

Bibliometric Analysis of NPL Papers Published during 1981–1985 and 2001–2005 : Case Study

N. K. Wadhwa¹, D. K. Tewari², Rajpal Walke³, A. K. Yadav⁴ and S. M. Dhawan⁵

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Abstract

The study analyzes publications output of the National Physical Laboratory, India, published during 1981–1985 and 2001–2005 and assesses how science at NPL India has progressed over time. The publications output has been analyzed using quantitative and qualitative indicators such as publications count, impact factor per paper, citations received per paper, 'h – index' and national and international collaboration. The study identifies that comprehensive access to primary and secondary electronic journals is an important factor in influencing the quality and quantity of research in academic and research institutions.

Introduction

The National Physical Laboratory, India is the premier research laboratory in India in the field of physical sciences. It has developed core competencies in standards, apex level calibration, engineering materials, electronic materials, materials characterization, radio and space physics, global change and environmental studies, low temperature physics, and instrumentation. Established in 1947, it is one of the oldest laboratories of the Council of Scientific and Industrial Research (CSIR) . Its main activities are:

- Research and development
- Consultancy
- Sponsored and contract research
- Calibration and testing

The main aim of the laboratory is to strengthen and advance physics-based research and ensure overall development of science and technology in the country. Over the long period, the Laboratory has come to develop several new technologies of strategic, societal and national importance.

Scientific research operates with information as input and produces information as output. Input information is in part already disclosed and in part it originates from the researchers themselves who conduct the respective research work. Output information is novel and or reorganized knowledge, which is disclosed in the form of publications. Over the years the laboratory has published number of papers in research journals. This study seeks to understand what kind of shift in research at National Physical Laboratory, India has taken place over time, if any, and to identify factors that have come to influence research. In addition, it seeks to understand to what extent results from the study could be generalized to understand parameters that have potential to advance and promote research. Such a study is of great significance since the laboratory is currently celebrating diamond jubilee of its inception.

¹ Scientist & Deputy Librarian, Library and Information Services, National Physical Laboratory, New Delhi 110012 India. E-mail nkwadhwa@nplindia.org

² Head Library and Information Services, National Physical Laboratory, New Delhi 110012 India. E-mail dktevari@nplindia.org

³ Technical Officer, Library and Information Services, National Physical Laboratory, New Delhi 110012 India. E-mail rajpal@nplindia.org

⁴ Technical Assistant, Library and Information Services, National Physical Laboratory, New Delhi 110012 India. E-mail yadavak@nplindia.org

⁵ Former Head, Library and Information Services, National Physical Laboratory, New Delhi 110012 India. E-mail smdhawan@yahoo.com

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Objectives

The purpose of the study is to analyze and assess how science at NPL has progressed over time using quantitative and qualitative indicators. The main objectives of the present study are

- Growth and decline of research at NPL in the main areas of its research,
- Shift in the quality of NPL research measured in terms of impact factor per paper,
- Shift in the quality of NPL research measured in terms of citations received per paper, and 'h - index'
- Shift in collaboration in research by subject, and
- High productivity authors

Methodology

The study is based on raw bibliographical publication data for the period 1981–85 and 2001–2005, extracted and downloaded from the *Science Citation Index – Expanded Version* (Web of Science) of the Thomson Scientific.

This database is used worldwide for mapping science largely because of its extensive coverage of literature from international journals. However its coverage of domestic journals, particularly from India and other Asian countries is limited. To that extent, the study has its limitations.

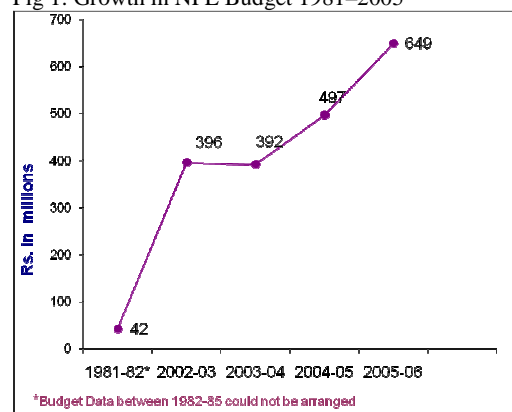
This study analyses NPL papers both qualitatively and quantitatively. The qualitative assessment looks at impact of NPL publications manifested in citations and quantitative assessment looks at number count of its publications.

The delineation of the broad and narrow subject areas in research publications was based on a set of journals assigned by the Thomson-ISI to relevant subject categories. For impact factor data, the study used journals impact factor data provided by Thomson Scientific for the year 2005.

The study periods, 1981–85 and 2001–05, have been chosen purposely to understand the shift in the laboratory research. It is during 2001–05 the laboratory witnessed significant progress in terms of inputs. Its expenditure on research rose by as much as 11 times during the period from 1981 to 2005. In 2005, the laboratory spent Rs 649 millions on its research pursuit (Fig. 1). The number of journals has increased from 318 print journals to 4500+ electronic

journals. There has been substantial expansion in its computing infrastructure that has led to desk top Internet access to all research scientists within the laboratory. It has over 400 nodes on its local area network.

Fig 1: Growth in NPL Budget 1981–2005



Data Analysis & Results

Publication Activity

Publications growth rate: The laboratory published 367 papers during 1981–85 and 623 during 2001–05 (Table 1). Its annual average growth rate during 1981–85 was 1.13%; it increased to 5.98% during 2001–05. The bulk of NPL papers were mainly published in low impact journals, 69% during 1981–85 and 75% during 2001–2005. The low impact journals having IF ranging between 0.001 and 1.999 are rated as low impact factor journals. Its papers in medium or high impact journals are still very small in number. The publishing pattern in journals did not change much even after a gap of 20 years. However it did show some change, at micro level. Its average impact per paper which was 1.222 in 1981–85 showed marginal increase to 1.570 during 2001–05 (Table 2).

Table 1: Papers by NPL during 1981–85 and 2001–2005

1981–85		2001–2005	
Year	Papers	Year	Papers
1981	86	2001	110
1982	82	2002	111
1983	58	2003	127
1984	60	2004	137
1985	81	2005	138
Total	367	Total	623

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Table 2: Distribution of Journals Used by NPL for Publishing Papers by Journal IF

Jl Category	IF Range	Journals Count which Published NPL Papers		% Share of total Papers	
		2001-05	1981-85	2001-05	1981-85
Zero IF Jls	0	12	107	1.92	29.15
Low IF Jls	0.001-0.5	138	83	22.15	22.61
	0.5-0.75	43	13	6.902	3.54
	0.75-1	86	45	13.80	12.26
	1-1.5	159	49	25.52	13.35
Medium IF Jls	1.5-2	70	28	11.23	7.62
	2-2.5	53	23	8.50	6.26
	2.5-3	24	9	3.85	2.45
High IF Jls	3-6	33	9	5.29	2.45
	6 & more	5	1	0.80	0.27
Total	Total	623	367	100	100
Average Impact per paper : 1981-85: 1.222 ; Average Impact per paper 2001-05: 1.570					

Citations per paper: The bulk of laboratory papers were low cited papers or not cited papers, even once since their publication. The combined share of such papers was 75.7% during 1981-85 and 79.9% during 2001-2005 (table 3). Papers receiving 1 – 4 citations each are rated as low cited papers. The laboratory output of medium and high cited papers continued to remain small (20 to 24%) during both periods of study.

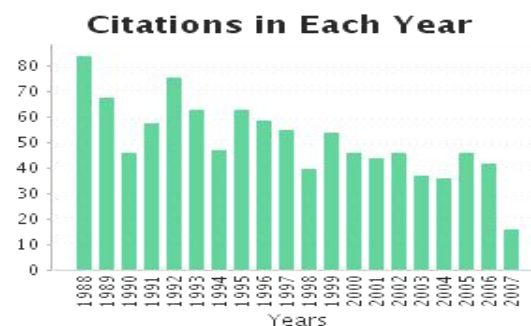
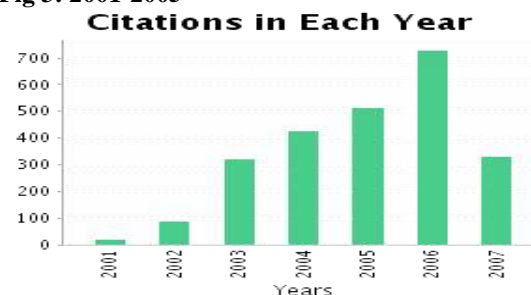
The low citations rate is generally attributed to publishing papers in low impact factor journals. But, in the case of the laboratory it was different since 11 papers by NPL were though published in low impact journals during 1981-85 yet they received high citations. These papers are symbolic of creativity and innovation as otherwise they would not have attracted such high citations despite their publication in low impact journals. This notable achievement was repeated in 2001-05 but in 4 papers only (Table 4). It is evident that creativity and innovation is the key to win high citations.

In overall, the quality of papers by laboratory did show improvement after a gap of 20 years. Their average citation per paper for the output published in 1981-85 was rated as 4.14, which rose to 5.77 for its output published in 2001-05 (Table 3).

Besides, the performance on average citations per paper is expected to show further rise in the next five years period since computation for the output published during 2001-05 has been done so far on five- seven years citation window as against 25 – 27 years citation window for the publications output for 1981-85.

The shift in the quality of research papers is also evident from 'h-index' which was 19 for its output published in

1981-85. The 'h-index' was nearly the same, 18, for its output published in 2001-05. Given the wide differences in the citation windows of the two periods of study, it is evident that the laboratory performance in terms of quality is on the rise. Besides, the laboratory did show consistent rise in its 'h-index' for its output published during 2001-05 (Figs 3 & 4).

Fig 2: 1981-1985**Fig 3: 2001-2005**

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Table 3: Distribution of NPL Papers by Citations Received per paper

Citations Quality	Range (Citations received per Papers)	No of Papers in the given Citation Range		% Share of total Papers	
		1981-85	2001-05	1981-85	2001-05
Zero Citations	0	126	214	34.33	34.35
Low cited Papers	1 – 4	152	284	41.42	45.59
Medium cited Papers	5 – 19	70	111	19.07	17.82
High cited Papers	20 or more	19	14	5.18	2.25
Total		367	623	100.00	100.00

Citations per paper: 1981-85 = 4.14 (Computed on 25 – 27 years window 1981-2007)
Citations per paper: 2001-05: = 5.77 (Computed on 5 – 7 years window 2001-2007)

Table 4: NPL Papers Distributed by Citations Received per paper: 1981-85

Range (Citations received per Paper)	No of Papers	No of Papers in the given Journal IF Range		% Share of total Papers	
		0	0.001-1.999	2.001 – 3.999	4.0 & more
0	126	55	62	8	1
1 – 4	152	46	95	11	0
5 – 19	70	5	49	14	2
20 or more	19	1	11	7	0
Total	367	107	217	40	3

Table 5: NPL Papers Distributed by Citations Received per paper: 2001-05

Range (Citations received per Paper)	No of Papers	No of Papers by Journal Impact Factor Range		% Share of total Papers	
		0	0.001-1.999	2.001 – 3.999	4.0 & more
0	214	4	197	10	3
1 – 4	284	8	228	38	10
5 – 19	111	0	67	40	4
20 or more	14	0	4	7	3
Total	623	12	496	95	20

Table 6: NPL Papers Distributed by Average citations per paper and H index Received 1981-85

Year	Total publications	Sum of times cited	Average citation per paper	*h-index
1981-1985	367	1513 without self citations 1173	4.14	19
1981	86	410	4.7	11
1982	82	386	4.71	11
1983	58	189	3.26	7
1984	60	230	3.83	9
1985	81	298	3.68	9

*h-index The h-index is indicator. The number of items above this indicator, which is *h*, has at least *h* citations. For example, an h-index of .10 means that there are 10 items that have 10 citations or more. This metric is useful because it discounts the disproportionate weight of highly cited papers or papers that have not yet been cited.

Table 7: NPL Papers Distributed by h – index Received: 2001-05

Year	Total publications	Sum of time cited	Average citation per paper	*h-index
2001-2005	623	2443 without self citations 1751	3.90	18
2001	110	916	8.33	12
2002	111	657	5.92	11
2003	127	353	2.78	8
2004	137	322	2.35	8
2005	138	195	1.48	6

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High Productivity Authors

Publication activity in NPL India is highly skewed. This trend was observed during both periods of study. Only a select few number of scientists (nearly 10%) account for bulk of the publication output by the laboratory (Appendix 4). It implies that not all scientists in the institution publish research papers in good number. Publication activity in

Findings and Suggestions

NPL India witnessed annual average growth rate of 1.13% in its publications output during 1981–85. It surged to 5.98% during 2001–05. The five-fold in itself increase in its publications growth rate is though a significant development, but in absolute terms the current growth of 5.98% is still not high enough given its state-of-the-art infrastructure and its research potential in science and technology.

An issue of great concern is that the bulk of the laboratory papers are low cited papers or not cited papers, even once since their publication. The laboratory output of medium and high cited papers continued to remain small (20 to 24%) during both periods of study. The quality of research measured in terms of citations per paper has shown some improvement after a gap of 20 years. The study also shows that the key to improving quality is creativity and innovation.

NPL India has published research papers in collaboration with different countries world over. In 2001–05 it had collaboration with a larger set of countries 33 compared to 6 countries in 1981–85. Its collaborative share has so far been the largest with countries like USA, followed by Japan and Germany. It also showed significant rise in the number of collaborating institutions from 43 in 1981-85 to 305 in 2001-05. The need of the hour is to plan for stronger collaborative linkages with all leading institutions in developed and developing countries.

The research priorities of the laboratory have changed with time, may be to keep the laboratory research focus in line with current research trends world over. The study reveals that the research areas of priority interest to the laboratory are applied physics, materials science, and atmospheric science. Given the current trends world over, it has also started publishing in newer and emerging areas of research such as nanotechnology, bio technology, and biochemistry. This signifies that the laboratory is continuously reorienting

NPL India at the level of source titles is also skewed. In 1981–85 NPL published in 102 titles, and in 2001–05 it published in 177 titles. However a small percent share of such journals account for bulk of NPL papers. Besides, the journals used for publishing NPL papers are of not high impact factor. For example, the average impact factor of source titles was 0.82, in 1981–85 and 1.38 in 2001–05 (Appendix 5).

its research programmes in line with current developments world over.

Conclusion

It may be concluded that NPL India showed significant rise in the research output during the period between 1981–85 and 2001–05. Much of this shift in research output and its quality may be attributed to several reasons including online facility offered by publishers. It may also be attributed to significant growth in its collaborative research. This shift may also be attributed to radical changes in its research focus and its research programmes. In fact, the key to growth in science is collaborative research, creativity and innovation.

The shift in laboratory research may as well be attributed to radical changes that it initiated in its information infrastructure, increasing its information base from 318 print journals (in 1981) to 4500+ electronic journals by 2005, as well as expanding its computing and network facilities. The computing infrastructure within the laboratory was vastly expanded providing desk top access to each and every scientist within the laboratory.

Such infrastructural developments can certainly be replicated in underperforming academic and research institutions as they seem to carry immense potential to influence research and development work in the institutions.

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Appendix 1
NPL's Collaboration with Different Countries

S. No.	1981-85			2001-2005		
	Country /Territory	Total number of collaborative papers	% of Total Papers	Country/ Territory	Total number of collaborative papers	% Share of Total Papers
1	India	367	100.00%	India	623	100.00%
2	USA	5	1.36%	Usa	48	7.70%
3	Japan	2	0.55%	Japan	45	7.22%
4				Germany	14	2.25%
5				South Korea	9	1.44%
6				France	8	1.28%
7				Malaysia	8	1.28%
8				Peoples R China	7	1.12%
9	Canada	1	0.27%	Canada	4	0.64%
10	England	1	0.27%	England	4	0.64%
11				Italy	4	0.64%
12	Fed Rep Ger	4	1.09%	Poland	4	0.64%
13	Mexico	1	0.27%	Russia	4	0.64%
14				South Africa	4	0.64%
15				Australia	3	0.48%
16				Brazil	3	0.48%
17				Israel	3	0.48%
18				Switzerland	3	0.48%
19				Taiwan	3	0.48%
20				Egypt	2	0.32%
21				Finland	2	0.32%
22				New Zealand	2	0.32%
23				Spain	2	0.32%
24				Sweden	2	0.32%
25				Thailand	2	0.32%
26				Vietnam	2	0.32%
27				Austria	1	0.16%
28				Belgium	1	0.16%
29				Indonesia	1	0.16%
30				Netherlands	1	0.16%
31				Romania	1	0.16%
32				Singapore	1	0.16%
33				Slovakia	1	0.16%
34				Wales	1	0.16%

Appendix 2
Distribution of NPL papers by Subject

1981-85			2001-2005		
Subject Category	No. of Papers	% of 367	Subject Category	No. of Papers	% of 623
PHYSICS, APPLIED	52	14.17%	PHYSICS, APPLIED	152	24.40%
MATERIALS SCIENCE, MULTIDISCIPLINARY	58	15.80%	MATERIALS SCIENCE, MULTIDISCIPLINARY	147	23.60%
PHYSICS, CONDENSED MATTER	29	7.90%	PHYSICS, CONDENSED MATTER	133	21.35%
PHYSICS, MULTIDISCIPLINARY	44	11.99%	PHYSICS, MULTIDISCIPLINARY	58	9.31%
METEOROLOGY & ATMOSPHERIC SCIENCES	60	16.35%	METEOROLOGY & ATMOSPHERIC SCIENCES	50	8.03%
MULTIDISCIPLINARY SCIENCES	15	4.09%	MULTIDISCIPLINARY SCIENCES	43	6.90%
ENGINEERING, ELECTRICAL & ELECTRONIC	16	4.36%	ENGINEERING, ELECTRICAL & ELECTRONIC	38	6.10%
CHEMISTRY, PHYSICAL	5	1.36%	CHEMISTRY, PHYSICAL	36	5.78%
INSTRUMENTS & INSTRUMENTATION	5	1.36%	INSTRUMENTS & INSTRUMENTATION	33	5.30%
GEOSCIENCES, MULTIDISCIPLINARY	2	0.55%	GEOSCIENCES, MULTIDISCIPLINARY	30	4.82%
ASTRONOMY & ASTROPHYSICS	50	13.62%	ASTRONOMY & ASTROPHYSICS	26	4.17%
OPTICS	19	5.18%	OPTICS	23	3.69%
ELECTROCHEMISTRY	1	0.27%	ELECTROCHEMISTRY	22	3.53%
MATERIALS SCIENCE, COATINGS & FILMS	8	2.18%	MATERIALS SCIENCE, COATINGS & FILMS	22	3.53%
POLYMER SCIENCE	5	1.36%	POLYMER SCIENCE	20	3.21%
CHEMISTRY, MULTIDISCIPLINARY	12	3.27%	CHEMISTRY, MULTIDISCIPLINARY	19	3.05%
ENGINEERING, MULTIDISCIPLINARY	21	5.72%	ENGINEERING, MULTIDISCIPLINARY	18	2.89%
CHEMISTRY, ANALYTICAL	5	1.36%	CHEMISTRY, ANALYTICAL	16	2.57%
GEOCHEMISTRY & GEOPHYSICS	4	1.09%	GEOCHEMISTRY & GEOPHYSICS	15	2.41%
CRYSTALLOGRAPHY	15	4.09%	CRYSTALLOGRAPHY	12	1.93%
TELECOMMUNICATIONS	5	1.36%	TELECOMMUNICATIONS	12	1.93%
ENGINEERING, INDUSTRIAL	41	11.17%	ENGINEERING, INDUSTRIAL	11	1.77%
ENERGY & FUELS	17	4.63%	ENERGY & FUELS	10	1.61%
MATERIALS SCIENCE, CERAMICS	2	0.55%	MATERIALS SCIENCE, CERAMICS	6	0.96%
PHYSICS, MATHEMATICAL	1	0.27%	PHYSICS, MATHEMATICAL	5	0.80%
ACOUSTICS	7	1.91%	ACOUSTICS	4	0.64%
IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	2	0.55%	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	4	0.64%
MATERIALS SCIENCE, CHARACTERIZATION & TESTING	1	0.27%	MATERIALS SCIENCE, CHARACTERIZATION & TESTING	4	0.64%
METALLURGY & METALLURGICAL	3	0.82%	METALLURGY & METALLURGICAL	4	0.64%

	ENGINEERING			ENGINEERING		
	PHYSICS, NUCLEAR	1	0.27%	PHYSICS, NUCLEAR	3	0.48%
	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	1	0.27%	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	2	0.32%
	CHEMISTRY, INORGANIC & NUCLEAR	2	0.55%	CHEMISTRY, INORGANIC & NUCLEAR	1	0.16%
	ENGINEERING, CHEMICAL	1	0.27%	ENGINEERING, CHEMICAL	1	0.16%
	INFORMATION SCIENCE & LIBRARY SCIENCE	2	0.55%	INFORMATION SCIENCE & LIBRARY SCIENCE	1	0.16%

Appendix 3

Distribution of NPL Papers in Related Areas of Research

1981-85			2001-2005		
Subject Category	No. of Papers	% of 367	Subject Category	No. of Papers	% of 623
COMPUTER SCIENCE, INFORMATION SYSTEMS	2	0.55%	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	17	2.73%
FOOD SCIENCE & TECHNOLOGY	2	0.55%	NANOSCIENCE & NANOTECHNOLOGY	14	2.25%
MICROSCOPY	2	0.55%	ENVIRONMENTAL SCIENCES	13	2.09%
NUCLEAR SCIENCE & TECH	2	0.55%	BIOCHEMISTRY & MOLECULAR BIO.	12	1.93%
PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	2	0.55%	ENGINEERING, AEROSPACE	11	1.77%
REMOTE SENSING	2	0.55%	REMOTE SENSING	9	1.44%
THERMODYNAMICS	2	0.55%	SPECTROSCOPY	8	1.28%
AGRONOMY	1	0.27%	BIOPHYSICS	5	0.80%
COMPUTER SCIENCE, SOFTWARE ENGINEERING	1	0.27%	NUCLEAR SCIENCE & TECHNOLOGY	5	0.80%
ENVIRONMENTAL SCIENCES	1	0.27%	OCEANOGRAPHY	3	0.48%
IMMUNOLOGY	1	0.27%	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	3	0.48%
MATERIALS SCIENCE, TEXTILES	1	0.27%	AGRICULTURE, SOIL SCIENCE	2	0.32%
MECHANICS	1	0.27%	CHEMISTRY, APPLIED	2	0.32%
MEDICINE, GENERAL & INTERNAL	1	0.27%	ENGINEERING, MARINE	2	0.32%
MEDICINE, RESEARCH & EXPERIMENTAL	1	0.27%	PHYSICS, PARTICLES & FIELDS	2	0.32%
			AUTOMATION & CONTROL SYSTEMS	1	0.16%
			COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	1	0.16%
			ENGINEERING, BIOMEDICAL	1	0.16%
			ENGINEERING, ENVIRONMENTAL	1	0.16%
			ENGINEERING, MANUFACTURING	1	0.16%
			MATERIALS SCIENCE, BIOMATERIALS	1	0.16%
			MICROSCOPY	1	0.16%
			RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	1	0.16%
			TRANSPORTATION SCIENCE & TECHNOLOGY	1	0.16%
			WATER RESOURCES	1	0.16%

Appendix 4:
Publication Activity of Top Authors

S. No.	2001-2005			1981-85		
	Author	No of papers	% of 623	Author	No of papers	% of 367
1	MALHOTRA, BD	32	5.14%	JAIN, GC	25	6.81%
2	AGNIHOTRY, SA	31	4.98%	MEHENDRU, PC	22	5.99%
3	SHIVAPRASAD, SM	29	4.65%	BHIDE, VG	21	5.72%
4	GUPTA, A	27	4.33%	DAS, BK	15	4.09%
5	NARLIKAR, AV	22	3.53%	REDDY, BM	15	4.09%
6	AWANA, VPS	21	3.37%	SINGH, SN	15	4.09%
7	GARG, SC	20	3.21%	NARLIKAR, AV	13	3.54%
8	RASTOGI, AC	20	3.21%	SARKAR, SK	13	3.54%
9	GUPTA, AK	19	3.05%	CHANDRA, S	12	3.27%
10	SAMANTA, SB	18	2.89%	DUTTA, HN	12	3.27%
11	KHARE, N	17	2.73%	KUMAR, N	12	3.27%
12	MITRA, AP	17	2.73%	NAGPAL, KC	12	3.27%
13	DEEPA, M	16	2.57%	PARSHAD, R	12	3.27%
14	KUMAR, A	16	2.57%	BAHADUR, H	11	3.00%
15	GUPTA, PK	15	2.41%	BAHL, DP	11	3.00%
16	GUPTA, SK	15	2.41%	TYAGI, TR	11	3.00%
17	SINGH, R	15	2.41%	BHUCHAR, VM	10	2.72%
18	BAWA, SS	14	2.25%	BINDAL, VN	10	2.72%
19	BHATTACHARYYA, R	14	2.25%	CHAND, S	10	2.72%
20	CHAKRABORTY, BR	14	2.25%	CHANDRA, K	10	2.72%
21	CHANDER, H	14	2.25%	GUPTA, SK	10	2.72%
22	KATARIA, ND	14	2.25%	LAL, K	10	2.72%
23	KISHAN, H	14	2.25%	WASAN, VP	10	2.72%
24	MAHAJAN, KK	14	2.25%	EKBOTE, SN	9	2.45%
25	MISRA, SCK	14	2.25%	SOMAYAJULU, YV	9	2.45%
26	SARKAR, AK	14	2.25%	SURI, DK	9	2.45%
28	SINGHAL, R	14	2.25%	DABAS, RS	8	2.18%
29	CHANDRA, S	13	2.09%	KUMAR, S	8	2.18%
30	DHAWAN, SK	13	2.09%	KUMARI, S	8	2.18%
31	ANNAPOORNI, S	12	1.93%	MAHAJAN, KK	8	2.18%
32	CHAUBEY, A	12	1.93%	MATHUR, RB	8	2.18%
33	GOVIND	12	1.93%	SHARMA, CP	8	2.18%
34	JOSHI, SK	12	1.93%	SHARMA, JKN	8	2.18%
35	KISHORE, R	12	1.93%	LUPPAL, GS	8	2.18%
36	RAJPUT, SS	12	1.93%	AGNIHOTRY, SA	7	1.91%
37	SINGH, N	12	1.93%	BAVEJA, KD	7	1.91%
38	BIRADAR, AM	11	1.77%	GERA, BS	7	1.91%
39	CHANDRA, R	11	1.77%	GUPTA, NP	7	1.91%
40	KANDPAL, HC	11	1.77%	KRISHAN, R	7	1.91%
41	KUMAR, V	11	1.77%	PRADHAN, MM	7	1.91%
42	SHARMA, RK	11	1.77%	RADHAKRISHNAN, S	7	1.91%
43	SINGH, DP	11	1.77%	SINGAL, SP	7	1.91%
44	SUBRAHMANYAM, P	11	1.77%	SINGH, L	7	1.91%
45	VERMA, A	11	1.77%	AGRAWAL, AK	6	1.63%
46	BANDYOPADHYAY, AK	10	1.61%	ARDRA, NK	6	1.63%
47	KUMAR, S	10	1.61%	GARG, RK	6	1.63%
48	MEHTA, BR	10	1.61%	JOHN, PT	6	1.63%
49	PANT, RP	10	1.61%	KISHORE, R	6	1.63%
50	SETHI, NK	10	1.61%	PUNTAMBEKAR, PN	6	1.63%
51	SHARMA, AL	10	1.61%	RAI, R	6	1.63%
52	SINGH, S	10	1.61%	SAKSENA, TK	6	1.63%
53	SODD, KN	10	1.61%	SETH, RL	6	1.63%
54	SRIVASTAVA, AK	10	1.61%			
55	SRIVASTAVA, DN	10	1.61%			

Appendix 5 Source Titles Publishing NPL Papers (Top 75)

S. No.	2001-2005			1981-85			S. No.	Source Title	No of papers	% of 627	S. No.	Source Title	No of papers	% of 387
	Source Title	No of papers	% of 627	Source Title	No of papers	% of 387								
1	INDIAN JOURNAL OF PURE & APPLIED PHYSICS	34	5.46%	INDIAN JOURNAL OF PURE & APPLIED PHYSICS	50	13.62%	38	PHYSICA STATUS SOLIDI B-BASIC RESEARCH	5	0.80%	INFRARED PHYSICS	2	0.55%	
2	CURRENT APPLIED PHYSICS	20	3.21%	INDIAN JOURNAL OF PURE & APPLIED PHYSICS	34	9.26%	39	RADIO SCIENCE	5	0.80%	JOURNAL OF INORGANIC CHEMISTRY	2	0.55%	
3	JOURNAL OF APPLIED PHYSICS	20	3.21%	RESEARCH AND INDUSTRIAL SCIENCE	33	8.99%	40	SURFACE SCIENCE	5	0.80%	JOURNAL OF MATERIALS SCIENCE	2	0.55%	
4	CURRENT SCIENCE	19	3.05%	JOURNAL OF MATERIALS SCIENCE	14	3.81%	41	BIOSENSORS & BIOELECTRONICS	4	0.64%	JOURNAL OF PHOTOGRAPHY	2	0.55%	
5	PHYSICA C-SUPERCONDUCTIVITY AND RELATED TOPICS	13	2.09%	PHYSICA STATUS SOLIDI B	12	3.27%	42	CHEMOSPHERE	4	0.64%	JOURNAL OF PHYSICS	2	0.55%	
6	PHYSICAL REVIEW B	12	1.93%	SOLAR CELLS	12	3.27%	43	DIAMOND AND RELATED MATERIALS	4	0.64%	OPTICA ACTA	2	0.55%	
7	APPLIED BIOCHEMISTRY AND BIOTECHNOLOGY	11	1.77%	INDIAN JOURNAL OF PURE & APPLIED PHYSICS	11	3.00%	44	ELECTROCHIMICA ACTA	4	0.64%	PHYSICS LETTERS	2	0.55%	
8	APPLIED SURFACE SCIENCE	11	1.77%	FIBRE SCIENCE & TECHNOLOGY	9	2.45%	45	FERROELECTRICS	4	0.64%	PRAMANA	2	0.55%	
9	INDIAN JOURNAL OF ENGINEERING AND TECHNOLOGY	11	1.77%	JOURNAL OF SCIENCE	8	2.18%	46	INTERNATIONAL JOURNAL OF REMOTE SENSING	4	0.64%	PROCEEDINGS OF THE INDIAN ACADEMY OF SCIENCES	2	0.55%	
10	THIN SOLID FILMS	11	1.77%	MOLECULAR CRYSTALS	8	2.18%	47	INTERNATIONAL REFERENCE JOURNAL OF REMOTE SENSING	4	0.64%	RADIO SCIENCE	2	0.55%	
11	JOURNAL OF ATMOSPHERIC AND SOLAR ENERGY	10	1.61%	JOURNAL OF PHYSICS	7	1.91%	48	JOURNAL OF NON-CRYSTALLINE SOLIDS	4	0.64%	SCANNING ELECTRON MICROSCOPY	2	0.55%	
12	JOURNAL OF PHYSICS AND CHEMISTRY	10	1.61%	CURRENT SCIENCE	6	1.63%	49	REVIEW OF SCIENTIFIC INSTRUMENTS	4	0.64%	ABSTRACTS OF PURE AND APPLIED PHYSICS	1	0.27%	
13	JOURNAL OF PHYSICS D-APPLIED PHYSICS	10	1.61%	THIN SOLID FILMS	6	1.63%	50	SEMICONDUCTOR SCIENCE AND TECHNOLOGY	4	0.64%	ACUSTICA	1	0.27%	
14	JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH	10	1.61%	VACUUM	6	1.63%	51	SPECTROCHIMICA ACTA PART A-MOLECULAR SPECTROSCOPY	4	0.64%	AIP CONFERENCE PROCEEDINGS	1	0.27%	
15	ANNALES GEOPHYSICAE	9	1.44%	CARBON	5	1.36%	52	VACUUM	4	0.64%	ANALYTICA CHIMICA ACTA	1	0.27%	
16	APPLIED PHYSICS LETTERS	9	1.44%	INDIAN JOURNAL OF PURE & APPLIED PHYSICS	5	1.36%	53	ASIAN JOURNAL OF CHEMISTRY	3	0.48%	ANALYTICAL LETTERS	1	0.27%	
17	JOURNAL OF MATERIALS SCIENCE LETTERS	9	1.44%	JOURNAL OF ATMOSPHERIC AND SOLAR ENERGY	5	1.36%	54	INDIAN JOURNAL OF PHYSICS AND PROCEEDINGS	3	0.48%	ANNALES DE GEOPHYSIQUE	1	0.27%	
18	SOLAR ENERGY MATERIALS AND SOLAR ENERGY	9	1.44%	OPTICS COMMUNICATIONS	5	1.36%	55	INDIAN JOURNAL OF PHYSICS AND PROCEEDINGS	3	0.48%	ATMOSPHERIC ENVIRONMENT	1	0.27%	
19	SUPERCONDUCTOR SCIENCE & TECHNOLOGY	9	1.44%	APPLIED ACOUSTICS	4	1.09%	56	INTERNATIONAL JOURNAL OF INFRARED AND RADIATION	3	0.48%	BULLETIN DES SOCIÉTÉS FRANÇAISES DE PHYSIQUE	1	0.27%	
20	JOURNAL OF MATERIALS SCIENCE	8	1.28%	JOURNAL OF APPLIED PHYSICS	4	1.09%	57	JAPANESE JOURNAL OF APPLIED PHYSICS	3	0.48%	CANADIAN JOURNAL OF PHYSICS	1	0.27%	
21	MATERIALS CHEMISTRY AND PHYSICS	8	1.28%	JOURNAL OF CRYSTAL GROWTH	4	1.09%	58	JOURNAL OF ALLOYS AND COMPOUNDS	3	0.48%	CROATICA CHEMICA ACTA	1	0.27%	
22	PRAMANA-JOURNAL OF PHYSICS	8	1.28%	JOURNAL OF THE INDIAN PHYSICAL SOCIETY	4	1.09%	59	JOURNAL OF APPLIED CRYSTALLOGRAPHY	3	0.48%	CRYOGENICS	1	0.27%	
23	SOLID STATE COMMUNICATIONS	8	1.28%	PHYSICA B & C	4	1.09%	60	JOURNAL OF NONLINEAR OPTICAL PHYSICS	3	0.48%	ELECTRONICS INFO	1	0.27%	
24	JOURNAL OF APPLIED POLYMER SCIENCE	7	1.12%	SOLID STATE COMMUNICATIONS	4	1.09%	61	JOURNAL OF OPTICS A-PURE AND APPLIED OPTICS	3	0.48%	ELECTRONICS LETTERS	1	0.27%	
25	JOURNAL OF CRYSTAL GROWTH	7	1.12%	ACTA CRYSTALLOGRAPHICA	3	0.82%	62	MATERIALS LETTERS	3	0.48%	ENERGY CONVERSION	1	0.27%	
26	JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS	7	1.12%	IEEE TRANSACTION ON MAGNETICS	3	0.82%	63	MEASUREMENT SCIENCE & TECHNOLOGY	3	0.48%	GEOPHYSICAL JOURNAL OF THE ROYAL SOCIETY	1	0.27%	
27	PHYSICA B-CONDENSED MATTER	7	1.12%	OPTICS AND LASER TECHNOLOGY	3	0.82%	64	MODERN PHYSICS LETTERS B	3	0.48%	GEOPHYSICAL RESEARCH LETTERS	1	0.27%	
28	SENSORS AND ACTUATORS B-CHEMICAL	7	1.12%	SOLAR ENERGY	3	0.82%	65	PHYSICA STATUS SOLIDI A-APPLIED PHYSICS	3	0.48%	IEEE ELECTRONIC LETTERS	1	0.27%	
29	SOLID STATE IONICS	7	1.12%	TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY	3	0.82%	66	POLYMER	3	0.48%	IEEE TRANSACTION ON ELECTRON DEVICES	1	0.27%	
30	GEOPHYSICAL RESEARCH LETTERS	6	0.96%	ANALYST	2	0.55%	67	POWDER DIFFRACTION	3	0.48%	IEEE TRANSACTION ON APPLIED SUPERCONDUCTIVITY	1	0.27%	
31	INDIAN JOURNAL OF PHYSICS AND PROCEEDINGS	6	0.96%	APPLIED OPTICS	2	0.55%	68	ANALOG INTEGRATED CIRCUITS AND SIGNAL PROCESSING	2	0.32%	IEEE TRANSACTION ON ELECTRONIC PACKAGING	1	0.27%	
32	SYNTHETIC METALS	6	0.96%	APPLIED PHYSICS	2	0.55%	69	ANALYTICA CHIMICA ACTA	2	0.32%	INDIAN JOURNAL OF PURE & APPLIED PHYSICS	1	0.27%	
33	ATMOSPHERIC ENVIRONMENT	5	0.80%	BOUNDARY-LAYER METEOROLOGY	2	0.55%	70	ANNALES GEOPHYSICAE-ATMOSPHERES	2	0.32%	INFORMATION PROCESSING LETTERS	1	0.27%	
34	BULLETIN OF MATERIALS SCIENCE	5	0.80%	FERROELECTRICS	2	0.55%	71	APPLIED OPTICS	2	0.32%	INTERNATIONAL JOURNAL OF REMOTE SENSING	1	0.27%	
35	IETE TECHNICAL REVIEW	5	0.80%	IEEE TRANSACTION ON FERROELECTRICS	2	0.55%	72	BOUNDARY-LAYER METEOROLOGY	2	0.32%	INTERNATIONAL JOURNAL OF SOLID STATE PHYSICS	1	0.27%	
36	IONICS	5	0.80%	IEEE TRANSACTION ON FERROELECTRICS	2	0.55%	73	CARBON	2	0.32%	JOURNAL OF CHEMICAL PHYSICS	1	0.27%	
37	PHYSICA C	5	0.80%	IEEE TRANSACTION ON FERROELECTRICS	2	0.55%	74	ELECTRONICS LETTERS	2	0.32%	JOURNAL OF DOCUMENTATION	1	0.27%	
							75	EUROPEAN PHYSICAL JOURNAL B	2	0.32%	JOURNAL OF FOOD SCIENCE	1	0.27%	