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## Publication study of Liquid crystals in International Perspective: a Scientometric Approach

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## **Publication study of Liquid crystals in international Perspective: a Scientometric Approach**

### **Abstract:**

The purpose of this paper is to identify the worldwide scientific publications of Liquid Crystal's research and a significant rising thrust area that has huge potential to improve information understanding, organization, decision making and administration. This study retrieved scholarly communications published during 1999-2019, which are available on the Web of Science. The scientometric analysis performed from global output characteristics, institutional, core journals, continental, countries/territories and topical aspects. International publications' features identified that Liquid crystal research has improved stage and colossal participation and collaboration. The vast research papers were published in 2018. This is the first study to evaluate global literature output trends in Liquid crystals, which might provide a potential guide for future research. These indicators lead Liquid crystals to formulate policy, setting priorities, and undertake strategic planning, monitoring, and evaluation.

### **Introduction:**

Liquid crystals (LCs) are a state of matter that has properties between those of conventional liquids and those of solid crystals. For instance, a liquid crystal may flow like a liquid, but its **molecules** may be oriented in a crystal-like way. There are many different types of liquid-crystal **phases**, which can be distinguished by their other **optical** properties (such as **textures**). The contrasting areas in the textures correspond to domains where the liquid crystal molecules are oriented in different directions. Within a domain, however, the molecules are well ordered. LC materials may not always be in a liquid-crystal state of matter (just as water may turn into ice or water vapour).

### **Review of related literature**

**Amsaveni and Hari Krishnan:** Scientometric analysis of Environmental Management research output (1989–2014) was conducted. The study examined Environmental Management's growth and found 61877 research papers were published in 2014, I.e. more research papers are published.

**Mahapatra (1994)** conducted the Relative Growth Rate (RGR) and Doubling time (Dt) for publications and citations which appeared in Indian library and information science journals during 1975 -1985 were determined. The reducing trend of RGR and increasing rate for doubling time in double-publications and citations indicates that the growth is neither exponential nor linear. The size of the literature calculated by applying logistic growth formula, intellectual and environmental conditions. With the increase of the number of publications, the number of citations will also increase.

**Gavisiddappa and Latha Achha (2018)** explored the research trend and productivity in the Mechatronics field. They analyze the study based on year-wise growth, Relative Growth, Rate Authors, Most Productivity Journals, Most Productivity and Doubling time, form-wise, Language wise and country-wise distribution of research data.

**Verma, Manoj Kumar and Ravi Shukla (2019):**

The scientometric analysis is done in different parameters such as year wise distributions of publications, annual growth rate, relative growth rate and doubling time, most productive authors, geographical distributions and found that the maximum of 1234 (12.99 %) are published in 2016, 25.679 per cent annual growth rate was recorded in the year 2010. The maximum 10.212 per cent CAGR recorded in 2009. The maximum RGR 0.795 and Dt. 5.824 are recorded in 2009 and 2017, respectively

**Objectives:**

The main aim of the objectives of the study are:

- To measure the year-wise distribution of Publication in liquid crystal.
- To identify the relative growth rate and doubling time of liquid crystal publication.
- To examine the document wise distribution of Publication.
- To find out the subject wise distribution publication.
- To trace the Country Wise Distribution of Publications.
- To investigate the most productivity of authors.

## Scope and limitation of the study

The present study covers articles, proceedings paper, Book chapters, Reviews of Liquid crystals in global Prospectives indexed in the Scopus database during the year 2009-2019.

## Methodology

The present study analyzes the research output of the researchers in the field of Liquid crystal. The required data were collected from the Web of Science (WoS) database for 2009 to 2019. 63586 records are compiled and analyzed data to satisfy the objectives of the study. The growth of publications and citations was analyzed using two parameters, i.e., Relative Growth Rate and Doubling Time. The Relative Growth Rate and Doubling Time of both publications

## Analysis and interpretation of data

The following data were analyzed according to the objective of the study.

### Table-1: Year-wise distribution of Publication.

Table 1 depicts the Year-wise distribution of Publication on liquid crystal article published from 2009 to 2019 in the Web of Science database. The study observed that out of a total of 63586 publications, 6254 (9.84%) is the highest number of Publication published in the year 2017, followed by 6199 (9.75%) publication with 2018 and the overall year-wise distribution of publication data shown in as Table 1.

Publication Years	Records count/No of publications	Cumulative No of Publication	% of 63586
2009	5279	5279	8.3
2010	5381	10660	8.46
2011	5663	16323	8.91
2012	5618	21941	8.83
2013	5452	27393	8.57

2014	5641	33034	8.87
2015	5943	38977	9.35
2016	6060	45037	9.53
2017	6254	51291	9.84
2018	6199	57490	9.75
2019	6096	63586	9.59
Total	63586	371011	100

**Table-2: Annual Growth Rate of Publications**

Table 2 shows the annual growth rate of Publication on 'Liquid crystal' (2009-2019). The annual growth rate (AGR) are calculated on the formula given by (Kumar and Kaliyaperumal, 2015) and

$$\text{AGR} = \frac{\text{End value} - \text{First value}}{\text{First value}} * 100$$

Publication Year	No of Publication	RGR
2009	5279	
2010	5381	1.93
2011	5663	5.24
2012	5618	-0.79
2013	5452	-2.95
2014	5641	3.46
2015	5943	5.35
2016	6060	1.96
2017	6254	3.2
2018	6199	-0.87
2019	6096	-1.66

Total	63586
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**RGR= Relative growth rate**

**Table-3: Relative Growth Rate and Doublin time of Liquid crystal publication**

Table-3 indicates the relative growth rate (RGR) and the Doubling Time (Dt) of the published literature in the Liquid crystal. It suggests that RGR decreases from the rate of 0.70 in 2009 to 0.10. in the year 2009 to 2019. The overall mean relative growth rate of 1.82. is observed that the Doubling Time of publications increased from 0.99 to 6.93 from the year 2009 to 2019.

Publication Years	Records count/No of publications	Cumulative No of Publication	W1	W2	R(a) (W1-W2)	Dt. (0.693/R(a))
2009	5279	5279		8.57	--	
2010	5381	10660	8.57	9.27	0.7	0.99
2011	5663	16323	9.27	9.7	0.43	1.61
2012	5618	21941	9.7	9.99	0.29	2.39
2013	5452	27393	9.99	10.22	0.23	3.01
2014	5641	33034	10.22	10.41	0.19	3.65
2015	5943	38977	10.41	10.57	0.16	4.33
2016	6060	45037	10.57	10.72	0.15	4.62
2017	6254	51291	10.72	10.84	0.12	5.77
2018	6199	57490	10.84	10.96	0.12	5.77
2019	6096	63586	10.96	11.06	0.1	6.93
Total	63586	371011	11.06	12.88	1.82	0.38

**Table -4: Document wise distribution of Publication**

Table 4 illustrates the document wise distribution of publications on 'Liquid crystal' during 11 years, i.e. (2009-2019). The maximum 54492 (85.69 %) of publications were 'Articles', followed by 'Proceedings Paper' with 8821 (13.87 %) of publications and 2280 (3.58 %) of Publication was 'Reviews'. The whole data of document wise distribution of Publication is as shown in Table 4.

SI No	Document wise	Publications	% of 63586
1	Articles	54492	85.69
2	Proceedings paper	8821	13.87
3	Reviews	2280	3.58
4	Book chapters	129	0.20
5	Early access	51	0.08
6	Retracted publications	6	0.009
7	Editorial material	3	0.005
8	Data paper	2	0.003

**Table-5: Top 10 country-wise distribution of Publication in Liquid Crystal.**

Table 5 depicts the country-wise distribution of publications on 'Liquid crystal'. The maximum 13938 (21.92%) publication were contributed by the Peoples R China, followed by the United States with 11473 (18.043) contribution and 6705 (10.54%) publication contributed by Japan. Germany and India contributed 5452(8.57%) and 3929 (6.17%) publications respectively.

SL NO	Country	Publications	% of 63,586
1	Peoples r China	13938	21.92
2	USA	11473	18.04
3	Japan	6705	10.54
4	Germany	5452	8.57
5	India	3929	6.17
6	South korea	3657	5.75
7	England	3517	5.53
8	France	3472	5.46
9	Russia	2996	4.71
10	Taiwan	2664	4.19

**Table 6: Top 10 Indian institutions contributions.**

Table 6 shows the Top 10 Indian institutions contributions. A maximum of 609(15.50%) publication are contributed by the Department of science and technology India, followed by the IIT system with 504 (12.82%) contribution and 379 (9.64%) publication contributed to CSIR India, respectively.

Sl No	Organization	Publications	% of 3929
1	Department of Science Technology India	609	15.50
2	Indian Institute of Technology system IIT system	504	12.82
3	Council of Scientific Industrial Research CSIR India	379	9.64
4	Centre for Nano and Soft Matter Sciences	236	6.00
5	Raman Research Institute	231	5.87
6	Indian Institute of Science IISc Bangalore	168	4.276
7	Banaras Hindu University	147	3.741
8	Military University of Technology in Warsaw	142	3.614
9	Lucknow University	129	3.283
10	University of Hyderabad	127	3.232

**Table-7: Subjects wise distribution of literature in Liquid Crystal in India**

Sl NO	Web of Science Categories	Publications	% of 3122
1	Materials science multidisciplinary	1386	35.276
2	Chemistry multidisciplinary	1265	32.196
3	Crystallography	948	24.128
4	Chemistry physical	728	18.529
5	Physics Applied	494	12.573
6	Physics Condensed Matter	410	10.435
7	Physics Atomic Molecular Chemical	301	7.661
8	Optics	207	5.269
9	Physics Multidisciplinary	185	4.709
10	Nanoscience Nanotechnology	176	4.480
11	Engineering Electrical Electronic	162	4.123
12	Physics Mathematical	118	3.003
13	Physics Fluids Plasmas	115	2.927



14	Polymer Science	108	2.749
15	Chemistry Inorganic Nuclear	100	2.545
16	Thermodynamics	80	2.036
17	Chemistry Analytical	77	1.960
18	Chemistry Organic	77	1.960
19	Engineering Chemical	65	1.654
20	Metallurgy Metallurgical Engineering	52	1.323
21	Spectroscopy	51	1.298
22	Engineering Mechanical	50	1.273
23	Multidisciplinary Sciences	44	1.120
24	Telecommunications	42	1.069
25	Instruments Instrumentation	40	1.018
26	Mechanics	37	0.942
27	Pharmacology Pharmacy	37	0.942
28	Energy Fuels	33	0.840
29	Biochemistry Molecular Biology	32	0.814
30	Materials Science Ceramics	28	0.713
31	Chemistry Applied	24	0.611
32	Computer Science Interdisciplinary Applications	24	0.611
33	Materials Science Coatings Films	24	0.611
34	Electrochemistry	23	0.585
35	Biochemical Research Methods	21	0.534
36	Environmental Sciences	21	0.534
37	Green Sustainable Science Technology	20	0.509
38	Biophysics	18	0.458
39	Computer Science Theory Methods	18	0.458
40	Chemistry Medicinal	14	0.356
41	Biotechnology Applied Microbiology	12	0.305
42	Engineering Environmental	12	0.305
43	Engineering Multidisciplinary	12	0.305
44	Food Science Technology	12	0.305
45	Computer Science Artificial Intelligence	11	0.280
46	Computer Science Information Systems	11	0.280
47	Automation Control Systems	10	0.255
48	Geochemistry Geophysics	9	0.229
49	Geosciences Multidisciplinary	9	0.229
50	Materials Science Biomaterials	9	0.229
51	Computer Science Hardware Architecture	8	0.204
52	Imaging Science Photographic Technology	8	0.204
53	Microbiology	8	0.204
54	Materials Science Textiles	7	0.178

55	Mathematics Applied	7	0.178
56	Mineralogy	7	0.178
57	Nuclear Science Technology	7	0.178
58	Mathematics Interdisciplinary Applications	6	0.153
59	Medicine Research Experimental	6	0.153
60	Physics Nuclear	6	0.153
61	Water Resources	6	0.153
62	Education Scientific Disciplines	5	0.127
63	Engineering Petroleum	5	0.127
64	Materials Science Characterization Testing	5	0.127
65	Meteorology Atmospheric Sciences	5	0.127
66	Plant Sciences	5	0.127
67	Astronomy Astrophysics	4	0.102
68	Immunology	4	0.102
69	Microscopy	4	0.102
70	Acoustics	3	0.076
71	Engineering Aerospace	3	0.076
72	Infectious Diseases	3	0.076
73	Materials Science Composites	3	0.076
74	Physics Particles Fields	3	0.076
75	Toxicology	3	0.076
76	Cell Biology	2	0.051
77	Computer Science Software Engineering	2	0.051
78	Engineering Biomedical	2	0.051
79	Engineering Manufacturing	2	0.051
80	Mathematics	2	0.051
81	Mining Mineral Processing	2	0.051
82	Operations Research Management Science	2	0.051
83	Physiology	2	0.051
84	Quantum Science Technology	2	0.051
85	Agricultural Engineering	1	0.025
86	Agriculture Multidisciplinary	1	0.025
87	Agronomy	1	0.025
88	Computer Science Cybernetics	1	0.025
89	Dermatology	1	0.025
90	Ecology	1	0.025
91	Education Educational Research	1	0.025
92	Engineering Geological	1	0.025
93	Engineering Industrial	1	0.025
94	Geology	1	0.025
95	Information Science Library Science	1	0.025

96	Marine Freshwater Biology	1	0.025
97	Nutrition Dietetics	1	0.025
98	Oncology	1	0.025
99	Ophthalmology	1	0.025
100	Public Environmental Occupational Health	1	0.025
101	Radiology Nuclear Medicine Medical Imaging	1	0.025
102	Remote Sensing	1	0.025
103	Robotics	1	0.025
104	Statistics Probability	1	0.025
105	Urology Nephrology	1	0.025

**Table 8: Contribution of articles by authors Top 10 authors in India or Author Productivity**

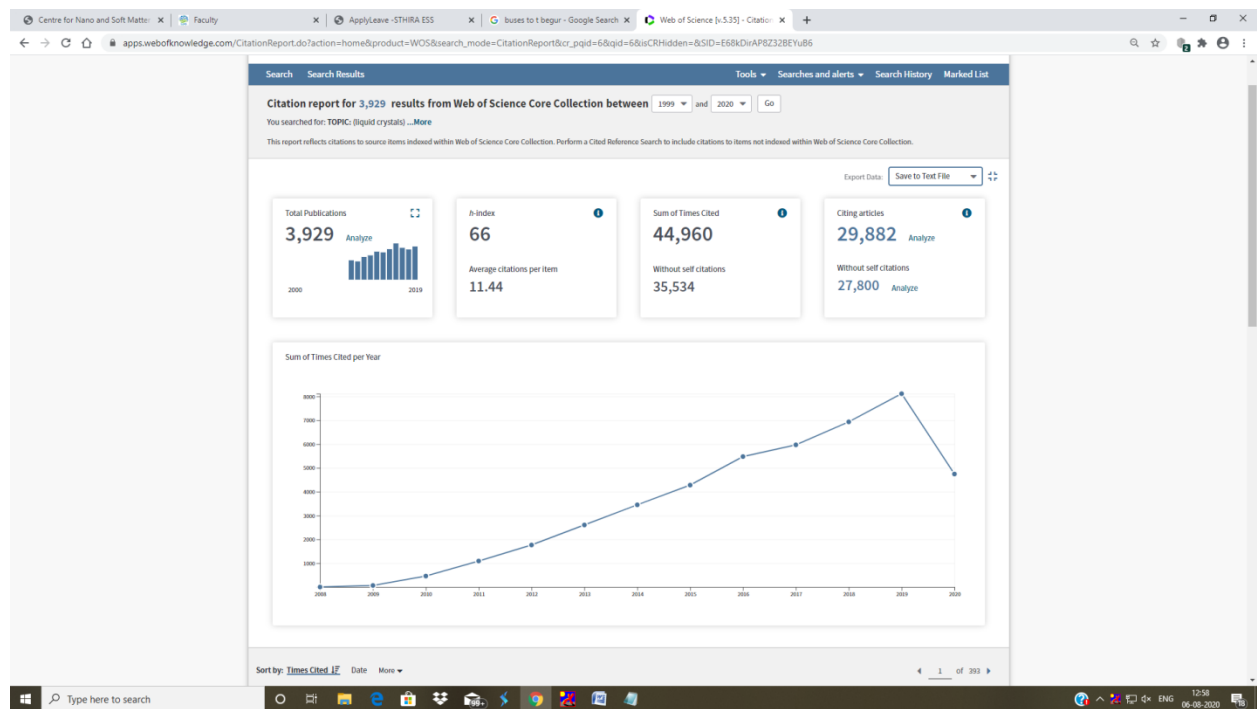
Table 8 shows the top 10 most productive authors the maximum 154 (3.92%) of publications are contributed by Kumar, S, followed by Prasad S K with 121 (3.08%) publication, and Manohar R contributed 117(2.97%) publication during the period of study. Overall data of the top 10 most productive authors is as shown in Table 8.

<b>Authors</b>	<b>Publications</b>	<b>% of 3929</b>
Kumar S	154	3.920
Prasad Sk	121	3.080
Manohar R	117	2.978
Dabrowski R	115	2.927
Mohan Mlnm	88	2.240
Rao Dss	86	2.189
Raina Kk	85	2.163
Yelamaggad Cv	80	2.036
Dhar R	79	2.011
Biradar Am	76	1.934

## **CONCLUSION:**

A total of 63586 contributions on Liquid crystal literature analyzed from 2009 to 2019. Out of this, 6254 (9.84%) is the highest Publication found in 2017. The relative growth rate (RGR) and

the Doubling Time (Dt) indicate that RGR decreases from 0.70 in 2009 to 0.10. in the year 2009 to 2019. The overall mean relative growth rate of 1.82 and Doubling Time of publications increased from 0.99 to 6.93 from 2009 to 2019. The most productive authors were Kumar, S, with 154 (3.92%) contribution. The maximum 54492 (85.69 %) of publications were 'Articles', followed by 'Proceedings Paper' with 8821 (13.87 %) of publications. China has contributed the maximum number of research papers with 13938 (21.92%) publication; the next significant contribution belongs to the United States with 11473 (18.043) contribution and 6705 (10.54%) publication contributed by Japan



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