

## Global Perspective of Research Productivity in Green Electronics: A Scientometric Analysis

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### Abstract

The paper presents a Scientometric analysis of publications of green electronics at global level during 1989 to 2014 as reflected web of science database. The study covers 7142 publications during the period. The study focused on author productivity, most used journals, sources, country, language etc.. It is found from the analysis that 92.31% of the articles were produced by multiple authors. It is found that the multi-author distribution is the most elevated contrast with single-author distribution. “Cederbaum LS” published highest number of articles for the study period. 91 percent of collaboration authors articles published during the study periods. Chinese Academy of Sciences had contributed the highest number of research publications. The USA country has the highest productivity and highest local and global citation scores measured. Physical Review B has emerged as the most preferred journal by authors for publication.

**Keywords:** Green Electronics, Scientometrics, Institution, Author Productivity, Degree of Collaboration, Research Publications, Relative Growth Rate, Doubling Time.

### 1. Introduction

The idea of “**green electronics**” in part refers to the materials used in the production of computers, cell phones, televisions and dozens of other electric devices. ... While it may be cheaper to use more toxic materials when building devices, **electronics** manufacturers are being urged to invest in eco-friendlier materials. Green electronics represents not only a novel scientific term but also an emerging area of research aimed at identifying compounds of natural origin and establishing economically efficient routes for the production of synthetic materials that have applicability in environmentally safe (biodegradable) and/or biocompatible devices.

Scientometrics is an important role of Information Science. Scientometrics are used in studies of properties and behaviour of recorded knowledge, analysis of subjects and evaluation of research activity. It is also used to give policy making inputs on research to the nations and organizations. The present study aims at analyzing the scientometric study in green electronic research based on web of science database. The major focus of the study is to apply the scientometric analysis with a view to analysed the evaluation and performance of research output in green electronic. This study also to analyses the performance and evaluation of green electronic research output in terms of its content and coverage, the prolific authors in green electronic, authorship pattern, single author vs. multi authors and degree of collaboration, source wise research output, Individual journal wise research

output, Institution wise research output, country wise research output, word frequency and language wise research output.

## 2. Review of Related Studies

**Avadesh Kumar Patel et al (2021)** presented to access the goal research trends in financial study. The various scientometric indicators have been applied in this study, such as year-wise growth pattern with Citation, Annual Growth Rate(AGR), Relative Growth Rate(RGR), Authorship pattern, degree of collaboration, correlation coefficient, most prolific authors, highly cited documents, most collaborative institutes etc. The study comprises a review of 2000 research documents published with 22229 citations from 2001 to 2020. The most productive year during the study was 2019. It is apparent that Lusardi, A. was the most prolific authors, with 33 publications. The most cited documents as financial literacy's Economic importance: Theory and evidence published in 2014. The leading institution in financial literacy was the University of Pennsylvania, with 25 publications. The top source was the journal of consumer affairs from the USA. The funding agency was the National Institute of Aging funding to 21 publications. The top subjects were economics, econometrics and finance. The present study revealed that there a continuous increase in financial literacy research productivity during the study period. **Vijaya kumar, R, Palaniappan, M and Thangamani, T (2021)** examined astronomy research performance from 2010 to 2019. The results are study based on the objectives of the Astronomy research. Scientometric analysis of collected data has been downloaded from the Web of Science database, a total of 6905 bibliography records. The highest number of publications 861 (12.47%) in the year 2018, it is found the degree of collaboration in astronomy ranges from 0.66 to 0.78 during the period from 2010 to 2019. The maximum annual growth rate of 0.14 was found during 2011 with 582 publications. In the mean of a degree of collaboration were  $C = \text{degree of collaboration}$  0.71. Average citations per paper and h-index it reveals that Katz U with 38 articles the most productive author contributing the USA is the world's major contribution in the field of astronomy research has contributed 2554 (36.99%) with first rank. **Priti Kumari and Rajeev Kumar (2020)** reported Computer Science articles in journals and conferences have been a topic of research. The study adopted a different approach; metrics based on authors and their affiliations and study the patterns of different publications. Authors considered publication of data of key CS journals and conferences in three sub-fields of past five years, during which that publication pattern have been stabilized and also calculate distinct institutions, occurrences of repeated authors and also examine overlap of authors and institutions in consecutive years. Thus, we show diversity of CS publications in terms of authors and institutions. It observed that in conferences 60-80% authors have participated from repeating institutions while this range is 40-60% for journals. Further, the maximum repeating frequency of authors is 28% in conferences, while it is 15% in journals. Moreover, cross comparison of conferences and journals in same sub-field indicates the mutual exclusiveness of these mediums.

## 3. Objectives of the Study

The present study was undertaken with the following objectives

1. To examine the relative growth rate and doubling time of the publications
2. To examine the scientific authors for Green Electronics research
3. To find authorship pattern for Green Electronics research

4. To identify the proportion of single and multi-author papers and degree of collaboration
5. To examine the effectiveness of various sources of research publications in Green Electronics research
6. To prepare a ranking list of core journals
7. To find the Institution wise research publications in Green Electronics research
8. To examine the Country wise research publications
9. To identify the word wise distribution of publications and test the Zipf's Law
10. To identify the language wise research publications in Green Electronic research

### **3.1 Methodology**

The Green Electronic research literature retrieved from web of science database from 1989-2014. Overall data retrieved by the researcher are 7142 records by analyzing the present study. The data has analyzed and classified into HistCite software. The Scientometric indicators are mainly proposed to recognize, compare and assessment appropriate research in more objectives. To evaluate publications and citation efficiency the study used scientometric tools.

## **4. Data Analysis and Interpretation**

### **4.1 Year Wise Distribution of Publications**

As indicated in the table- 1, authors contributed as many as 7142 publications during 1989-2014 in different scholarly journals. The highest number of research output 731(10.24%) was produced in the year 2014 followed by 660(9.24%) was produced in the year 2013.

**Table 1 shows year wise distribution of publications**

<b>S. No</b>	<b>Year</b>	<b>Records</b>	<b>%</b>	<b>TLCS</b>	<b>TGCS</b>
1	1989	4	0.06	22	36
2	1990	15	0.21	12	175
3	1991	131	1.83	335	3550
4	1992	120	1.68	253	3064
5	1993	136	1.90	256	3232
6	1994	146	2.04	236	5268
7	1995	129	1.81	138	2753
8	1996	144	2.02	358	5246
9	1997	180	2.52	297	4405
10	1998	164	2.30	269	5764
11	1999	186	2.60	407	5304
12	2000	179	2.51	336	7329
13	2001	197	2.76	237	6378
14	2002	200	2.80	795	9686
15	2003	199	2.79	343	5612
16	2004	253	3.54	363	7034
17	2005	303	4.24	388	7755

18	2006	344	4.82	432	8941
19	2007	346	4.84	434	8874
20	2008	393	5.50	425	7743
21	2009	405	5.67	460	9321
22	2010	454	6.36	373	8000
23	2011	548	7.67	403	7031
24	2012	575	8.05	299	4728
25	2013	660	9.24	147	3205
26	2014	731	10.24	46	823
<b>TOTAL</b>		<b>7142</b>	<b>100</b>		

However there was a gradual growth of publications during 1989-2014. On considering the citation profile of green electronic researches it was observed 200 papers scored highest citation 9686 in the year 2002 followed by 405 papers scored next highest citation 9321 in the year of 2009.

**4.2 Relative Growth Rate and Doubling Time of Publications**

Table-2 presents data of relative growth rate and doubling time for total research output in Green Electronics. It could be noted that in 1989, 4 papers have been published and the number went up to 7142 by the end of the year 2014. It is seen that its relative growth rates have decreased gradually from 1.558 in 1990 to 0.108 in 2014. The mean relative growth rates for the periods 1989-2001 and 2002-2014 are 0.467 and 0.109 respectively. The whole study period record the mean relative growth rate of 0.288.

At the same time doubling time of publications of articles increased gradually from 0.445 to 6.417 over a period of twenty six years. Hence the mean doubling time of first block period is 2.844(1989-2001), where as it has increased to 6.373 in the second block period (2002-2014). The doubling time for publications reflects an increasing trend.

**Table 2 Relative Growth Rate and Doubling Time of Publications**

Year	No. of Output	Cum. No. of Output	Log <sub>e</sub> 1 <sup>P</sup>	Log <sub>e</sub> 2 <sup>P</sup>	R(a)=W <sub>2</sub> - W <sub>1</sub>	Mean R(a)	Dt= 0.693 ----- R(a)	Mean Dt (a)
1989	4	4	-	1.386	-		-	
1990	15	19	1.386	2.944	1.558		0.445	
1991	131	150	2.944	5.011	2.067		0.335	
1992	120	270	5.011	5.598	0.587		1.181	
1993	136	406	5.598	6.006	0.408		1.699	
1994	146	552	6.006	6.314	0.308		2.25	
1995	129	681	6.314	6.524	0.21		3.3	
1996	144	825	6.524	6.715	0.191		3.628	
1997	180	1005	6.715	6.913	0.198		3.5	
1998	164	1169	6.913	7.064	0.151		4.589	

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1999	186	1355	7.064	7.212	0.148	0.467	4.682	2.844
2000	179	1534	7.212	7.336	0.124		5.589	
2001	197	1731	7.336	7.456	0.12		5.775	
2002	200	1931	7.456	7.566	0.11	0.109	6.3	6.373
2003	199	2130	7.566	7.664	0.098		7.071	
2004	253	2383	7.664	7.776	0.112		6.1875	
2005	303	2686	7.776	7.896	0.12		5.775	
2006	344	3030	7.896	8.016	0.12		5.775	
2007	346	3376	8.016	8.124	0.108		6.417	
2008	393	3769	8.124	8.235	0.111		6.243	
2009	405	4174	8.235	8.337	0.102		6.794	
2010	454	4628	8.337	8.440	0.103		6.728	
2011	548	5176	8.440	8.552	0.112		6.188	
2012	575	5751	8.552	8.657	0.105		6.6	
2013	660	6411	8.657	8.766	0.109		6.358	
2014	731	7142	8.766	8.874	0.108		6.417	
<b>Total</b>	<b>7142</b>						<b>0.288</b>	

**4.3 Ranking of authors based on publications**

**Table 3 shows ranking of Authors**

S.No	Author	Records	TLCS	TGCS
1	Cederbaum LS	72	259	1965
2	Liu DS	57	113	309
3	Zeller R	53	201	1234
4	Dederichs PH	48	161	1244
5	Chen KQ	37	84	672
6	Deleuze MS	37	313	821
7	Zhao P	37	93	254
8	Ebert H	36	21	499
9	Johansson B	35	93	1121
1	Velasco VR	33	97	323
1	Wang J	33	45	2620
1	Sanvito S	31	20	844
1	Abrikosov IA	28	112	1105
1	Zhang Y	28	52	448
1	Zhong JX	28	52	184
1	Kudrnovsky J	27	103	739
1	Tamiaki H	26	37	372
1	Drchal V	24	98	563
1	Mertig I	24	35	492
2	Ruban AV	23	103	2532

Table- 3 indicates ranking of authors by number of publications up to top twenty authors are taken. Among the top twenty authors, the Author “Cederbaum LS” published highest number of articles for the study period with 72 publications, consecutive authors “Liu DS” are published next highest number of articles for the study period with 57 publications. “Wang J” having highest Global Citation Scores of 2620 with just 33 publications followed by “Ruban AV” is having Global Citation Score of 2532 with just 23 publications, while Zhong JX having lowest Global Citation Score of 184 with 28 publications.

**4.4 Authorship Pattern of Publications**

**Table 4 Shows Authorship Pattern**

S. No	Year	Single	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten and Above
1	1989			1	2			1	-		-
2	1990	2	7	2	1	1		1	1		-
3	1991	20	44	31	21	5	6	1	2	1	-
4	1992	15	39	33	21	5	4	2	-	1	-
5	1993	12	49	33	17	11	9	2	1	2	-
6	1994	12	45	37	22	11	10	4	2	3	-
7	1995	14	35	35	24	10	5	5	-	-	1
8	1996	16	42	29	30	11	6	3	1	2	4
9	1997	27	48	41	28	12	14	4	4	1	1
10	1998	15	37	45	19	21	12	5	3	4	3
11	1999	21	33	47	31	22	13	8	7	1	3
12	2000	18	43	28	40	18	14	4	8	3	3
13	2001	20	35	43	44	28	12	6	4	3	2
14	2002	19	40	58	33	20	15	10	3	1	1
15	2003	20	45	50	35	17	19	3	3	4	3
16	2004	20	46	67	40	26	21	11	5	3	14
17	2005	21	63	65	58	34	23	15	11	4	9
18	2006	21	63	84	66	51	28	14	6	3	8
19	2007	24	68	63	58	44	41	24	9	7	8
20	2008	22	73	76	81	55	36	24	12	10	4
21	2009	31	65	86	72	58	38	21	18	6	10
22	2010	35	63	81	89	75	32	31	27	10	11
23	2011	34	88	116	92	83	62	35	18	7	13
24	2012	30	108	113	112	72	70	30	17	15	8
25	2013	37	125	124	126	98	66	39	19	8	18
26	2014	43	90	143	123	115	81	52	33	22	29
<b>Total</b>		<b>549 (7.69)</b>	<b>1394 (19.52)</b>	<b>1531 (21.44)</b>	<b>1285 (17.99)</b>	<b>903 (12.64)</b>	<b>637 (8.92)</b>	<b>355 (4.97)</b>	<b>214 (3.00)</b>	<b>121 (1.69)</b>	<b>153 (2.140)</b>

Table- 4 demonstrates the initiation example of exploration distribution on Green Electronics research yield. It very well may be noticed that two authors distributions contribute 19.52 %, trailed by three authors distributions that contribute 21.44 %, four-author publications 17.99%, single-author research yield with **7.69** %. From the outcome, we come to realize that the multi-author distribution is the most elevated contrast with single-author distribution.

#### 4.5 Single Vs Multiple-Authored Research Output and Degree of Collaboration

The table 5 shows that single vs. multiple authors research output, the highest number of single author research output of 43 in the year 2014 followed by 37 research output in the year 2013. As soon as the highest number of multiple authors research output of 688 publications in the year 2014 followed by 623 publications in the year of 2013. 7.69% of articles were produced by single authors and 92.31% of the articles were produced by multiple authors. It is a general trend that collaborate research is taking place in all the subject fields.

The author’s degree of collaboration is one of the yardsticks to measure the productivity of authors. It is defined as the number of multi author publications in the discipline published during the period of year as against the total number of papers. (Multi author and the single author) published during a year. Subramaniam’s formula for calculating in the degree of collaboration is followed. The single version multi-author research output during the period 1989–2014 is observed.

$$C = \frac{NM}{NM+NS}$$

Here, NM = Number of multiple authors

NS = Number of Single authors

Based on this study the degree of collaboration in the publications productivity of Green Electronics during the period of study is C = 0.91. i.e., 91 percent of collaboration authors articles published during the study periods.

**Table 5: Single Vs Multiple-Authored Research Output and Degree of Collaboration**

S.No	Year	Single Author		Multi Authors		Total	%	Degree of Collaboration	Mean in Degree of Collaboration
		No. of Output	%	No. of Output	%				
1	1989	-	0	4	<b>0.06</b>	4	0.06	1	0.90
2	1990	2	0.36	13	0.19	15	0.21	0.867	
3	1991	20	3.64	111	1.68	131	1.83	0.847	
4	1992	15	2.73	105	1.59	120	1.6	0.875	

							8		
5	1993	12	2.18	124	1.88	136	1.90	0.912	
6	1994	12	2.18	134	2.03	146	2.04	0.918	
7	1995	14	2.55	115	1.74	129	1.81	0.891	
8	1996	16	2.91	128	1.94	144	2.02	0.889	
9	1997	27	4.91	153	2.32	180	2.52	0.85	
10	1998	15	2.73	149	2.25	164	2.30	0.909	
11	1999	21	3.82	165	2.50	186	2.60	0.887	
12	2000	18	3.27	161	2.44	179	2.51	0.899	
13	2001	20	3.64	177	2.68	197	2.76	0.898	
14	2002	19	3.46	181	2.74	200	2.80	0.905	0.93
15	2003	20	3.64	179	2.71	199	2.79	0.899	
16	2004	20	3.64	233	3.53	253	3.54	0.921	
17	2005	21	3.82	282	4.27	303	4.24	0.931	
18	2006	21	3.82	323	4.89	344	4.82	0.939	
19	2007	24	4.37	322	4.88	346	4.84	0.931	
20	2008	22	4	371	5.62	393	5.50	0.944	
21	2009	31	5.64	374	5.67	405	5.67	0.923	
22	2010	35	6.37	419	6.35	454	6.36	0.921	
23	2011	34	6.19	514	7.79	548	7.67	0.938	
24	2012	30	5.46	545	8.26	575	8.05	0.948	
25	2013	37	6.73	623	9.44	660	9.24	0.944	



26	2014	43	7.83	688	10.43	731	10.24	0.941	
<b>TOTAL</b>		<b>549(7.69%)</b>	<b>100</b>	<b>6593(92.31%)</b>	<b>100</b>	<b>7142</b>	<b>100</b>		0.91

#### 4.6 Types of Publications

Table 6 presents the distribution of published literature according to type. Out of the 7142 published papers, 6184(86.59%) were journal articles with 116809 Global Citation Scores followed by 267(3.54%) review, 60(2.3%) proceedings papers and other publications followed by other forms. That the highest number of publications journal articles indicates that involved enough in various research activities to disseminate their research findings through scholarly journals.

**Table 6 shows document wise distribution of publications**

S.No	Document Type	Records	%	TLCS	TGCS
1	Article	6184	86.586	6621	116809
2	Article; Proceedings Paper	610	8.54102	519	5748
3	Review	267	3.73845	714	16626
4	Note	26	0.36404	102	488
5	Letter	19	0.26603	54	794
6	Editorial Material	11	0.15402	7	100
7	Meeting Abstract	10	0.14002	0	0
8	Review-Book Chapter	7	0.09801	44	672
9	Correction	4	0.05601	2	14
10	Article-Book Chapter	3	0.04201	1	7
11	Reprint	1	0.014	0	0
<b>Total</b>		<b>7142</b>	<b>100</b>		

#### 4.7 Journal wise distribution of publications

The most 20 Journals in Green Electronics research contributed from 42 to 870 publications during 1989-2014. The most productive journal of Physical Review B has 870 records with 27731 global citation scores followed by journal of Chemical Physics has 285 publications with 5998 global citation scores and journal of Physics-Condensed Matter has 174 publications with 2764 global citation scores.

**Table 7 shows journal wise distribution of publications**

S. No	Journal	Publications	TLCS	TGCS
	Physical Review B	870	1251	27731
	Journal of Chemical Physics	285	354	5998
	Journal of Physics-Condensed Matter	174	220	2764
	Journal of Applied Physics	156	59	5111

Journal of Physical Chemistry C	109	252	2255
Applied Physics Letters	108	18	3229
Journal of Physical Chemistry B	108	423	3768
Journal of Physical Chemistry A	107	282	2007
Surface Science	106	73	1838
Journal of The American Chemical Society	104	372	7845
Inorganic Chemistry	98	67	3494
Chemical Physics	79	424	2274
Solid State Communications	79	95	648
Physics Letters A	75	159	553
Physical Status Solidi B-Basic Solid State Physics	71	71	577
Physical B-Condensed Matter	68	28	312
Chemical Physics Letters	65	160	975
Physical Chemistry Chemical Physics	62	112	928
Physical Review Letters	62	136	3663
Physical E-Low-Dimensional Systems & Nanostructures	61	62	373

#### 4.8 Institution Wise Growth Rate:

The analysis of the table 8 given below indicates Institution wise research output. It is noted that Chinese Academy of Sciences had contributed the highest number of research publications 230 with 3346 global citation score and University of Heidelberg has contributed the second highest number of research publications 94 with 2366 global citation scores and Forschungszentrum Julich university has contributed the third highest number of research publications with records 88 stands third and others.

**Table 8 Institution wise distribution of publications**

S. No	Institution	Records	TLCS	TGCS
1	Chinese Academy of Science	230	207	3346
2	University of Heidelberg	94	328	2366
3	Forschungszentrum Julich	88	189	1777
4	Shandong University	87	125	503
5	University of Tokyo	79	56	1698
6	CSIC	78	250	3032
7	Nanjing University	77	107	1604
8	Osaka University	77	35	1111
9	Russian Academy of Science	76	113	1044
10	University Calif Berkeley	76	444	5436
11	Tech University Denmark	65	441	7409
12	CNRS	64	31	1456
13	Peking University	59	71	914

1	Uppsala University	59	79	1349
1	Hunan University	57	92	786
1	Polish Academy of Science	56	18	499
1	Jining University	53	113	306
1	University Science & Technology of China	53	19	610
1	University of Illinois	52	129	3736
2	CNR	50	34	721

#### 4.9 Country Wise Research Output of Green Electronic

Table 9 indicates Country wise research output of Green Electronic research covered by the study period. It is observed that the country wise analysis of the research output related to Green Electronic indicates the following results. The USA has the highest productivity and highest local and global citation scores measured and it stands first rank among countries. Peoples R China has 1383 output with 1127 Local citation and 16457 global citation scores measured.

**Table 9 shows Collaboration country wise distribution of publications**

S.No	Country	Records	TLCS	TGCS
1.	USA	1407	2202	47346
2.	Peoples R China	1383	1127	16457
3.	Germany	878	1248	18702
4.	Japan	610	537	10216
5.	India	401	251	3620
6.	France	330	445	7864
7.	UK	330	382	8671
8.	Italy	301	663	7797
9.	Spain	264	589	7450
10.	Russia	201	254	2722
11.	Canada	200	190	5103
12.	Brazil	188	73	2186
13.	Poland	177	103	2004
14.	Sweden	175	309	4178
15.	South Korea	172	135	2693
16.	Taiwan	137	59	1477
17.	Iran	134	87	495
18.	Australia	132	171	2176
19.	Netherlands	114	218	2807
20.	Belgium	108	333	2277

#### 4.10 keyword wise distribution of publications and Zipf's Law of Word Occurrences

The significant words are called “Keyword” are perhaps the best pointer to comprehend and get a handle on momentarily the idea substance of the papers, methodologies used and areas of research

addressed to the high frequency keywords were “Electronic” is topped with 1601 records with first rank of the frequency and the Global Citation Score of 25322. The next word follows as “Properties” with 995 records with second rank of the frequency and global citation score of 15252 as well as follows the publications.

It is identified from these analyses of TLCS, TGCS the “Electronic” has scored the highest Global Citation Score of 25322 followed by the “Green” that has scored the second highest Global Citation Score of 16531 respectively.

Zipf’s Law of Word Occurrences states that, "in a long textual matter if words are arranged in their decreasing order of frequency, then the rank of any given word of the text will be inversely proportional to the frequency of occurrence of the word"

$rf = c$  (where, c is constant) Taking log on both the sides,  $\text{Log}(f) + \log(r) = \log c$

To apply this law, the words (terms) were collected from the title of the articles and ranked according to their frequency of occurrence in decreasing order, applying this law, it was found that log of frequency of occurrence of words when added to log of their rank; the results are almost same for each word.

**Table 10 Shows keyword wise distribution of publications and Zipf’s Law of Word Occurrences**

S. No	Word	Record	TLCS	TGCS	Rank	Log F	Log R	Log C
1	Electronic	1601	2521	25322	1	7.38	0.00	7.38
2	Properties	995	725	15252	2	6.90	0.69	7.60
3	Green	870	2006	16531	3	6.77	1.10	7.87
4	Transport	774	854	12841	4	6.65	1.39	8.04
5	Structure	635	684	10868	5	6.45	1.61	8.06
6	Quantum	535	757	10933	6	6.28	1.79	8.07
7	Molecular	506	1078	11690	7	6.23	1.95	8.17
8	Synthesis	394	96	7219	8	5.98	2.08	8.06
9	Electron	384	674	8406	9	5.95	2.20	8.15
10	Effects	363	339	5446	10	5.89	2.30	8.20
11	Graphene	356	190	4881	11	5.87	2.40	8.27
12	Based	353	490	9341	12	5.87	2.48	8.35
13	Carbon	327	378	4807	13	5.79	2.56	8.35
14	Theory	310	355	5774	14	5.74	2.64	8.38
15	Effect	307	213	3338	15	5.73	2.71	8.43
16	Optical	305	240	4513	16	5.72	2.77	8.49
17	Complexes	293	211	6097	17	5.68	2.83	8.51
18	Function	289	1050	6491	18	5.67	2.89	8.56
19	States	284	389	3886	19	5.65	2.94	8.59
20	Light	273	320	9732	20	5.61	3.00	8.61

#### 4.11 Language wise distribution of publications

Table 11 shows that the maximum numbers of articles have been published in English Language with 6989 publications and received 140830 global citations, followed by Chinese 93 publications with 251 global citations, Russian 14 publications with 28 global citation and rest of the publications are published in other languages.

**Table 11 shows the language wise distribution of publications**

S.No	Language	Records	TLCS	TGCS
1	English	6989	8006	140830
2	Chinese	93	53	251
3	Russian	14	4	28
4	German	12	1	74
5	Spanish	10	0	32
6	Japanese	6	0	16
7	Ukrainian	5	0	2
8	Portuguese	4	0	1
9	French	3	0	18
10	Croatian	1	0	1
11	Czech	1	0	4
12	Hungarian	1	0	0
13	Rumanian	1	0	1
14	Slovak	1	0	0
15	Slovene	1	0	0

#### 5. Major Findings:

In the present study the research output on Green Electronic publication is taken as a tool to evaluate the performance at various levels

1. It is observed from this study the highest number of publications is 731 in 2014 with 46 local citation score and 823 global citation score, The least number of publications in the year 1989 with only 04 records and 22 local citation score and 36 global citation score.
2. It is seen that its relative growth rates have decreased gradually from 1.558 in 1990 to 0.108 in 2014. It is inferred from this analysis that relative growth rates have decreased gradually from 1.558 in 1990 to 0.108 in 2014. The relative growth rate of publications reflects an decreasing trend. At the same time doubling time doubling time of publications of articles increased gradually from 0.445 to 6.417 over a period of twenty six years. The doubling time for publications reflects an increasing trend.
3. To found the author “Cederbaum LS” published highest number of articles for the study period with 72 publications, consecutive authors “Liu DS” are published next highest number of articles for the study period with 57 publications. “Wang J” having highest Global Citation Scores of 2620 with just 33 publications followed by “Ruban AV” is having Global Citation Score of 2532 with just 23 publications, while Zhong JX having lowest Global Citation Score of 184 with 28 publications.

4. It is seen that two authors distributions contribute 19.52 %, trailed by three authors distributions that contribute 21.44 %, four-author publications 17.99%, single-author research yield with 7.69 %. From the outcome of this study, we come to realize that the multi-author distribution is the most elevated contrast with single-author distribution.
5. It is found from the analysis that the highest number of single author research output of 43 in the year 2014 followed by 37 research output in the year 2013. As soon as the highest number of multiple authors research output of 688 publications in the year 2014 followed by 623 publications in the year of 2013. 7.69% of articles were produced by single authors and 92.31% of the articles were produced by multiple authors
6. Based on this study the degree of collaboration in the publications productivity of Green Electronic during the period of study is  $C = 0.91$ . i.e., 91 percent of collaboration authors articles published during the study periods.
7. Out of the 7142 published papers, the maximum number of publications 6184(86.59%) were journal articles with 116809 Global Citation Scores followed by 267(3.54%) review, 60(2.3%) proceedings papers and other publications followed by other form.
8. The most productive journal of Physical Review B has 870 records with 27731 global citation scores followed by journal of Chemical Physics has 285 publications with 5998 global citation scores and journal of Physics-Condensed Matter has 174 publications with 2764 global citation scores.
9. It is noted that Chinese Academy of Sciences had contributed the highest number of research publications 230 with 3346 global citation score.
10. It is observed that the country wise analysis of the research output related to Green Electronics indicates the following results. The USA has the highest productivity and highest local and global citation scores measured and it stands first rank among countries. Peoples R China has 1383 output with 1127 Local citation and 16457 global citation scores measured.
11. The significant words are called “Keyword” are perhaps the best pointer to comprehend and get a handle on momentarily the idea substance of the papers, methodologies used and areas of research addressed to the high frequency keywords were “Electronic” is topped with 1601 records with first rank of the frequency and the Global Citation Score of 25322. The next word follows as “Properties” with 995 records with second rank of the frequency and global citation score of 15252 as well as follows the publications.
12. It is found from the analysis that the maximum numbers of articles have been published in English Language with 6989 publications and received 140830 global citations, followed by Chinese 93 publications with 251 global citations, Russian 14 publications with 28 global citations and rest of the publications are published in other languages.

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