Electrochemistry Journals

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A bibliometric study of journals publishing papers in electrochemistry has been carried out using an on-line literature searching system. The journals are ranked by percentage of their contents on electrochemistry and by number of electrochemical papers published; 149 journals published 15 713 electrochemical papers; 22 journals devote over half of their contents to electrochemistry. This is somewhat larger for this mature field than for a newer and still-growing area of chemistry. Analysis by Bradford's law suggests that the core of journals for electrochemistry contains 11 journals, and the "complete" body of literature contains 3500 journals.

INTRODUCTION

Electrochemistry is an old branch of chemistry which has been of interest for many years. It encompasses not only chemical phenomena of batteries, cells, and so on, but also such peripheral areas as corrosion, dielectrics, and portions of thermodynamics, semiconductors, ceramics, and other fields. Interest in this area therefore remains high. This study investigates the characteristics of the literature of electrochemistry, and specifically some of the journals publishing actively in this field.

The Lockheed Corporation's DIALOG system[1] was used to obtain the data. The DIALOG system is an on-line interactive information retrieval system, with access to over 30 data bases. Such systems are very useful for studies of a bibliometric type because of their speed, comprehensiveness, and ability to search for nonsubject information. (For further details on the techniques of on-line bibliometric searching, see ref 2.)

A similar study on semiconductor journals has been published.[3] In contrast to semiconductors, electrochemistry is relatively mature and well established. One of the objectives of this study was to compare an older area of interest with one still growing rapidly to see if any general distinctions could be made.

METHOD

Using the method of searching described previously,[3] a search was made of all *Chemical Abstracts* (CA) *Condensates* data available in the DIALOG system. The files covered included CA Volumes 76 through 84 (1972 through June 1976). A set of electrochemical papers was formed using a combination of CA section numbers, words in title, or keywords (descriptors). A paper was defined to be an "electrochemical" paper if it was placed by CA in Section 72 (Electrochemistry–known as Section 77 before 1975); Section 52 (Electrochemical, Radiational, and Thermal Energy Technology), Subsection 2 (Energy Conversion Devices); or if its title or descriptor fields contained one of the words in Table I. A total of 58 918 documents met these criteria, of which 14 014 were patents. Of the 44 904 nonpatents, 16 894 were in English, and 28 010 were in another language.

A list of 149 journals likely to publish papers in electrochemistry was drawn up from the following sources: the list of the most frequently cited journals in CA,[4] the list of journals abstracted by *Metals Abstracts*,[5] the *Science Citation Index* journal lists,[6] Kiehlmann's list of chemical journals covered by the major abstracting services,[7] the journal hierarchy studies of Carpenter and Narin,[8] and Narin, Carpenter, and Berlt,[9] and Garfield's "Journal Citation Reports".[10] The CODEN for each journal was combined in turn in a Boolean AND operation with the set of electrochemical papers to yield the number of electrochemical papers appearing in each journal.

Table I. Electrochemical Words[a]

Amperocoulomet*	Electromachin*
Amperomet	*Electromotive
Anode*	Electroorganic
Anodic*	Electrooxid*
Anodiz*	Electroplat*
Batter*	Electropolish*
Cathode*	Electrorecovery
Cathodic*	Electroreduction
Corros	Electrorefin*
Electroanaly*	Electrowin*
Electrochem	*Emf
Electrodeposit*	Polarogr*
Electrolysis	*Potentiomet*
Electrolyz*	Voltammetr*

[a] An asterisk indicates truncation.

(Using the CODEN relieves one of the necessity of checking for variations in journal titles, abbreviations, and so on.) For each journal, the total number of papers and the number of electrochemical papers it published were recorded. The journals were ranked by the percentage of their contents devoted to electrochemistry. Table II lists these data. The journals were also ranked by absolute number of electrochemical papers in each, and a cumulative percent of total was calculated for each journal. Figure 1 is a plot of cumulative percentage against number of journals.

DISCUSSION

A total of 15 713 electrochemistry papers (35% of the total of 44 904) were published by the 149 journals. The remainder are scattered in a large number of additional journals, as well as in diverse media such as government reports, theses, conference proceedings, and so on.

Table II shows that 12 journals devote over 80% of their contents to electrochemistry, and 22 journals devote over half of their contents to this field. Recall is less than 100%, even for those journals whose titles indicate that they should be devoted entirely to electrochemistry. Indexing errors and inconsistencies are undoubtedly responsible for this. Four of the top five journals have the word "electrochemistry" or some variant of it in their titles (the other journal in this group, *Corrosion*, is devoted to a closely related topic); 25 journals contain more than 20% electrochemical papers; and 36 contain more than 10%. This leaves 113 journals of those identified with less than 10% of their papers on electrochemistry, including 32 with less than 1%. The well-documented phenomenon of clustering in a small number of core journals[8,9,11] holds true for electrochemistry. However, the core of journals is larger for electrochemistry than was found in the study on semiconductors, probably because electrochemistry is a better established and older (but still quite active) field of interest. More journals, therefore, might be expected to be established in this field. A somewhat larger total number of papers was

Table II. Journals Ranked by Percentage of Electrochemical Papers Published

Rank	Journal	No. of papers Total	Electrochem	% electrochem
1	*J. Appl. Electrochem.*	212	198	93.4
2	*Corrosion*	330	299	90.6
3	*Elektrokhimiya*	2234	2021	90.5
4	*J. Electrochem. Soc. India*	132	119	90.2
5	*J. Electroanal. Chem.*	1645	1471	89.4
6	*Br. Corros. J.*	145	127	87.6
7	*Boshoku Gijutsu (Corros. Eng.)*	117	102	87.1
8	*Electrochim. Acta*	751	649	86.4
9	*Werkst. Korros.*	318	269	84.6
10	*Zashch. Met.*	912	765	83.9
11	*Anticorros. Methods Mater.*	47	39	83.0
12	*Corros. Sci.*	356	291	81.7
13	*Trans. Inst. Met. Finish*	126	97	77.0
14	*Corros. Trait. Prot. Finition*	57	43	75.4
15	*Australas. Corros. Eng.*	72	54	75.0
16	*Electroplat. Met. Finish*	80	59	73.8
17	*Plating (East Orange, N. J.)*	190	136	71.6
18	*Denki Kagaku*	382	249	65.2
19	*Denki Kagaku Oyobi Butsuri Kagaku*	210	130	61.9
20	*Energy Conver.*	44	27	61.4
21	*Met. Finish J.*	46	27	58.7
22	*Met. Finish.*	178	101	56.7
23	*J. Electrochem. Soc.*	1807	871	48.2
24	*Met. Corros. Ind.*	100	41	41.0
25	*Elektron. Obrab. Mater.*	400	157	39.3
26	*J. Anal. Chem. USSR*	2020	388	19.2
27	*Anal. Chim. Acta*	1501	262	17.5
28	*Ukr. Khim. Zh.*	1570	243	15.5
29	*Anal. Chem.*	3051	438	14.4
30	*Ber. Bunsenges. Phys. Chem.*	842	117	13.9
31	*Chem. Ing. Tech.*	678	91	13.4
32	*J. Appl. Chem.*	3837	509	13.3
33	*Izv. Vyssh. Uchebn. Zaved. Khim. Khim. Tekhnol.*	2712	326	12.0
34	*Mag. Kem. Foly.*	599	70	11.7
35	*Chem. Listy*	409	48	11.7
36	*Fresenius Z. Anal. Chem.*	1176	133	11.3
37	*C. R. Hebd. Seances Acad. Sci., Ser. C*	3554	326	9.2
38	*J. Indian Chem. Soc.*	1437	120	8.4
39	*J. Chim. Phys. Phys. Chim. Biol.*	1042	87	8.3
40	*Collect. Czech. Chem. Commun.*	2053	160	7.8
41	*Bunseki Kagaku*	1034	78	7.5
42	*Rocz. Chem.*	1304	97	7.4
43	*Thin Solid Films*	1120	68	6.1
44	*Bull. Soc. Chim. Fr.*	2853	171	6.0
45	*Metall. Trans.*	1368	79	5.8
46	*Z. Chem.*	1215	65	5.3
47	*Russ. J. Phys. Chem.*	5574	294	5.3
48	*J. Vac. Sci. Technol.*	879	46	5.2
49	*J. Gen. Chem. USSR*	3624	188	5.2
50	*J. Chem. Soc., Faraday Trans. 1*	1145	58	5.1
51	*Indian J. Chem.*	2218	112	5.0
52	*J. Less Common Met.*	847	41	4.8
53	*Chem. Scr.*	314	15	4.8
54	*Litov. Fiz. Sb.*	362	16	4.4
55	*J. Phys. D*	990	44	4.4
56	*J. Prakt Chem.*	635	27	4.3
57	*Sov. Phys. Semicond.*	2418	101	4.2
58	*Gazz. Chim. Ital.*	581	24	4.1
59	*Bull. Soc. Chim. Belg.*	386	16	4.1
60	*Izv. Vyssh. Uchebn. Zaved. Fiz.*	1692	68	4.0
61	*Bull. Chem. Soc. Jpn.*	4132	163	3.9
62	*Z. Metallkd.*	607	23	3.8
63	*J. Phys. E*	689	26	3.8
64	*Aust. J. Chem.*	1429	54	3.8
65	*Acta Chem Scand*	1430	51	3.6
66	*J. Inorg. Nucl. Chem.*	2736	92	3.4
67	*J. Electron. Mater.*	189	6	3.2
68	*Surf. Sci.*	1473	45	3.1
69	*Inorg. Mater.*	2568	80	3.1
70	*J. Phys. Chem.*	2902	88	3.0
71	*IEEE Trans. Electron. Devices*	235	7	3.0
72	*Electron. Lett.*	235	7	3.0
73	*Chem. Lett.*	1586	48	3.0
74	*Solid State Electron.*	444	13	2.9
75	*J. Chem. Thermodyn.*	588	17	2.9

Table II (*Continued*)

Rank	Journal	No. of papers Total	Electrochem	% electrochem
76	*Inorg. Chem.*	3218	86	2.7
77	*J. Non-cryst. Solids*	535	14	2.6
78	*Z. Naturforsch.*	1001	25	2.5
79	*Isr. J. Chem.*	395	10	2.5
80	*Rev. Sci. Instrum.*	995	24	2.4
81	*Am. Ceram. Soc. Bull.*	336	8	2.4
82	*Russ. J. Inorg. Chem.*	3546	81	2.3
83	*J. Am. Ceram. Soc.*	931	21	2.3
84	*J. Chem. Eng. Data*	622	13	2.1
85	*Teor. Eksp. Khim.*	637	13	2.0
86	*Phys. Met. Metallogr.*	1815	36	2.0
87	*J. Mater. Sci.*	1160	23	2.0
88	*Czech. J. Phys.*	453	9	2.0
89	*Solid State Technol.*	105	2	1.9
90	*J. Chem. Soc., Perkin Trans. 2*	2023	39	1.9
91	*J. Appl. Physiol.*	3552	67	1.9
92	*Izv. Akad. Nauk SSSR, Ser. Khim.*	3645	70	1.9
93	*Dokl. Akad. Nauk SSSR*	6503	124	1.9
94	*Ukr. Fiz. Zh.*	1247	22	1.8
95	*J. Res. Nat. Bur. Stand., Sect. A*	166	3	1.8
96	*J. Colloid Interf. Sci.*	1083	19	1.8
97	*J. Am. Chem. Soc.*	8874	157	1.8
98	*Appl. Phys. Lett.*	2095	37	1.8
99	*Mater. Res. Bull.*	975	17	1.7
100	*Jpn. J. Appl. Phys.*	1673	29	1.7
101	*J. Chem. Soc., Dalton Trans.*	2540	43	1.7
102	*Chem. Rev.*	121	2	1.7
103	*Can. J. Chem.*	2631	45	1.7
104	*Z. Anorg. Allg. Chem.*	1295	21	1.6
105	*J. Solid State Chem.*	760	12	1.6
106	*Appl. Opt.*	575	9	1.6
107	*Proc. IEEE*	195	3	1.5
108	*J. Chem. Soc., Chem. Commun.*	4067	57	1.4
109	*Sov. Phys. Solid State*	3526	45	1.3
110	*J. Org. Chem.*	5444	70	1.3
111	*Tetrahedron Lett.*	5909	72	1.2
112	*Izv. Akad. Nauk SSSR, Ser. Fiz.*	1921	23	1.2
113	*Scr. Metall.*	942	10	1.1
114	*J. Lumin.*	368	4	1.1
115	*J. Chem. Soc. Faraday Trans. 2*	988	11	1.1
116	*Helv. Chim. Acta*	1386	15	1.1
117	*Angew. Chem.*	950	10	1.1
118	*Tetrahedron*	2510	23	0.9
119	*Proc. Roy. Soc. London, Ser. A*	459	4	0.9
120	*Physica*	579	5	0.9
121	*Phys. Status Solidi A*	3081	29	0.9
122	*J. Org. Chem. USSR*	3200	30	0.9
123	*J. Cryst. Growth*	1266	12	0.9
124	*J. Chem. Soc., Perkin Trans. 1*	2640	25	0.9
125	*JETP Lett.*	1275	10	0.8
126	*J. Opt. Soc. Am.*	383	3	0.8
127	*Chem. Ber.*	1943	16	0.8
128	*Acta Metall.*	650	5	0.8
129	*J. Phys. Chem. Solids*	1105	8	0.7
130	*J. Phys. (Paris)*	720	5	0.7
131	*Opt. Spectrosc.*	1816	11	0.6
132	*Nature (London)*	3840	22	0.6
133	*Phys. Lett. A*	3063	13	0.4
134	*Philos. Mag.*	975	4	0.4
135	*J. Chem. Phys.*	7669	30	0.4
136	*Chem. Phys. Lett.*	4240	17	0.4
137	*Sov. Phys. JETP*	1386	4	0.3
138	*Solid State Commun.*	2908	10	0.3
139	*Phys. Status Solidi B*	2660	7	0.3
140	*Science*	2075	4	0.2
141	*Phys. Rev. B*	4789	8	0.2
142	*J. Phys. Soc. Jpn.*	2415	6	0.2
143	*J. Phys. F*	1017	2	0.2
144	*Can. J. Phys.*	1183	2	0.2
145	*Z. Phys.*	986	1	0.1
146	*Phys. Rev. Lett.*	3795	2	0.1
147	*Phys. Rev. A*	2188	3	0.1
148	*J. Phys. C*	1782	2	0.1
149	*Phys. Rev. D*	2942	1	0.0

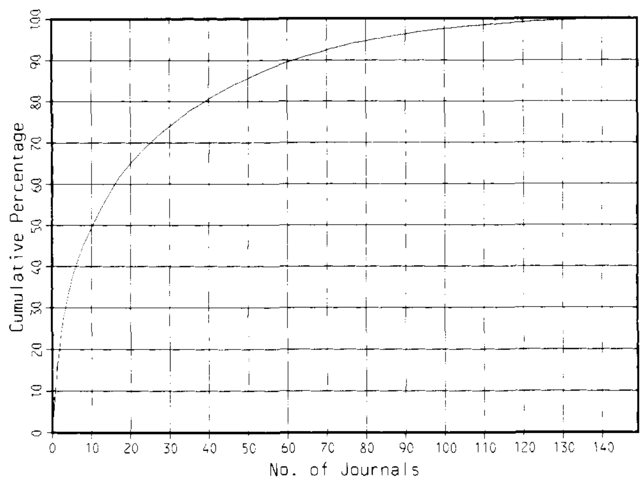

Figure 1. Distribution of electrochemical papers. Cumulative percentage as a function of number of journals.

Table III. Top 31 Journals Publishing Electrochemical Papers

Journal	No. of electrochemical papers: No. in journal	Cumulative total	Rank[a]
Elektrokhimiya	2021	2021	3
J. Electroanal. Chem.	1471	3492	5
J. Electrochem. Soc.	871	4363	23
Zashch. Met.	765	5128	10
Electrochim. Acta	649	5777	8
J. Appl. Chem.	509	6286	32
Anal. Chem.	438	6724	29
J. Anal. Chem. USSR	388	7112	26
Izv. Vyssh. Uchebn. Zaved. Khim. Khim. Tekhnol.	326	7438	33
C. R. Hebd. Seances Acad. Sci., Ser. C	326	7764	37
Corrosion	299	8063	2
Russ. J. Phys. Chem.	294	8357	47
Corros. Sci.	291	8648	12
Werkst. Korros.	269	8917	9
Anal. Chim. Acta	262	9179	27
Denki Kagaku	249	9428	18
Ukr. Khim. Zh.	243	9671	28
J. Appl. Electrochem	198	9869	1
J. Gen. Chem. USSR	188	10057	49
Bull. Soc. Chim. Fr.	171	10228	44
Bull. Chem. Soc. Jpn.	163	10391	61
Collect. Czech. Chem. Commun.	160	10551	40
J. Am. Chem. Soc.	157	10708	97
Elektron. Obrab. Mater.	157	10865	25
Plating (East Orange, N.J.)	136	11001	17
Fresenius Z. Anal. Chem.	133	11134	36
Denki Kagaku Oyobi Butsuri Kagaku	130	11264	19
Br. Corros. J.	127	11391	6
Dokl. Akad. Nauk SSSR	124	11515	93
J. Indian Chem. Soc.	120	11635	38
J. Electrochem. Soc. India	119	11754	4

[a] From Table II.

also observed: nearly 59 000 for electrochemistry as against 34 400 for semiconductors. Given the financial and other constraints upon the number of papers a journal can publish, one would expect a larger number of journals to be active in electrochemistry.

The well-known *Journal of the Electrochemical Society* (JES) ranks relatively low in Table II: 23rd, with only 48% of its papers on electrochemistry. In spite of the word "electrochemical" in its title, JES apparently views its world somewhat broadly, publishing a considerable number of papers in allied fields such as ceramic science, metallurgy, semiconductors, and thermodynamics. (Indeed, JES is a leading journal in semiconductors,[3] ranking 8th of 91 journals on a percentage basis, and 8th in absolute number of semiconductor papers.) JES ranks third in absolute number of electrochemical papers, with 871 papers.

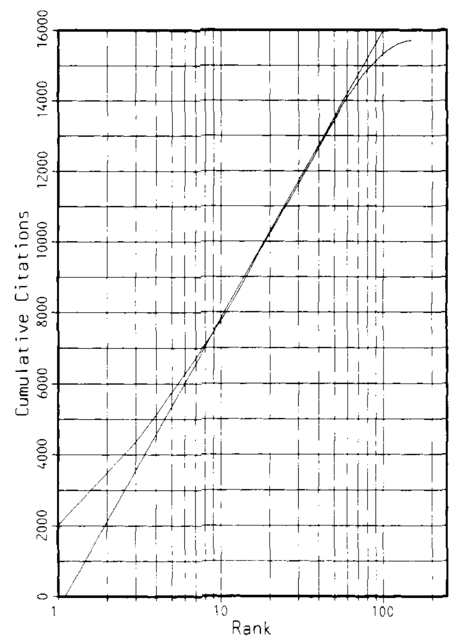

Figure 2. Bradford plot for electrochemistry.

Table IV. Publication Rate of Electrochemical Papers

Year	No. of publications
1972	10 007
1973	9 241
1974	9 605
1975	10 699
1976	10 704[a]

[a] Extrapolated.

On an absolute number basis, Figure 1 shows that 10 journals published half of the 15 713 journal papers, and 31 published 75%. These top 31 journals and the number of electrochemical papers they published are listed in Table III. The rank of each journal from Table II is also listed in Table III. Several of the top journals in Table III also rank high on Table II.

The quantitative study of scientific periodical literature was first formulated by Bradford,[12] who observed that a collection of articles on a given subject, when ranked as in Table III, could be partitioned into "zones" of productivity. This observation has come to be known as Bradford's law. In a graphical representation of Bradford's law, the cumulative number of items for each journal is plotted against the logarithm of the rank of the journal. Such a plot for electrochemistry is shown in Figure 2. The data obey Bradford's law. The point at which the initial concave upward portion of the curve becomes linear delineates the core of journals (about 11), and the slope of the linear portion provides an estimate of the total number of journals on the subject (about 3500 journals, or 28 500 articles). The tailing off of the upper portion of the curve indicates that the body of literature under study is not complete. Knowing the slope and intercept of the linear portion of the curve, one can calculate the total number of articles on the subject. (More complete discussions and derivations of Bradford's law have been published by several authors. See, for example, papers by Brookes.[13])

Finally, the distribution of the 44 904 journal articles with time was determined. Table IV shows the number of electrochemical papers abstracted by CA each year for the years

1972–1976. The publication rate for 1975 and 1976 appears to be approximately 10700 papers per year. For 1972 through 1974, the rate was 9620 papers per year. The average for the five years is 10050 (±800) papers per year.

CONCLUSION

The leading journals publishing papers in electrochemistry have been identified. Electrochemistry is a mature field generating papers at a nearly constant annual rate. Its core of heavily used journals is larger than that for semiconductors, which is a younger and more rapidly growing discipline. The distribution of papers over the 149 journals follows Bradford's law.

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Searching the Literature for Concepts

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Chemical Abstracts was searched during a 3-month period for papers involving Correlation Analysis to determine the incidence of citation of pertinent material in the Keyword Index. Results indicate that the index is not a reliable tool for searching if conceptual material is sought, particularly in those areas of research which are not bound to a particular class of compounds or reaction types.

Is a controlled vocabulary necessary? It could be, for the excellent abstract reporting evident in *Chemical Abstracts* (CA) for compounds and skeletal systems is unfortunately not replicated when concepts or methods are the access points. If one looks for a generic approach to a problem, finding all references is quite difficult. It is well known that casting a net for all references is bound to pull in enormous amounts of extraneous material. It also promotes a reasonable question—how does one know that it is truly all? In some areas, such as legal, patent, pharmaceutical, and such, finding every single reference is often necessary, whatever the cost. One is prepared to cope with excess material in return for completeness. However, can one depend upon an index and be sure of completeness?

To test this we examined CA for a test period of 3 months of 1975. During this time we searched one field. The area studied was one in which we have done work and have a "chemical insider's" advantage in terms of familiarity with both vocabulary and authors. It also crosses a number of disciplines and has been applied to a variety of research and development projects. The field, Correlation Analysis, involves application of linear free energy relationships or structure–activity relationships to physical properties, e.g., spectral phenomena, chemical reactivities such as rate and equilibrium constants, and biological activities.[1,2]

Since this field can treat many types of data and a large group of subject compounds, pertinent papers appear in more than one section of CA and under a fairly extensive collection of keywords. We have compiled the lists shown in Table I for entry in the Keyword Index. There are two lists since some terms do not appear in both large divisions of CA: Physical-Polymer-Analytical and Organic-Biochemical.

Table I. Search Terms Developed by Users

Organic sections	Physical sections
Hammett	Hammett
Taft	Taft
Hansch	Price–Alfrey
Structure–activity	Q and e constants
Substituent effect	Dissociation constant
Substituent constant	Reactivity ratio
Substituent dipole	Ionization constant
Reactivity	Substituent effect
Kinetics	
Free energy	
Steric effect	
Dissociation constant	
Ionization constant	
Drug design	

METHOD

Each CA issue was searched for the terms indicated. All appropriate abstract numbers were listed, and then the sections in which likely papers would be found were paged through by hand. The Physical sections were easiest to do since relevant material appears in relatively few sections: High Polymers, Kinetics, Thermodynamics, Equilibria, Spectra, Electro-