

## Scientometric dimensions of pulsed laser deposition research: a global perspective

Ganesh Surwase, B.S. Kademani and Vijai Kumar

Scientific Information Resource Division, Knowledge Management Group, Bhabha Atomic Research Centre,  
Mumbai-400085,

E-mails: ganeshbarc@yahoo.co.in; bskademani@yahoo.co.in; bsk@barc.gov.in

Attempts to highlight quantitatively the growth and development of world literature in the field of pulsed laser deposition in terms of publication output as per Science Citation Index (1982-2006). During 1982-2006 a total of 8534 papers were published by the scientists in the field pulsed laser deposition. The average number of publications published per year was 341.36. The highest number of papers 1074 were published in 2005. There were 84 countries involved in the research in this field. USA is the top producing country with 2014 publications (19.35%) followed by Japan with 1553 publications (14.92%), Peoples-R-China with 1106 publications (10.63%), Germany with 763 publications (7.33%) South Korea with 694 publications (6.67%) and France with 615 publications (5.91%). India ranked 9<sup>th</sup> among other countries with 291 publications during 1985-2006. Authorship and collaboration trend was towards multi-authored papers. There were 8338 (97.70%) multi-authored publications and 196 (2.30 %) single authored publications. Chinese Academy of Sciences (Peoples-R-China) topped the list with 304 publications followed by Nanjing University (Peoples-R-China) with 244 publications, Tokyo Institute of Technology (Japan) with 233 publications and CNRS (France) with 217 publications. The most productive Indian institutions were: Tata Institute of Fundamental Research, Mumbai with 52 publications and Indian Institute of Science, Bangalore with 49 publications. The most prolific Indian authors were: R. Pinto (Indian-Inst-Technol-Bombay, Mumbai) with 38 publications, M.S. Hegde (Indian-Inst-Sci, Bangalore) with 31 publications, S.B. Ogale (Univ Pune, Pune) with 29 publications, L.M. Kukreja (Raja Ramanna Ctr-Adv-Technol, Indore) with 21 publications, P. Misra (Raja Ramanna Ctr-Adv-Technol, Indore) with 16 publications, R.K. Thareja (Indian-Inst-Technol-Kanpur) with 15 publications. The most preferred journals by the scientists were: *Applied Physics Letters* with 962 publications, *Journal of Applied Physics* with 714 publications, *Applied Surface Science* with 614 publications and *Thin Solid Films* with 541 publications.

### Introduction

Invention of laser in 1960 has opened up new areas of research and found various applications in many scientific fields. Pulsed Laser Deposition (PLD) is one of the several techniques of the deposition of the thin film on the substrates besides other techniques like Molecular Beam Epitaxy (MBE), Metal Organic Chemical Vapour Deposition (MOCVD) and Sputtering<sup>1-2</sup>. The pulsed laser deposition has several advantages over other deposition techniques. There are several applications of the thin films developed because of its helpful technique in developing quantum dots and quantum wells of several sizes and shapes.

Pulsed laser deposition as a film growth technique has gained importance and attracted wide spread interests after it has been used successfully to grow high-temperature Tc superconducting films<sup>3</sup> in 1987. During the last decade, pulsed laser deposition has been used to fabricate crystalline thin films with epitaxy quality.

Ceramic oxide, nitride films, metallic multilayers, and various super-lattices grown by pulsed laser deposition have been demonstrated. It has been reported in the literature that pulsed laser deposition is being used to synthesise nanotubes<sup>4</sup>, nanopowders<sup>5</sup> and quantum dots<sup>6</sup>.

Evaluation is a key component of any research and development activity. A well known productivity indicator is the number of publications produced by the scientists, institutions and countries. Studies like this will provide some insight into the complex dynamics of research activity and enable the scientists, policy makers and science administrators to provide adequate facilities and proper guidance as to which direction the research has to be conducted.

Research publications are clearly one of the quantitative measures for the basic research activity in a country. It must be added, however, that what excites the common man, as well as the scientific community, are the peaks of scientific and technological achievement, not just the

statistics on publications. There are also other kinds of research and technology development such as mission oriented, industry-oriented, country-specific, etc., and progress in these cannot be obviously measured by counting only the number of publications<sup>7</sup>. Many scientometric studies have appeared in the literature to focus on the performance of science in the field of laser<sup>8-13</sup> and other domains<sup>14-29</sup>.

### Objectives

The main objective of the study is to present the growth of world literature in pulsed laser deposition and make the quantitative assessment of the research in terms of year-wise research output, geographical distribution of research output, nature of collaboration, characteristics of highly productive institutions and the channels of communications used by the scientists.

### Methodology

Data was collected from the Science Citation Index-On Disc (CD-ROM) (1982-2006) published by a division of the Thomson Corporation (formerly Institute for Scientific Information, Philadelphia). Science Citation Index is one of the very comprehensive databases covering all aspects of science. The study period (1982-2006) is selected as the database is available in machine readable form since 1982. The search string 'PULSED LASER DEPOSIT\* OR PULSE LASER DEPOSIT\*' in the 'BASIC INDEX' field of SCI was used for the years 1982-2006 to download the records on the subject 'Pulsed Laser Deposition'. A total of 8534 records were downloaded and analysed by using the spreadsheet application as per the objectives of the study.

### Results and discussion

#### Growth of publications in pulsed laser deposition

During 1982-2006 a total of 8534 publications were published in pulsed laser deposition by various countries. The average number of publications produced per year was 341.36. The highest number of publications 1074 was produced in 2005. Figure 1 gives year-wise growth and collaboration rate in pulsed laser deposition. It can be clearly visualized from the figure that growth of the literature was very low during 1982-1990 and it peaked during 1991-2006. It indicates that research in pulsed laser deposition received a major impetus during this period.

An exponential growth in number of publications was observed during 1982-2006. The highest growth rate

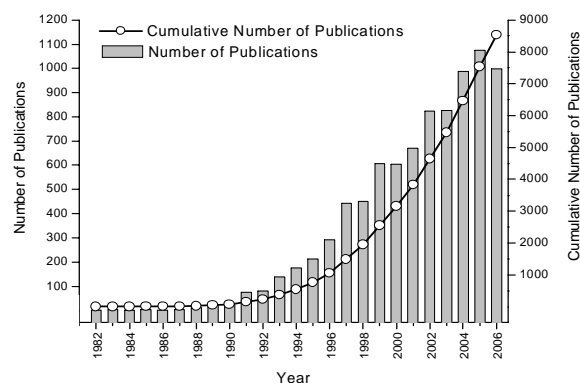


Fig. 1 — Year-wise publication productivity growth in PLD research

Table 1 — Growth rate of publications in different five-year blocks in PLD research

Five year blocks	No. of publications	Growth Rate (1982-2006)
1982-1986	11	-
1987-1991	138	1154.55
1992-1996	900	552.17
1997-2001	2776	208.44
2002-2006	4709	69.63

(1154.55%) was found during 1987-1991 with 138 publications followed by (552.17%) with 900 publications during 1992-1996, (208.44%) with 2776 publications during 1997-2001 and (69.63%) with 4709 publications during 2002-2006. Table 1 gives the growth rate of publications in pulsed laser deposition research in different five year blocks.

#### Geographical distribution of research output

There were as many as 84 countries carrying out research in the field of pulsed laser deposition and produced 10409 authorships. Figure-2 provides a list of countries whose research output is more than 50 publications. USA is the top producing country with 2014 publications (19.35%), followed by Japan with 1553 publications (14.92%), Peoples-R-China with 1106 publications (10.63%), Germany with 763 publications (7.33%), France with 615 publications (5.91%), Italy with 336 publications (3.49%), England with 297 publications (2.85%), India with 291 publications (2.80%) and Spain with 253 publications (2.43%).

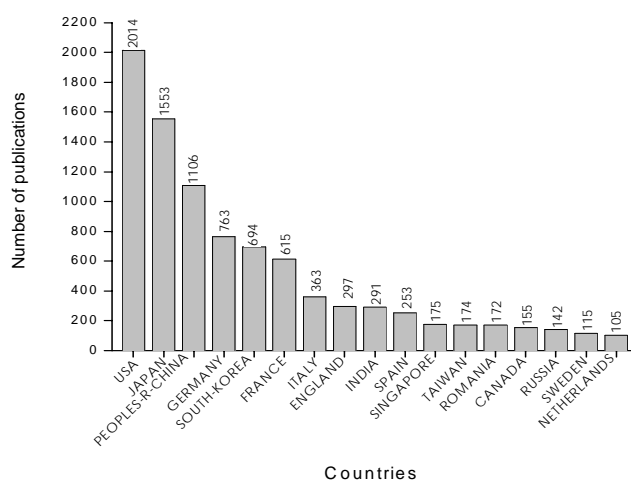


Fig. 2 — Country-wise distribution of number of publications (more than 100) in PLD research

**Publication output by India and rest of the world in PLD research**

There were 8534 publications in PLD research during 1982-2006 in the whole world, of which 291 publications were by Indian scientists and 8243 by rest of the world. During 1982-1984 and 1986-1987 there were no publications by Indian scientists. The average number of publications per year was 11.64 and 329.72 for India and rest of the world respectively. The highest number of publications 1033 was produced by rest of the world in 2005 and the highest number of publications 41 each in 2003 and 2005 respectively by India. The publications trend for India and rest of the world is almost similar. Figure 3 gives year-wise growth of publications in PLD research.

**International collaboration**

Table 2 gives the country-wise collaboration trend in pulsed laser deposition research. Out of 8534 publications, 1587 (18.59% of total) publications had international collaboration. Bilateral collaboration was found with 1335 (84.12%) publications and 205 (12.92%) publications had collaboration with three countries. This indicates that scientists also preferred to collaborate with foreign scientists.

**Authorship and collaboration pattern**

Authorship and collaboration trend in PLD research is given in Figure 4. Authorship and collaboration trend

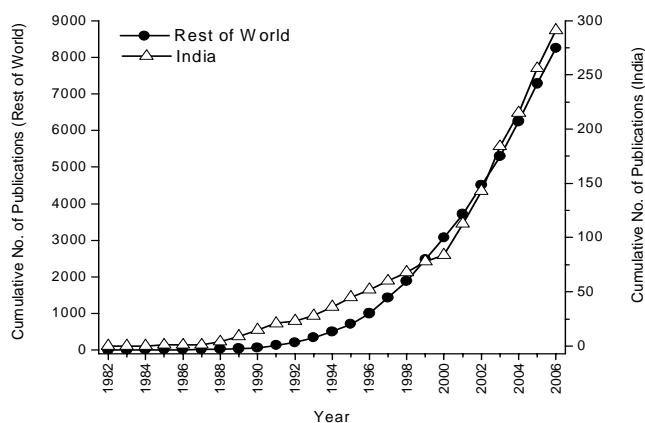


Fig. 3 — Year-wise publication growth in PLD research in India and rest of the world

Table 2 — Country-wise collaboration trend in PLD research

Collaborating countries	No. of publications	Percentage
2	1335	84.12
3	205	12.92
4	38	2.39
5	8	0.50
6	1	0.06
Total	1587	100.00

was towards multi-authored papers as there were 8338 (97.70%) collaborative publications. There were only 196 (2.30%) single-authored publications, two authored 719 (8.43%) publications, multi-authored (3-4 authors) 2890 (33.86%) publications and mega-authored (five and above authors) 4729 (55.41%) publications indicates that scientists in this field preferred to work in groups and also indicates the multidisciplinary nature of the field which demand specialisations from various disciplines

**Organisation-wise distribution of publications**

In all, there were 2035 organizations involved in the research in pulsed laser deposition. Table 3 shows the organizations that have contributed 50 or more publications during 1982-2006. Chinese Academy of Science (Peoples-R-China) topped the list with 304 publications followed by Nanjing University (Peoples-

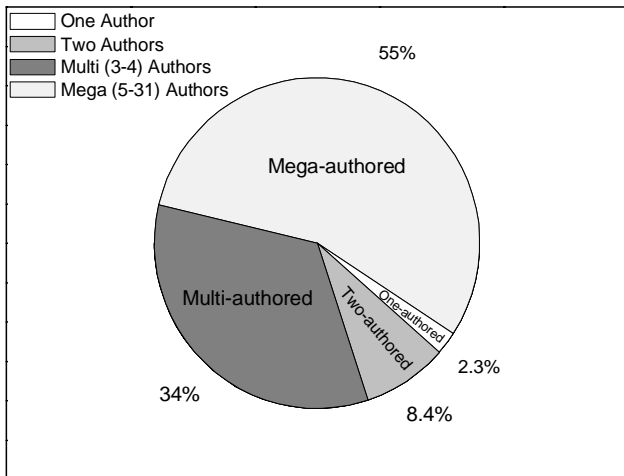


Fig. 4 — Authorship and collaboration trend in PLD research

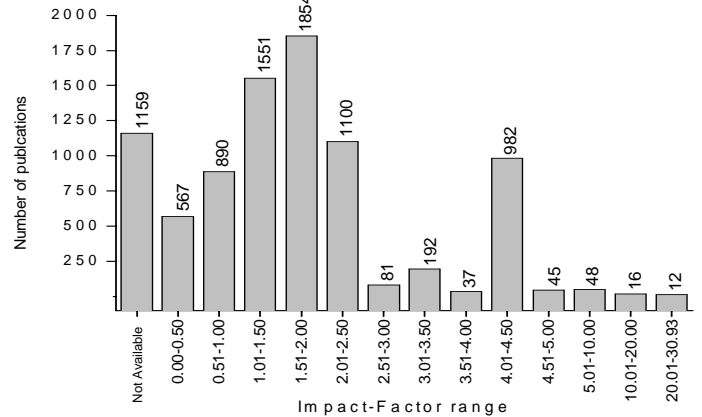


Fig. 5 — Impact factor range and distribution of journals publishing articles in PLD research

R-China) with 244 publications, Tokyo Institute of Technology (Japan) with 233 publications and Centre National De La Recherche Scientifique (CNRS) (France) with 217 publications.

**Distribution of Indian institutions in pulsed laser deposition**

There were 73 research institutes and universities involved in research in pulsed laser deposition. The leading institutes were Tata Institute of Fundamental Research, Mumbai with 52 publications, Indian Institute of Science, Bangalore with 49 publications, University of Poona, Poona with 38 publications, Indian Institute of Technology, Kanpur with 28 publications, Raja Ramanna Centre for Advanced Technology, Indore with 24 publications and Indira Gandhi Centre for Atomic Research, Kalpakkam with 18 publications. Table 4 provides a list of prominent Indian research institutes which had published five or more publications.

**Most prolific Indian authors**

There were 673 authors in Indian publications who have published 291 publications with 1423 authorships. The most prolific Indian authors were: R. Pinto (Indian-Inst-Technol-Bombay, Mumbai) with 38 publications, M.S. Hegde (Indian-Inst-Sci, Bangalore) with 31 publications, S.B. Ogale (Natl-Chem-Lab, Pune) with 29 publications, L.M. Kukreja (Raja-Ramanna-Ctr-Adv-Technol, Indore) with 21 publications, P. Misra (Raja-Ramanna-Ctr-Adv-Technol, Indore) with 16 publications, R.K. Thareja (Indian-Inst-Technol-Kanpur) with 15 publications.

Table 5 provides the list of authors who have contributed 5 or more publications.

**Preference of channels of communication by scientists**

Scientists communicated their publications through variety of communications channels. A total of 97.25 percent of the literature was published in journal articles followed by reviews - 1.34 percent, notes - 0.46 percent and letters - 0.42 percent and meeting abstracts - 0.32 percent.

The distribution of publications were spread over 315 journals. The leading journals preferred by the scientists were *Applied Physics Letters* with 962 publications followed by *Journal of Applied Physics* with 714 publications, *Applied Surface Science* with 614 publications, *Thin Solid Films* with 541 publications, *Physica C* with 432 publications, *Applied Physics A* with 320 publications and *Japanese Journal of Applied Physics I* with 269 publications. Table 6 provides journal wise scattering of publications. More than 92 percent of the publications were published in the journals with impact factors ranging from 0.01 to 32.18. This indicates that the publication behaviour of scientists who preferred to publish their publications in high impact factor journals. About 22.43 percent of the publications were published in the journals having no impact factor. The distribution of journals as per impact factors range is given in the Figure 5.

Table 3 — Distribution of institutions as per number of publications (more than 50) in PLD research

Sl. No.	Institute	Country	Publications
1	Chinese Acad Sci	Peoples-R-China	304
2	Nanjing Univ	Peoples-R-China	244
3	Tokyo Inst Technol	Japan	233
4	Centre National De La Recherche Scientifique (CNRS)	France	217
5	Osaka Univ	Japan	196
6	Univ Tokyo	Japan	161
7	Oak Ridge Natl Lab	USA	158
8	Consejo Super Invest Cientificas	Spain	152
9	Consiglio Nazionale Delle Ricerche (CNR)	Italy	148
10	Univ Maryland	USA	145
11	Natl Univ Singapore	Singapore	138
12	Los Alamos Natl Lab	USA	135
13	United States Navy	USA	129
14	Univ Florida	USA	124
15	Int Superconduct Technol Ctr	Japan	118
16	N Carolina State Univ	USA	116
17	Hong Kong Polytech Univ	Peoples-R-China	114
18	Univ Paris	France	109
19	Tohoku Univ	Japan	103
20	Yonsei Univ	South-Korea	101
21	Max Planck Inst Microstruct Phys	Germany	97
22	Penn State Univ	USA	97
23	Seoul Natl Univ	South-Korea	91
24	United States Air Force	USA	87
25	Natl Inst Adv Ind Sci & Technol	Japan	85
26	Natl Inst Laers Plasma & Radiat Phys	Romania	81
27	Nagoya Univ	Japan	80
28	Natl Tsing Hua Univ	Taiwan	80
29	Univ Leipzig	Germany	80
30	Natl Inst Mat Sci	Japan	79
31	Royal Inst Technol	Sweden	79
32	Univ Cambridge	England	77
33	Univ Calif Berkeley	USA	76
34	Acad Sci Czech Republ	Czech-Republic	75
35	Fudan Univ	Peoples-R-China	74
36	Japan Sci & Technol Corp	Japan	74
37	Kyoto Univ	Japan	74
38	Kyushu Univ	Japan	73
39	Electr & Telecommun Res Inst	South-Korea	72
40	Russian Acad Sci	Russia	71
41	Inst Festkorper & Werkstofforsch Dresden	Germany	68
42	Nagoya Inst Technol	Japan	66
43	Univ Twente	Netherlands	61
44	Pohang Univ Sci & Technol	South-Korea	56
45	Inrs Energie & Mat	Canada	55
46	Queens Univ Belfast	North-Ireland	54
47	Instituto Nazionale Per La Fisica Della Materia (INFM)	Italy	53
48	Tata Inst Fundamental Res	India	52
49	Univ Houston	USA	51
50	Univ Roma Tor Vergata	Italy	51
51	Pukyong Natl Univ	South-Korea	50

Table 4 — Distribution of Indian research institutes in PLD research

Sl. No.	Institute	Publications
1	Tata Institute of Fundamental of Research, Mumbai	52
2	Indian Institute Science, Bangalore	49
3	University of Poona, Poona	38
4	Indian Institute Technology Kanpur, Kanpur	28
5	Raja Ramanna Centre for Advance Technology, Indore	24
6	Indira Gandhi Centre for Atomic Research, Kalpakkam	18
7	Centre for Nuclear Science, New Delhi	13
8	Indian Institute of Technology Bombay, Mumbai	13
9	Indian Institute of Technology Madras, Chennai	10
10	Inter University Consortium for DAE Facilities, Indore–	10
11	National Chemical Laboratory, Poona	10
12	Sri Venkateswara University, Tirupati	10
13	University of Delhi, Delhi	10
14	Bhabha Atomic Research Centre, Mumbai	9
15	Solid State Physical Laboratory, New Delhi	9
16	Alagappa University, Karaikkudi	8
17	Bharathiar University, Coimbatore	7
18	Cochin University of Science & Technology, Cochin	7
19	Saurashtra University, Rajkot	7
20	University of Hyderabad, Hyderabad	7
21	National Physical Laboratory, New Delhi	6
22	Central Electrochemical Research Institute, Karaikkudi	5
23	Indian Association for Cultivation of Science, Kolkata	5

The Journals (315) publishing articles in pulsed laser deposition research were spread over 20 countries. Table 7 gives country-wise distribution of journals and publications. USA has published 3300 (38.67%) publications in 102 (31.29%) journals, publications followed by England with 1257 (14.73%) publications in 83 (25.46%) journals, Netherlands with 1854 (21.72%) publications in 46 (14.11%) journals, Switzerland with 1176 (13.78%) publications in 22 (6.75%) journals and Germany with 129 (1.51%) publications in 21 (6.44%).

#### Language-wise distribution of publications

English was the most predominant language with 8468 (99.23%) publications, followed by Chinese with 36

(0.42%) publications, Japanese with 14 (0.16%), French 184 (0.430%) publications, Russian with 9 (0.07%) publications and Spanish with 1 (0.01%) publications.

#### Conclusion

USA is the major producer of scientific output with 2014 publications to its credit in this field. Japan comes next with 1553 publications. The growth of the literature was very low during 1982-1990 which may be attributed for not receiving boost for research in this field. Since 1991, an exponential growth of publications was observed which indicates the sustained impetus received for the research during 1991-2006. Four countries (USA, Japan, Peoples R China and Germany) have contributed more

Table 5 — Most prolific Indian authors in PLD research

Sl. No.	Author	Affiliation	Publications
1	Pinto R	Indian Inst Technol Bombay, Mumbai	38
2	Hegde MS	Indian Inst Sci, Bangalore	31
3	Ogale SB	Natl Chem Lab, Pune	29
4	Kukreja LM	Raja Ramanna Ctr Adv Technol, Indore	21
5	Misra P	Raja Ramanna Ctr Adv Technol, Indore	16
6	Thareja RK	Indian Inst Technol Kanpur	15
7	Joseph M	Indira Gandhi Ctr Atom Res, Kalpakkam	12
8	Kanetkar SM	Univ Pune, Pune	12
9	Manoravi P	Indira Gandhi Ctr Atom Res, Kalpakkam	12
10	Apte PR	Tata Inst Fundamental Res, Mumbai	11
11	Chaudhari SM	Univ Pune, Pune	11
12	John J	Tata Inst Fundamental Res, Mumbai	10
13	Krupanidhi SB	Indian Inst Sci, Bangalore	10
14	Kumar R	Ctr Nucl Sci, Div Mat Sci, New Delhi	10
15	Pai SP	Tata Inst Fundamental Res, Mumbai	10
16	Vispute RD	Univ Pune, Pune	10
17	Hussain OM	Sri Venkateswara Univ, Tirupati	9
18	Patil SI	Univ Pune, Pune	9
19	Satyalakshmi KM	Indian Inst Sci, Bangalore	9
20	Adhi KP	Univ Pune, Pune	8
21	Malik SK	Tata Inst Fundamental Res, Mumbai	8
22	Prasad V	Indian Inst Sci, Bangalore	8
23	Subramanyam SV	Indian Inst Sci, Bangalore	8
24	Godbole VP	Univ Pune, Pune	7
25	Karunakaran B	Bharathiar Univ, Coimbatore	7
26	Lekshmi IC	Indian Inst Sci, Bangalore	7
27	Mangalaraj D	Bharathiar Univ, Coimbatore	7
28	Narayandass SK	Bharathiar Univ, Coimbatore	7
29	Ramachandra Rao MS	Indian Inst Technol Madras, Chennai	7
30	Ramamoorthy K	Alagappa Univ, Karaikudi	7
31	Sankaranarayanan K	Alagappa Univ, Karaikudi	7
32	Sharon M	Birla College, Kalyan	7
33	Bhattacharya P	Raja Ramanna Ctr Adv Technol, Indore	6
34	Budhani RC	Indian Inst Technol Kanpur, Kanpur	6
35	Gupta LC	Tata Inst Fundamental Res, Mumbai	6
36	Gupta V	Univ Delhi, Delhi	6
37	Koinkar VN	Univ Pune, Pune	6
38	Kumar RTR	Bharathiar Univ, Coimbatore	6
39	Ramana CV	Sri Venkateswara Univ, Tirupati	6
40	Raychaudhuri P	Tata Inst Fundamental Res, Mumbai	6
41	Vasanthacharya NY	Indian Inst Sci, Bangalore	6
42	Venimadhav A	Indian Inst Sci, Bangalore	6
43	Venkatesan T	Univ Pune, Pune	6
44	Vitta S	Indian Inst Technol Bomaby, Mumbai	6
45	Choudhary RJ	Univ Pune, Pune	5
46	Date SK	Univ Pune, Pune	5
47	Ganguli T	Raja Ramanna Ctr Adv Technol, Indore	5
48	Gayen A	Indian Inst Sci, Bangalore	5
49	James AR	Solid State Phys Lab, Delhi	5
50	Jayachandran M	Cent Electrochem Res Inst, Karaikkudi	5
51	Kshirsagar ST	Natl Chem Lab, Pune	5
52	Kundaliya DC	Tata Inst Fundamental Res, Mumbai	5
53	Manoharan SS	Indian Inst Sci, Bangalore	5
54	Prakash C	Solid State Phys Lab, Delhi	5
55	Purandare SC	Tata Inst Fundamental Res, Mumbai	5
56	Sanjeeviraja C	Alagappa Univ, Karaikudi	5

Table 6 — Journals publishing articles (more than 50) in PLD research

Sl. No.	Journal	Country	IF 2005	# Publications
1	<i>Applied Physics Letters</i>	USA	4.127	962
2	<i>Journal of Applied Physics</i>	USA	2.498	714
3	<i>Applied Surface Science</i>	Netherlands	1.263	614
4	<i>Thin Solid Films</i>	Switzerland	1.569	541
5	<i>Physica C</i>	Netherlands	0.948	432
6	<i>Applied Physics A</i>	USA	1.990	320
7	<i>Japanese Journal of Applied Physics I</i>	Japan	NA	269
8	<i>Physical Review B</i>	USA	3.185	196
9	<i>Journal of Crystal Growth</i>	Netherlands	1.681	193
10	<i>IEEE Transactions on Applied Superconductivity</i>	USA	1.071	177
11	<i>Superconductor Science &amp; Technology</i>	England	1.896	177
12	<i>Integrated Ferroelectrics</i>	England	0.345	161
13	<i>Journal of Materials Research</i>	USA	2.104	155
14	<i>Journal of Vacuum Science &amp; Technology A</i>	USA	1.399	137
15	<i>Surface &amp; Coatings Technology</i>	Switzerland	1.646	135
16	<i>Materials Science And Engineering B</i>	Switzerland	NA	127
17	<i>Journal of The Korean Physical Society</i>	South Korea	0.828	122
18	<i>Diamond And Related Materials</i>	Switzerland	1.988	113
19	<i>Japanese Journal of Applied Physics II</i>	Japan	NA	112
20	<i>Journal of Magnetism and Magnetic Materials</i>	Netherlands	0.985	104
21	<i>Ferroelectrics</i>	England	0.459	96
22	<i>Solid State Communications</i>	England	1.489	94
23	<i>Journal of Physics D</i>	England	1.957	90
24	<i>Materials Letters</i>	Netherlands	1.299	67
25	<i>Journal of Physics Condensed Matter</i>	England	2.145	64
26	<i>Nuclear Instruments &amp; Methods in Physics Research B</i>	Netherlands	NA	56
27	<i>IEEE Transactions on Magnetics</i>	USA	1.014	53
28	<i>Journal of The Electrochemical Society</i>	USA	2.190	53
29	<i>Materials Science Forum</i>	Switzerland	0.399	52

(NA: Not Available)

than fifty percent of the total publications indicates that these countries have received tremendous official support for the research in this field. Collaboration trend is towards multi authored papers. Chinese Academy of Sciences (Peoples R China) topped the list with 304 publications followed by Nanjing University (Peoples

R China) with 244 publications, Tokyo Institute of Technology (Japan) with 233 publications and CNRS (France) with 217 publications. India ranked 9<sup>th</sup> among other countries with 291 publications during 1985-2006. The most productive Indian institutions were: Tata Institute of Fundamental Research, Mumbai with 52



Table 7 — Country-wise distribution of journals publishing articles in PLD research

Journal publishing country	Number of journals	Percentage	Number of publications	Percentage
USA	102	31.29	3300	38.67
England	83	25.46	1257	14.73
Netherlands	46	14.11	1854	21.72
Switzerland	22	6.75	1176	13.78
Germany	21	6.44	129	1.51
France	10	3.07	64	0.75
Japan	10	3.07	427	5.00
Peoples R China	9	2.76	51	0.60
Russia	4	1.23	6	0.07
South Korea	4	1.23	131	1.54
Singapore	3	0.92	76	0.89
Austria	2	0.61	4	0.05
India	2	0.61	9	0.11
Poland	2	0.61	13	0.15
Canada	1	0.31	1	0.01
Czech-Republic	1	0.31	17	0.20
Italy	1	0.31	4	0.05
Mexico	1	0.31	6	0.07
Romania	1	0.31	1	0.01
Taiwan	1	0.31	8	0.09
Total	326	100	8534	100

publications and Indian Institute of Science, Bangalore with 49 publications. More than 92 percent of the publications were published in the journals with impact factors which is suggestive of the publications behaviour of scientists who preferred to publish their papers in highly reputed journals. Citation analysis of these papers may give interesting insights into the dynamics of this field.

## References

- Gardiner D J and Graves P R, *Practical pulsed laser deposition*, (Springer Verlag), 1989.
- Chrisey D B and Hubler G K, *Pulsed laser deposition of thin films*, (John Wiley), 1994.
- Dijkkamp D, Venkatesan T, Wu X D, Shaheen S A, Jisrawi N, Lee Y H Min, McLeal W L and Croft M, Preparation of Y Ba Cu oxide superconductor thin films using pulsed laser from high Tc bulk material, *Applied Physics Letters*, 51 (1998) 619-621.
- Zhang Y, Gu H and Lijima S, Single wall carbon nanotubes synthesized by laser ablation in a nitrogen atmosphere, *Applied Physics Letters*, 73(26) (1998) 3827-3829.
- Geohegan D B, Poretzky A A and Reader D J, Gas phase nanoparticle formation and transport during pulsed laser deposition of Y1Ba2Cu3O7, *Applied Physics Letters*, 74(25) (1999) 3788-3790.
- Goodwin T J, Leppert V J, Risbud S H, Kennedy I M and Lee H W H, Synthesis of gallium nitride quantum dots through reactive laser ablation, *Applied Physics Letters*, 70(23) (1997) 3122-3124.
- Chidambaram R, Measures of progress in science and technology, *Current Science*, 88(6) (2005) 856-860.
- Garg K C and Padhi P, Scientometrics of institutional productivity of laser science and technology, *Scientometrics*, 46 (1999) 19-38.
- Garg K C and Padhi P, Scientometric study of laser patent literature, *Scientometrics*, 43 (1998) 443-454.
- Garg K C and Padhi P, A study of collaboration in laser science and technology, *Scientometrics*, 51 (2001) 415-427.
- Garg K C, Inventing and patenting on lasers- An overview, *Journal of Intellectual Property Rights*, 6 (2001) 134-137.
- Garg K C and Padhi P, Scientometrics of laser research in India during 1970-1994, *Scientometrics*, 55 (2002) 215-241.
- Garg K C, Scientometrics of laser research in India and China, *Scientometrics*, 55 (2002) 71-85.
- Lawson J, Kostrewiski B and Oppenheim C, A bibliometric study on a new subject: Energy analysis, *Scientometrics*, 2(3) (1980) 227-237.
- Verma R K, Sharma Y K and Khatri H S D, Trends in nuclear research and its publications: An analysis based on five years coverage in the Indian Science Abstracts, *Annals of Library Science and Documentation*, 29(2) (1982) 64-69.
- Hall D H, The interface between geoscience and industry: A case study of the interaction between research and discovery and mining of areas for nuclear fuels, *Scientometrics*, 11(34) (1987) 199-216.
- Trofimenko P, Scientometric analysis of the development of nuclear physics during the last 50 years, *Scientometrics*, 11(34) (1987) 231-250.
- Czerwon H J, Scientometric indicators for a specialty in theoretical high energy physics: Monte Carlo methods in lattice field theory, *Scientometrics*, 18(12) (1990) 5-20.

19. Mavguin P, Using a contracts database for evaluating the dynamics of a technological program: the case of the European 'non nuclear' energy program, *Scientometrics*, 22(1) (1991) 207-228.
20. Hall D H, The Science industry interface: Correlation time series of indicators and their spectra and growth models in the nuclear fields industry, *Scientometrics*, 24(2) (1992) 237-280.
21. Kademani B S, Vijai Kumar, Anil Sagar and Anil Kumar, Scientometric dimensions of nuclear science and technology research in India: A study based on INIS 1970-2002 database, *Malaysian Journal of Library and Information Science*, 11(1) (2006) 23-48.
22. Kademani B S, Vijai Kumar, Anil Sagar, Anil Kumar, Lalit Mohan and Ganesh Surwase, Scientometric dimensions of thorium research in India, *DESIDOC Bulletin of Information Technology*, 26(3) (2006) 9-25.
23. Kademani B S, Ganesh Surwase, Anil Sagar and Vijai Kumar, Mapping of literature on Bose Einstein Condensation, *Malaysian Journal of Library and Information Science*, 11(2) (2006) 87-104.
24. Kademani B S, Vijai Kumar, Anil Sagar and Anil Kumar, World literature on thorium: A study based on Science Citation Index, *Scientometrics*, 69(2) 2006; 347-364.
25. Kademani B S, Anil Kumar and Vijai Kumar, Analytical chemistry in nuclear science and technology. In: Proceedings of the *DAE-BRNS Symposium on Role of Analytical Chemistry in Nuclear Technology*. 2007. Mumbai (India). 135-148.
26. Anil Kumar, Kademani B S, Vijai Kumar, Ganesh Surwase and Lalit Mohan, Electrochemistry research in India: A scientometric view. In: Proceedings of the *International Conference on Electroanalytical Chemistry and Allied Topics*. 2007. Shimla (India). 1-21.
27. Anil Sagar, Kademani B S and Vijai Kumar, Scientometric mapping of mass spectrometry research in nuclear science and technology. In: Proceedings of the *12<sup>th</sup> ISMAS Symposium cum Workshop on Mass Spectrometry*. 2007. Goa (India). 1-16.
28. Kademani B S, Anil Sagar, Anil Kumar And Vijai Kumar, Scientometric mapping of vacuum research in nuclear science and technology: A global perspective. In: Proceedings of the *International Symposium on Vacuum Science and Technology*. 2007. TIFR, Mumbai (India).
29. Kademani B S, Anil Kumar, Anil Sagar, Ganesh Surwase and Vijai Kumar, Web-resources in nuclear science and technology, *Malaysian Journal of Library and Information Science*, 12(2) (2007) 1-12.