. During 2001, 243 scientific and technical personnel were in the service roll of the laboratory. Currently NML has in its employment 195 scientific and technical personnel with specialized knowledge and skills. Most of them have engineering and basic or applied science background. The laboratory today has mainly 5 R&D divisions, 3 Centres and has one extension centre at Chennai, Southern India networked by business development group at its headquarters. NML encourages R&D programmes networked with other R&D institutions at National level and also international collaborations. In-house R&D programme are funded by CSIR India and also partial grants are received from several Ministerial Departments. Apart from the grant, NML also undertakes sponsored specific programme funded by large public sector companies and also by industries belonging to private sectors. Over the last decade (2001-2010), NML contributed with its involvement in more than 14 mega projects, 287 sponsored projects, 143 grant-in-aid projects, 135 exploratory projects, 178 Consultancy and technical services projects with an amount of Rs. 3269 million[1].

Over the years NML has diversified its R&D activities and established its strength in R&D areas, such as – mineral processing and engineering; ferrous and non-ferrous metal extraction, metal casting and forming; material characterization and evaluation; advanced materials; corrosion protection of metals and materials; waste management; process modeling and simulation; standard reference materials and hall marking; R&D management and IP acquisition; publication and information services. NML has established a water research laboratory (WRL) for providing complete solution to water problems under one roof in the country and especially for the state of Jharkhand. The laboratory has also a centrally located Knowledge Resource Centre (KRC), which is one of the richest libraries in the field of metallurgy & materials science in India.

During last 10 years, NML scientists had published 881 papers in SCI and 912 in Non-SCI journals / conference proceedings, 119 MoU signed, 152 patents were granted and 46 copyrights got registered. Further, various technologies were developed/transferred, out of which some of them got commercialized (Laboratory Annual Reports 2000-2010). A relationship exists between the importance of the scientist and the logarithm of the number of papers published by him during his life time. Further prestige is a driving force that prompts authors to publish their work in reputed journals[2]. Prestige and productivity go together and can be summed up as a "scientist's lifework" which is one of the driving force that encourages scientist to publish profusely[3]. Kademani et al[4] have given a bird's eye view of the bibliometric and scientometric technique used to study various quantitative and qualitative aspects of scientific endeavors. Maheswaran and others[5] also observed a similar pattern in case of CSIR-SERC, India. Further, Walke and Wadhwa[6] in a case study of CSIR-NPL hierarchically ranked their appropriate journals. A good publication is an identity of a scientist and the institution. Keeping all these in view, an attempt has been made to analyse the kind of publications made by NML scientists over last 10 years from the laboratory.

Objectives of the study

The objectives of the study are as follows: -

- To examine the citation pattern and research productivity of NML over last decade;
- To evaluate authors' preference and their collaborations with inter and intra institutions at national as well as international level; and
- To identify the prolific authors having large number of publications with types of paper characteristics, and global visibility of their works.

Methodology

The data for the study was obtained from the Science Citation Index database available on Web of Science platform[7]. The annual reports of the laboratory and inputs of the scientists were also referred to verify the data obtained from Science Citation Index. MS-Excel 2007 was used for tabulation and preparing relevant charts. The literature growth percentage (R) of NML research output was calculated with the help of following simple mathematical formula:

$R = (P_1-P_0) \times 100 / P_0$

where, R = Annual literature growth in percentage;

P_1 = No. of research papers produced in the year;

P_0 = No. of research papers produced in the base year.

H-index has been worked based on Hirsch (2007)[8].

Analysis

Research productivity and growth of citations

NML has produced a total of 881 SCI publications and received 4431 citations during the period under study. As indicated in the Table 1, the highest numbers of articles were 120 published in 2010 and 62 citations were received by 28 papers out of these 120 papers. The lowest number of 45 articles was published in 2002 out of which 37 papers have received 476 citations. The number of publications rose from 7.21 percent in 2001 to 160.87 percent in 2010. Also, the citations of 620 papers reached 4431 till April 2011 from the date of publication. The average citation per paper for these ten years was 5.02. It is observed from the study that one paper published in 2002 has received the maximum citations (94) so far. The highest h-index was 16 for the papers published in the year 2004, while the highest citations, i.e., 738 were received by 88 papers in 2006.

Table 1—Citation analysis and impact of research productivity

Year	TP	TCP	TC	SC	h-index	ACPP	R %
2001	48	39	346	26	9	7.21	4.35
2002	45	37	476	8	13	10.58	-2.17
2003	78	64	549	38	12	7.04	69.57
2004	82	71	691	44	16	8.43	78.26
2005	72	61	551	41	14	7.56	56.52
2006	107	88	738	100	15	6.9	132.61
2007	113	92	494	34	10	4.37	145.65
2008	108	78	366	22	9	3.39	134.78
2009	108	62	158	20	5	1.46	134.78
2010	120	28	62	18	4	0.52	160.87
Total	881	620	4431	351	25	5.02	

Note: TP = Total papers; TCP = Total cited papers; TC = Total citations; SC = Self-citations; ACPP = Average citation per paper; R = Annual Research Growth (calculated on the base year (P_o) 2000 where 46 research papers were published)

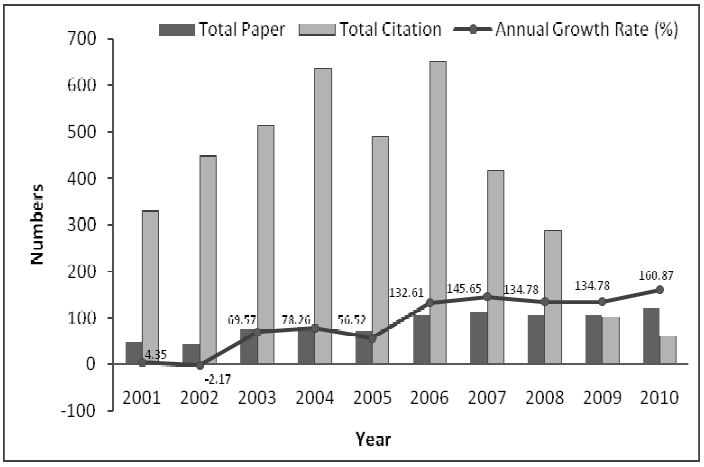


Fig. 1—Growth of NML research output and Citations during last decade

NML's annual literature growth percentage and productivity of SCI papers during the last decade is shown in Fig. 1. The year 2010 showed highest research growth (160.87%), followed by 2007 (145.65%), 2008, 2009 (134.78%) and so on.

Out of 881 papers, 620 received citations ranging from 1 to 94 while 261 papers did not receive any citation till April 2011. Table 2 shows the number of papers and their citations. It is evident from the table that 367 papers received between 1 to 5 citations totaling 877; followed by 131 papers which received between 6 to 10 citations totaling 989; 43 papers received between 11 to 15 citations totaling 548; 41 papers received between 16 to 20 citations totaling 726 and the rest 38 papers received citations ranging from 21 to 94 totaling 1291.

Authorship pattern

Figure 2 shows the authorship pattern which reveals that majority of the scientists preferred to publish the research results in joint authorship mode (96.48%) rather than individual authorship (single authorship i.e. 3.52%). However, the degree of the joint authorship gradually increased with the increase in number of authors (two- authors: 101 papers; in three & four authors: 231, 241 papers respectively). This shows that scientists tend to make team to publish their research works with three, four & more authors, instead of individual authorship. This was primarily due to better team effort, close co-operation among the scientists, sharing their diversified expertise for common interest and for acclaiming maximum creditability of research output globally from their

Table 2—Distribution of NML publications on the basis of citations received

NC	NP	TC	Cumulative	NC	NP	TC	Cumulative
0	261	0	0	22	2	44	3310
1	128	128	128	23	3	69	3379
2	84	168	296	24	2	48	3427
3	72	216	512	25	2	50	3477
4	50	200	712	26	2	52	3529
5	33	165	877	27	1	27	3556
6	38	228	1105	28	2	56	3612
7	32	224	1329	29	2	58	3670
8	26	208	1537	31	1	31	3701
9	21	189	1726	32	1	32	3733
10	14	140	1866	34	2	68	3801
11	8	88	1954	37	2	74	3875
12	9	108	2062	38	1	38	3913
13	15	195	2257	41	1	41	3954
14	8	112	2369	44	1	44	3998
15	3	45	2414	45	1	45	4043
16	12	192	2606	47	1	47	4090
17	9	153	2759	49	1	49	4139
18	5	90	2849	56	1	56	4195
19	9	171	3020	68	1	68	4263
20	6	120	3140	74	1	74	4337
21	6	126	3266	94	1	94	4431

Note: NC = No. of times cited; NP = No. of papers; TC = Total citations; The data provided in the table is up to April, 2011

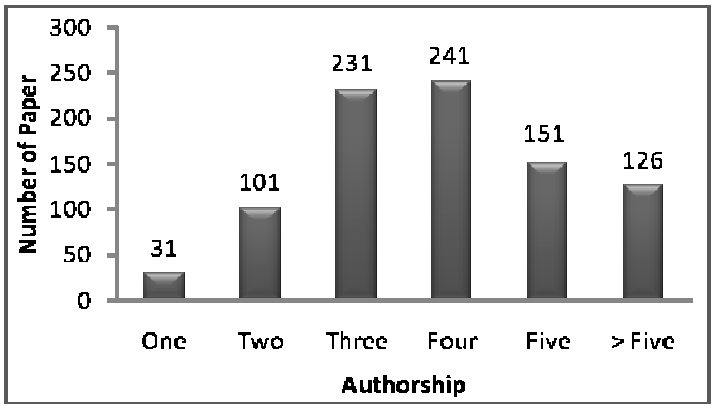


Fig. 2—Proportion of authorship

publications. The data shows that there are some inter-divisional and international collaborative papers which indicate the multidisciplinary nature of the research activity being carried out during the period. Also, the authorship pattern clearly shows that most of the papers are the product of collaborative research.

Category-wise distribution of papers

From the study, it is observed that 881 papers were published in different categories as shown in Table 3. It indicates that the majority (87.63%) of them were journal articles, 8.29 percent were proceedings papers, 2.72 percent were review papers and only small fraction of publications (1.36%) were found as letters and editorial material.

Highly cited papers and productive authors of NML

The top 25 highly cited papers are listed in Table 4.

Table 3—Distribution of papers under various types of document

Distribution of papers	No. of papers	% of 881
Journal articles	772	87.63
Proceedings papers	73	8.29
Reviews	24	2.72
Others	12	1.36
Total	881	100

Table 4—Characteristics of highly cited papers and productive authors

Code	Authors	SC	TC	Journal references	Subject	CS
A1	Chakravarty S, Dureja V, Bhattacharya G, Maity S and Bhattacharjee S	3	94	*Water Research*, 36(3) (2002) 625-632	Environmental Sc & Engg.; Water Resources	2003-
A2	Balaraju J N, Narayanan T S N S and Seshadri S K	6	74	*Journal of Applied Electrochemistry*, 33(9) (2003) 807-816	Electrochemistry; Materials Science, Coatings & Films	2005-
A3	Rath C, Anand S, Das R P, Sahu K K, Kulkarni S D, Date S K and Mishra N C	0	68	*Journal of Applied Physics*, 91(4) (2002) 2211-15	Physics, Applied	2002-
A4	Murugananthan M, Raju G B and Prabhakar S	2	56	*Separation and Purification Technology*, 40(1) (2004) 69-75	Engineering, Chemical	2005-
A5	Das N N, Pattanaik P and Das R	1	49	*Journal of Colloid & Interface Science*, 292(1) (2005) 1-10	Chemistry, Physical	2006-
A6	Jha M K, Kumar V and Singh R J	0	47	*Resources Conservation and Recycling*, 33(1) (2001) 1-22	Environmental Engg.; Environmental Sc.	2003-
A7	Das N N, Konar J, Mohanta M K and Srivastava S C	2	45	*Journal of Colloid and Interface Science*, 270(1) (2004) 1-8	Chemistry, Physical	2004-
A8	Mishra H N and Das C	1	44	*Critical Reviews in Food Science & Nutrition*, 43(3) (2003) 245-64	Food Science & Tech.; Nutrition & Dietetics	2005-
A9	Lakshmipathiraj P, Narasimhan B R, Prabhakar S and Raju G B	2	41	*Journal of Hazardous Materials*, 136(2) (2006) 281-287	Engineering, Engineering, Civil; Environmental Sc.;	2006-
A10	Krishnaveni K, Narayanan T S N S and Seshadri S K	4	38	*Surface & Coatings Technology*, 190(1) (2005) 115-121	Materials Sc.,Coatings and Films	2006-
A11	Murugananthan A, Raju G B and Prabhakar S	1	37	*Journal of Hazardous Materials*, 109(1-3) (2004) 37-44	Engineering, Engineering, Civil; Environmental Sc.	2005-
A12	Pathak L C, Singh T B, Das S, Verma A K and Ramachandrarao P	1	37	*Materials Letters*, 57(2) Dec (2002) 380-385	Materials Sc., Multidisciplinary; Physics, Applied	2004-
A13	Kundu S, Ghosh A, Laik A, Bhanu murthy K, Kale G B and Chatterjee S	1	34	*Materials Science and Engineering A*, 407(1-2) Oct (2005) 154-160	Nanoscience & Nanotechnology; Materials Sc.	2006-
A14	Balaraju J N, Narayanan T S N S and Seshadri S K	3	34	*Journal of Solid State Electrochemistry*, 5(5) (2001) 334-338	Electrochemistry	2003-

Contd...

Table 4—Characteristics of highly cited papers and productive authors

…Contd

A15	Upadhyay C, Verma H C, Rath C, Sahu K K, Anand S, Das R P and Mishra N C	7	32	*Journal of Alloys & Compounds*, 326 (1-2) (2001) 94-97	Chemistry, Physical; Materials Sc.	2002-
A16	Maity S, Chakravarty S, Bhattacharjee S and Roy B C	0	31	*Water Research*, 39(12) Jul (2005) 2579-2590	Environmental Sc. & Engg.; Water Resources	2006-
A17	Bhattacharjee S, Chakrabarty S, Maity S, Kar S, Thakur P and Bhattacharyya G	2	29	*Water Research*, 37(16) Sep (2003) 3954-3966	Engineering, Environmental Sc.; Water Resources	2004-
A18	Singh R and Dahotre N B	0	29	*Journal of Materials Science: Medicine*, 18(5) (2007) 725-751	Biomedicals; Materials Science, Biomaterials	2007-
A19	Narayanan T S N S and Seshadri S K	3	28	*Journal of Alloys & Compounds*, 365(1-2) (2004) 197-205	Chemistry, Physical; Materials Sc.	2005-
A20	Kumar S, Kumar R and Bandopadhyay A	2	28	*Resources Conservation and Recycling*, 48(4) (2003) 301-314	Engineering, Engineering, Environmental Sc.	2007-
A21	Sinha A, Nayar S, Agrawal A and Bhattacharyya D	9	27	*Journal of the American Ceramic Society*, 86(2) (2003) 357-359	Materials Science, Ceramics	2004-
A22	Baskaran I, Narayanan T S N S and Stephen A	1	26	*Materials Chem. & Physics*, 99(1) (2006) 117-126	Materials Sc., Multidisciplinary	2007-
A23	Balaraju JN, Narayanan T S N S and Seshadri S K	5	26	*Materials Research Bulletin*, 41(4) Apr (2006) 847-860	Materials Sc., Multidisciplinary	2007-
A24	Jegannathan S, Narayana T S N S, Ravichandra K and Rajeswari S	4	25	*Surface & Coating Technology*, 200(12-13) (2006) 4117-4126	Materials Sc.; Coatings & Films, Applied Physics	2006-
A25	Narayanan T S N S, Krishnaveni K and Seshadri S K	3	25	*Materials Chem. & Physics*, 82(3) (2003) 771-779	Materials Sc., Multidisciplinary	2004-

Note: TC = Total Citations; SC = Self-Citations; CS = Citation started from the year after publication

These papers received 1004 citations with an average of 40.16 citations. The paper A1 has received the 94 citations out of which 3 were self citations. The average citation of this paper was 11.75 per year after one year of its publication. The paper A2 has received second rank, i.e. 74 citations published in Journal of applied electrochemistry during 2003, out of which 6 were self citations. The average citation of this paper was 10.57 per year after two year of its publication. Therefore, the 25 research articles listed in the table may be called as highly cited and appeared in 18 reputed journals. The most productive articles with reference to NML publications were in the journal *Water Research* (3 papers and 154 citations).

Core areas and the focus of the published papers

The scientists of NML mainly preferred to publish in nearly 67 major disciplines of science and technology as categorized after Web of Science. Further, it is observed from the study that contribution of NML papers were mainly in five subject areas, namely, Materials Science-Multidisciplinary (420 papers with 1968 citations), Metallurgical engineering (255 papers with 790 citations), Nanoscience & nanotechnology (120 papers with 769 citations), Applied physics (82 papers with 586 citations) and Environmental engineering (40 papers with 565 citations). The publication share in these five disciplines varied from 11.92 percent to 44.41 percent citations.

Contribution of research publication by the collaborating institutions

Table 5 shows the quantity of publications contributed by other institutions in collaboration with NML Scientists. Authors from the top 20 institutions together have contributed 48.69 percent of the total published papers during the period. In addition to the

list shown, other notable national and international institutions are Consejo Superior de Investigaciones Cientificas CSIC, Spain; Hahn Meitner Institute, Berlin Gmbh; Yonsei University; Tohoku University; Bharat Heavy Electrical Ltd.; NASA, USA; Birla Institute of Technology; Colorado School of Mines, USA; Lulea University Technology; Mcmaster University; New Mexico Institute Mining & Technology; Technical University Dresden; University of Southampton; University of Tennessee; University of Wollongong; IFW Dresden; University of Maryland; Russian Academic of Science; University of Cardiff Wales etc. One interesting result as indicated in table is that most of the collaborating authors were from academic institutions, i.e. IITs, BHU, NITs, and national & international Universities. The 13.94 percent of the contributing institutions/universities were from foreign countries and 86.06 percent from Indian academic and research institutions.

Source journals

The 881 papers were published in 234 peer reviewed national and international source Journals of different disciplines of science and technology. The frequency distribution of NML output in these 234 journals / conference proceedings revealed a typical publication scattering pattern as shown in Table 6. About 93 papers were published in a single journal i.e., *Materials science and Engineering 'A'*, out of which 78 papers received 623 citations. Next six journals, contained articles ranging from 21 to 36 each, and in the remaining 227 journals, the publication frequency had been ranging from 1 to 20 each over the period of last 10 years. Considering all source titles shown in the table, 50.85 percent citations were received by 20 journals out of the total citations. H-index of these papers published in the top 20 journals was 20 and the average impact factor per paper was observed to be 1.22. The table shows that *Materials Science and Engineering 'A'* is one of the most preferred journal of foreign origin and *Transaction of the Indian Institute of Metals* is the most preferred journal of Indian origin. It is also interesting to know that out of the top 20 journals, 13 journals are from Elsevier Science. Further, the 19 journals are of foreign origin and only one journal is of Indian origin.

Table 5—Contribution of top twenty institutions in NML research papers

Sl. No.	Institutions	Contribution	% of 881
1	Indian Institutes of Technology	138	15.66
2	Banaras Hindu University	44	4.99
3	National Institutes of Technology	40	4.54
4	Jadavpur University	36	4.09
5	Bengal Engineering & Science University	31	3.52
6	Defence Metallurgical Research Laboratory	22	2.50
7	University of Bermen	13	1.48
8	University of Madras	11	1.25
9	Central Glass & Ceramic Research Institute	11	1.25
10	Bhabha Atomic Research Centre	11	1.25
11	Korea Inst. Geoscience & Mineral Resources	10	1.14
12	Regional Research Laboratory	9	1.02
13	Sri Venkateswara College & Engg.	8	0.91
14	RVS College of Engineering & Technology	8	0.91
15	National Institute of Foundry & Forge Technology	7	0.79
16	Indian Institute of Science	6	0.68
17	Anna University	6	0.68
18	National Aerospace laboratories	6	0.68
19	National Chemical Laboratory	6	0.68
20	Tata Steel	6	0.68

Table 6—Highly preferred journals in which authors prefer to publish their papers

Sl. No.	Source Title	TPP	TPC	TC	H-index	IF 2009	% of 881	Publishers
1	*Materials Science and Engineering A*	*93*	*78*	*623*	*14*	*1.806*	*10.56*	*Elsevier*
2	*Transactions of the Indian Institute of Metals*	*36*	*11*	*34*	*3*	*0.078*	*4.09*	*IIM*
3	*Journal of Materials Science*	*32*	*23*	*128*	*6*	*1.181*	*3.63*	*Springer*
4	*Engineering Failure Analysis*	*29*	*21*	*67*	*5*	*0.428*	*3.29*	*Elsevier*
5	*Metallurgical and Materials Transactions A*	*24*	*18*	*83*	*5*	*1.389*	*2.72*	*Springer*
6	*Materials Science and Technology*	*23*	*12*	*65*	*5*	*0.894*	*2.61*	*Elsevier*
7	*Materials Letters*	*21*	*20*	*197*	*9*	*1.748*	*2.38*	*Elsevier*
8	*Journal of Magnetism and Magnetic Materials*	*20*	*12*	*43*	*4*	*1.212*	*2.27*	*Elsevier*
9	*Scripta Materialia*	*19*	*16*	*102*	*6*	*2.887*	*2.16*	*Elsevier*
10	*Hydrometallurgy*	*18*	*14*	*86*	*6*	*1.227*	*2.04*	*Elsevier*
11	*Surface & Coatings Technology*	*18*	*18*	*198*	*8*	*1.86*	*2.04*	*Elsevier*
12	*High Temperature Materials and Processes*	*15*	*9*	*51*	*5*	*0.469*	*1.7*	*Freund*
13	*Journal of Hazardous Materials*	*13*	*11*	*169*	*7*	*1.855*	*1.48*	*Elsevier*
14	*Journal of Materials Processing Technology*	*13*	*9*	*35*	*4*	*1.143*	*1.48*	*Elsevier*
15	*Journal of Alloys and Compounds*	*12*	*9*	*89*	*5*	*1.51*	*1.36*	*Elsevier*
16	*Journal of Colloid and Interface Science*	*11*	*10*	*178*	*7*	*2.233*	*1.25*	*Elsevier*
17	*Metallurgical and Materials Transactions B*	*11*	*7*	*23*	*3*	*0.798*	*1.25*	*Springer*
18	*Bulletin of Materials Science*	*10*	*6*	*31*	*4*	*0.522*	*1.14*	*Springer*
19	*Corrosion Science*	*10*	*9*	*51*	*5*	*0.741*	*1.14*	*Elsevier*
20	*Ironmaking & Steelmaking*	*10*	*10*	*21*	*3*	*0.358*	*1.14*	*Maney*
	Total	428	313	2253	20	1.217		

Note: TPP = Total Papers Published; TPC = Total Papers Cited; Total Citations; IF = Impact Factor

NML's research collaboration countries

It is found from the study that NML authors published nearly 154 (17.48%) of its papers through international collaboration with institutions of 27 countries from USA, Germany, South Korea, England, Japan, Russia, Spain, Brazil, Canada, Finland, Vietnam, France, South Africa, Australia, Ireland, Netherlands, Singapore, Sweden, and ten more countries. Among the top 10 collaborating countries, the leading ones from the developed world that had significant share in collaboration with India are United States with 4.65 percent followed by Germany (4.09%) during the period. The other countries in this category are South Korea (2.16%), England (0.91%), Japan (0.79%), Spain (0.57%), Russia (0.45%), Finland (0.45%), Brazil (0.34%) and Canada (0.34%). It is noted that there were 40 papers with US authors and 36 with German authors as international collaborators during the last 6 years. The publication activity through collaborative research was the largest in materials science, followed by metallurgical engineering areas.

Relationship among the published paper and its length

Figure 3 shows the length-wise distribution of papers. It is seen that 4, 5 and 8 paged papers are very common. Though the length of a publication does not necessary demonstrate the quality of the research, but it often reveals the comprehensive and elaborate effort made by the author on a specific piece of research

work carried out on the subject. It was observed that one article had the maximum of 68 pages while two articles were of only two pages length. It was found that majority of the articles were of six pages constituting (141), followed by 131 articles of seven pages long. It was observed that short communication contained two pages; upto 8 pages are experimental article and beyond 8 pages are mostly review articles. However, it was found that articles within the range of 6 to 10 pages had the maximum citations.

Distribution of citing countries

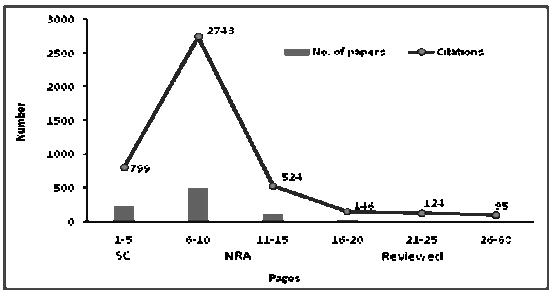
Figure 4 shows the analyses of the authors citing the NML publications considered in this article, which belongs to 1618 national and international academic / R&D institutions of 92 countries. Figure 4 shows the top 15 countries in the chart while other 77 countries whose authors cited NML publications were from Egypt, Poland, Italy, Mexico, Portugal, Malaysia, Greece, Romania, Sweden, Finland, Czech Republic, Russia, South Africa and so on. It is observed that 72.95 percent total citing articles were from foreign countries and only 27.05 percent from India. The analysis reflects that NML research output have impact in the global R&D.

Conclusion

The citation indicators and the pattern have been increasingly applied in the context of science policy and evaluation of R&D productivity. The year 2010 was the most productive year over the last ten years for CSIR-NML and the affinity towards publication in foreign journals was significant in comparison with Indian Journals for all these years. It is observed that share of self-citations decreases with time. There are positive correlations between the number of self-citations and the number of co-authors of the articles which implies a healthy team spirit. Co-authorship also influences Self citation patterns. Publishing in high impact journals was not always to be assumed as an index of quality since all such papers eventually did not receive high citations. The analysis of R&D publication growth, its characteristics, research impacts etc. of CSIR-National Metallurgical Laboratory is expected to invoke more R&D management studies with respect to resources and also in planning future programme of the institute.

Acknowledgements

The authors are grateful to Dr. S. Srikanth, Director, NML for his encouragement to take up such



* SC = Short communication; NRA = Normal Research Article

Fig. 3—Length-wise distribution of research papers

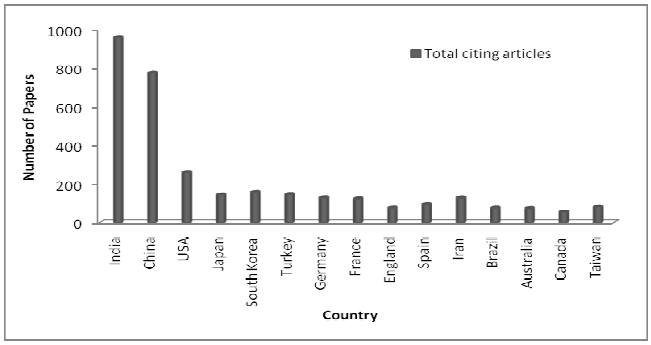


Fig. 4—Country-wise distribution of citing-authors

scientometric and productometric studies in the laboratory. The authors gratefully acknowledge all the NML scientists/researchers for giving their valuable inputs and suggestions.

References

1. NML Annual Report 2000-2010 (11 volumes).
2. Price D J, and Beaver D, Collaboration in an invisible college, *American Psychologist*, 21 (1966), 1011-1018.
3. Budd J M and Seavey C A, Productivity of U.S. library and information science faculty: the Hayes study revisited, *Library Quarterly*, 66 (1996) 1-20.
4. Kademi B S, Kumar V, Surwase G, Sagar A, Mohan L, Kumar A and Gaderao C R, Research and citation impact of publications by the Chemistry Division at Bhabha Atomic Research Centre, *Scientometrics*, 71(1) (2007), 25–57.
5. Maheswaran S, Kumar R D S and Sridharan K R, Scientometric analysis of area-wise publications in the field of structural engineering : a case study of SERC, India, *Annals of Library and Information Studies*, 56, (1) (2009), 22-28.
6. Publishing pattern and Citation analysis of NPL (India) researchers: a study *http://www.scribd.com/doc/49837297/poster-Publishing-pattern-and-Citation-analysis-of-NPL*, (Accessed on 4 April 2011).
7. ISI Web of Science databases, *http://pcs.isiknowledge.com*, (Accessed in March 2010 and April 2011).
8. Hirsch J E, Does the h-index have predictive power?, *PNAS* (2007), 104: 19193–19198. *http://www.pnas.org/content/104/49/19193*, (Accessed on 5 June 2010).