A patentometric analysis of the International Nuclear Information System database: 1970–2006

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Abstract: Of the 46 461 patents studied for the period 1970–2006 from the INIS Database, inputs (in percentages) were from Japan (27.9), the USA (23), Germany (13.7), France (11.3) and the UK (7.2). The main languages used were English (35.7), Japanese (27.9), German (14) and French (11.4), out of 20 languages. Patents with percentages in a single category were Engineering and Technology (62.4); Chemistry, Materials and Earth Sciences (13.9); Isotopes and Isotope and Radiation Applications (6.2); Physics (5.5); Life and Environmental Sciences (4.6); Other Aspects of Nuclear and Non-nuclear Energy (0.2); and multidisciplinary (7.2). Among the top inventors, Makoto Ueda had 140 patents, J. Schoening 121 and F.S. Jabsen 115.

Keywords: patents; records of patents; database of patents; International Nuclear Information System; INIS.

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1 Introduction

Patents are the largest single source of technological information on inventions of products and methods. Just as scientific articles are accepted as a legitimate reflection of scientific research, patents are accepted as a reflection of technological achievements. The analyses of patents provide an overall view of international technical activity and the technological policies and strategies adopted by nations (Rozhkov and Ivantcheva, 1998).

There are several databases devoted to the coverage of patents literature, such as the International Patent Documentation System (INPADOC), which gives access to national and international patent offices and the World Patent Index (WPI), which provides information on patents from 30 countries. There are also subject-oriented nonpatent databases that include patents besides other types of literature in a particular field, such as the International Nuclear Information System (INIS), Information Service in Physics, Electrotechnology and Control (INSPEC) and the Chemical Abstracts Service (CAS). These and other databases have been used for scientometric studies (Stefaniak, 1987; Oppenheim and Sutherland, 1978). In the present study, the patents retrieved from the INIS database from 1970 to 2006 have been analysed.

2 About the International Nuclear Information System (INIS)

INIS, operated by the International Atomic Energy Agency (IAEA), is an international cooperative information system that provides comprehensive bibliographic details of the literature on the peaceful applications of nuclear science and technology. INIS was established in 1970 with a total of 25 members (including countries and international organisations) and in 2006, INIS' membership grew to 140 (IAEA, 2006). The subject scope of INIS consists of nuclear reactors, reactor safety, nuclear fusion, the applications of radiation and radioisotopes in medicine, agriculture, industry and pest control and the related fields include nuclear chemistry, nuclear physics and materials science. The literature covered by the INIS database includes journal articles, reports, conference papers, books, patents, theses, laws, regulations and standards. This database is distributed free of charge to the participating member states and organisations. In 2006, the INIS database included 2.7 million bibliographic references. This database is accessible by subscription only and had in 2006 about 1.3 million authorised users.

Some of the previous studies done using the INIS database include the following: Bonitz (1985) described a method of ranking journals according to a new parameter (Selective Impact) and applied it to study journals publishing papers on nuclear research using the INIS database. Huxlin (2002) has studied Australia's share of publications in the INIS database in the subfields of nuclear chemistry, physics, materials science and nuclear medicine. Barrett (1970) has compared CAS, INSPEC, the Medical

Literature Analysis and Retrieval System (MEDLARS) and INIS, which revealed considerable international activity at working levels towards establishing global scientific and technical information systems. Marinkovic (2002) has conducted a bibliometric study of research reactors in the INIS database for the period from 1970 to 2001. Hillebrand (1998a–c), in three separate studies, has analysed publications on fusion research and technology in the INIS database during 1970 to mid-1998, literature on high-energy physics in the same period and literature on low and medium-energy physics. Negeri (2005) has analysed records on the Chernobyl accident and its consequences covered by the INIS database from 1986 to 2005. Kademani *et al.* (2006) have analysed India's contribution to the INIS database during 1970 to 2002.

3 Objectives of the study

The specific objectives of the present paper were to study the publication trends of the patents in nuclear science and technology included in the INIS database for the following characteristics:

- proportion of patents compared to other types of literature
- year-wise analysis of patents
- country-wise input
- language-wise distribution
- time-lag index
- pioneer first inventors and patronising first inventors
- content analysis.

4 Materials and methods

Database on CD-ROM, brought out by INIS during 1970 to 2006, was used for the study. A search was made for 'patent' in the field 'type of document', which resulted in 46 461 patents being retrieved from the database. Bibliographic fields such as the publication year of the patent, country of input, language, volume number of the database, authors and subject codes were downloaded for each record.

5 Results and discussion

5.1 Proportion of patents compared to other types of literature

Table 1 indicates the year-wise proportion of patents compared to other types of literature in the INIS database from 1970–2006.

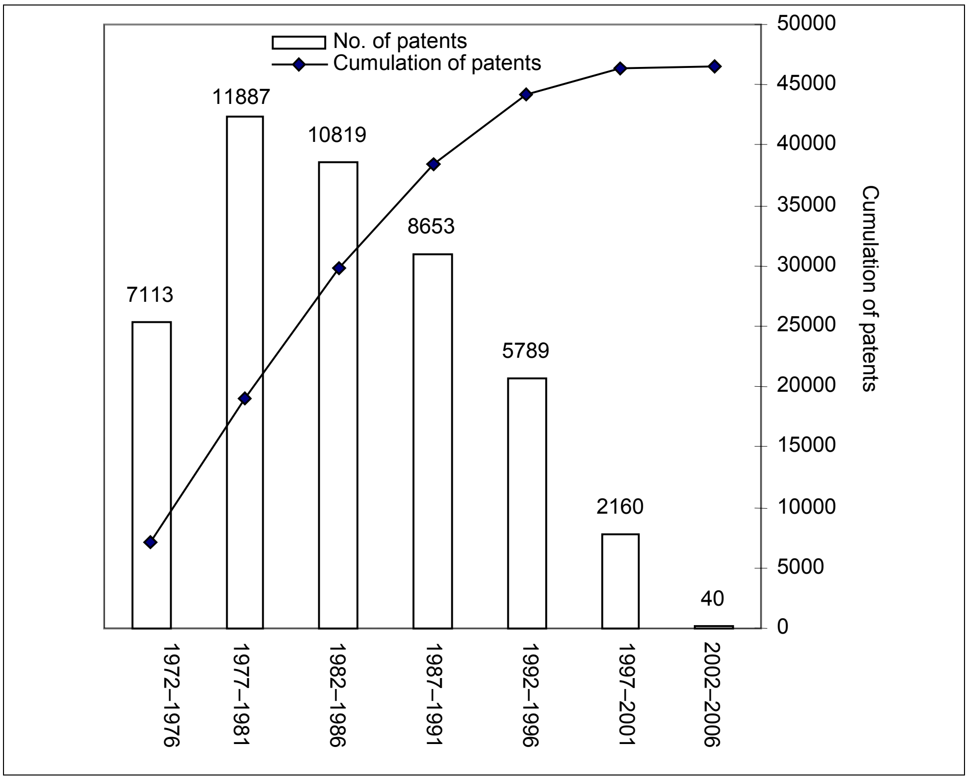
Table 1 The year-wise proportion of patents in the INIS database from 1970–2006

INIS database		*Total number of documents*	*Number of patents*	*Percentage of patents*
Volume no.	*Year*			
1	1970	3981	0	0.00
2	1971	10 408	0	0.00
3	1972	20 846	202	0.97
4	1973	56 614	924	1.63
5	1974	63 614	1772	2.78
6	1975	63 296	1746	2.76
7	1976	60 478	2469	4.08
8	1977	69 028	2516	3.64
9	1978	70 795	2279	3.22
10	1979	75 966	2828	3.72
11	1980	76 599	2242	2.93
12	1981	70 820	2022	2.86
13	1982	72 718	2256	3.10
14	1983	92 216	2019	2.19
15	1984	73 362	1503	2.05
16	1985	86 529	2154	2.49
17	1986	90 401	2887	3.19
18	1987	101 118	2378	2.35
19	1988	106 919	1889	1.77
20	1989	86 281	1590	1.84
21	1990	95 604	1547	1.62
22	1991	92 012	1249	1.36
23	1992	88 990	1587	1.78
24	1993	76 577	1325	1.73
25	1994	77 107	1228	1.59
26	1995	79 021	743	0.94
27	1996	80 854	906	1.12
28	1997	80 899	936	1.16
29	1998	67 994	726	1.07
30	1999	61 398	385	0.63
31	2000	65 768	111	0.17
32	2001	69 662	2	0.00
33	2002	71 306	0	0.00
34	2003	84 574	13	0.01
35	2004	107 062	20	0.02
36	2005	117 230	6	0.00
37	2006	122 498	1	0.00
Total		2 790 545	46 461	1.66

The initial two years, 1970 and 1971, did not include any patents in the database. Subsequently, the percentage of patents included compared to other types of literature increased gradually and was at a maximum of 4.08% (2469) in 1976. The maximum number of patents added to the database in a year was 2887 in 1986 and then declined gradually to no patents being included in the database in 2002, 13 in 2003, 20 patents in 2004, 6 in 2005 and 1 in 2006. The overall proportion of patents in the database was 1.66% compared to other types of literature. This skewed distribution of patents in the database may be on two accounts: the patent laws prevailing in the participating nations and/or the laxity on the part of the participating nations and organisations.

Figure 1 indicates the quinquennial publication trend of a number of patents and their cumulation in the INIS database (1970–2006). A maximum number of patents (11 887) were added in the second quinquennium (1977–1981) and then there was a steep fall in the number of added patents. Approximately 50% (22 706) of the patents included in the database were in the second and third quinquennium (1977–1986) and 75% (31 359) from 1977–1991. From then on, there has been a steady decrease in the number of patents added to the database.

Figure 1 The quinquennial publication trend of the number of patents published and their cumulation in the INIS database (1970–2006)



5.2 Year-wise analyses of patents

Figure 2a gives the year-wise distribution of the patents in the INIS database from 1970 to 2006.

The inclusion of patents in the INIS database was very gradual, with only one patent in 1951 and 1952 being included in the database and no patents of 1953 to 1961 (Figure 2b). The maximum numbers of patents included in the database was in 1975 (2749) and 1976 (2712). Two patents were excluded in this segment of the study because their year of publication was not known.

Figure 2a The patents in the INIS database from 1970–2006 compared to other types of literature

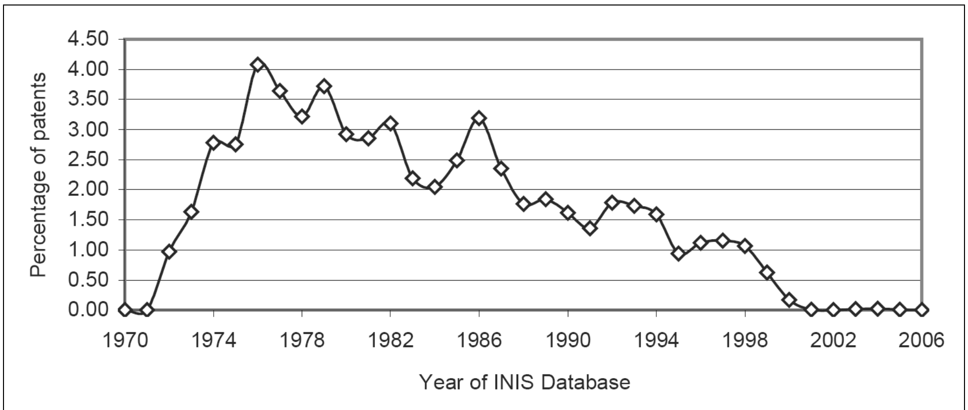
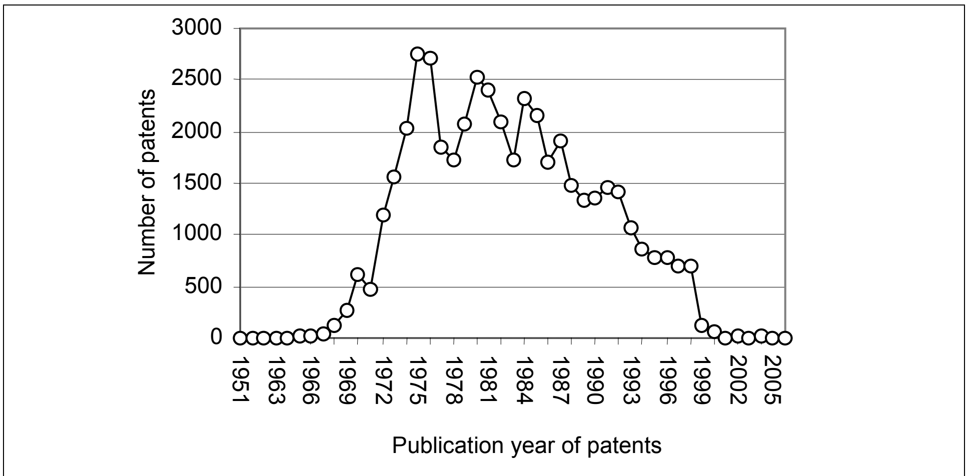


Figure 2b The year-wise number of patents published in the INIS database (1970–2006)



5.3 Country-wise input analyses of patents

Each bibliographic record in the INIS database is assigned with the country of input as one of its attributes. Though this does not mean that the country of input is the same as the country of the contributing author/s, it is still indicative of the country's contribution to the database.

A total of 46 461 patents were contributed by 34 countries and one organisation – the Commission of the European Communities (Table 2).

Table 2 The country-wise input of patents in the INIS database (1970–2006)

Country of input	*No. of patents*	*Percentage*
Japan	12 953	27.9
USA	10 668	23.0
Germany	6360	13.7
France	5272	11.3
UK	3331	7.2
USSR	1644	3.5
Czechoslovakia	1548	3.3
Canada	1253	2.7
The Netherlands	939	2.0
Australia	784	1.7
South Africa	452	1.0
Sweden	228	0.5
Switzerland	160	0.3
Norway	159	0.3
Bulgaria	129	0.3
Austria	122	0.3
Poland	78	0.2
Denmark	65	0.1
Hungary	62	0.1
Czech Republic	64	0.1
Russian Federation	41	0.1
Republic of Moldova	62	0.1
Commission of the European Communities	33	0.1
Belgium	24	0.1
Kazakhstan	9	0.0
Mongolia	5	0.0
Brazil	5	0.0
Romania	3	0.0
Finland	3	0.0
Italy	2	0.0
Lithuania	1	0.0
Sri Lanka	1	0.0
Algeria	1	0.0
Total	46 461	100.0

The top five countries contributing almost 75% (38 582) of the patents to the INIS database are: Japan (27.9%), the USA (23.0%), Germany (13.7%), France (11.4%) and the UK (7.2%).

The year-wise contributions of the five most productive nations (Japan, the USA, Germany, France and the UK) are indicated in Table 3. Two French patents whose publication years were not known have been excluded from Table 3 and Figure 3.

The contributions of all these nations have drastically declined in the recent years, with no contributions from the UK since 1996, Germany since 1997, France since 1998, Japan since 2000 and the USA since 2001. Hillebrand (1998c), in his study of publications related to fusion research and technology in the INIS database (1970 to mid-1998), has noted that the input of patents had been erratic during this period probably due to the change in the patent law in some countries and the difficulty of converting records from patent to bibliographic database. However, there was an increase of patents input during this period probably due to the increased effort to commercialise research and technological results. Figure 3 indicates the cumulation of patents of the top five contributing countries.

5.4 Language-wise analyses of patents

A total of 46 461 patents were published in 20 languages (Table 4). Of these, 16 606 (35.7%) were in English, 12 953 (27.9%) were in Japanese, 6527 (14.1%) were in German and 5317 (11.4%) were in French.

5.5 Time-lag index

The time lag between the publication and its appearance in indexing and abstracting services is of paramount importance both to users and librarians who are concerned with current references in a particular field. The currency of literature published in secondary sources is also one of the factors considered for the evaluation of the source (Jacso, 1998). Few studies have been conducted on the time lag of indexing and abstracting services (Smalley, 1980; Corth, 1977; Poyer, 1982; Miller and Rau, 1977; Robinson and Turtle, 1974; Williams, 1972; Braun *et al*., 2001).

The patents were analysed for time lag between the publication year of the patent and the year of its incorporation in the INIS database. The time lag was taken as zero if the publication year of the patent and the year in which it was included in the database was the same. Two French patents whose publication years were not known have been excluded from this segment of the study.

Figure 4 depicts a similar trend for 50% and 100% of the patents included in the INIS database. The time taken for 50% of the yearly patents to appear in the database is known as '50 percentile' and the time taken for 100% of the patents to appear in the database is called '100 percentile'.

There is a definite indication that the participating nations are making efforts to keep the database as current as possible.

Table 3 The year-wise number of patents input by the top five countries in the INIS database (1970–2006)

Year of publication of patent	*Japan*	*USA*	*Germany*	*France*	*UK*
1962	3				
1963	1				
1964	6	1			
1965	13				
1966	10				
1967	35	2			
1968	105	1		12	
1969	223	6	3	15	
1970	343	18	9	215	
1971	37	48	13	285	
1972	16	102	133	341	163
1973	16	445	127	381	197
1974	58	698	234	359	98
1975	535	693	530	374	102
1976	496	654	699	308	111
1977	33	364	794	248	105
1978	177	347	626	126	100
1979	524	241	588	78	266
1980	491	480	453	208	408
1981	488	547	200	183	414
1982	497	387	250	147	217
1983	480	336	275	129	128
1984	487	801	345	149	137
1985	524	606	440	165	188
1986	500	350	320	180	121
1987	500	637	267	179	119
1988	500	413	50	126	91
1989	508	378	0	165	75
1990	608	356	3	131	79
1991	634	526	1	111	59
1992	597	518		141	67
1993	589	218		150	37
1994	559	84		139	47
1995	561	24		151	2
1996	600	73		74	
1997	586	80			
1998	606	86			
1999	7	107			
2000		38			
2001					
2002					
2003					
2004		1			
2005		2			
Total	12 953	10 668	6360	5270	3331

Figure 3 The cumulation of patents input by top five countries as per the INIS database (1970–2006)

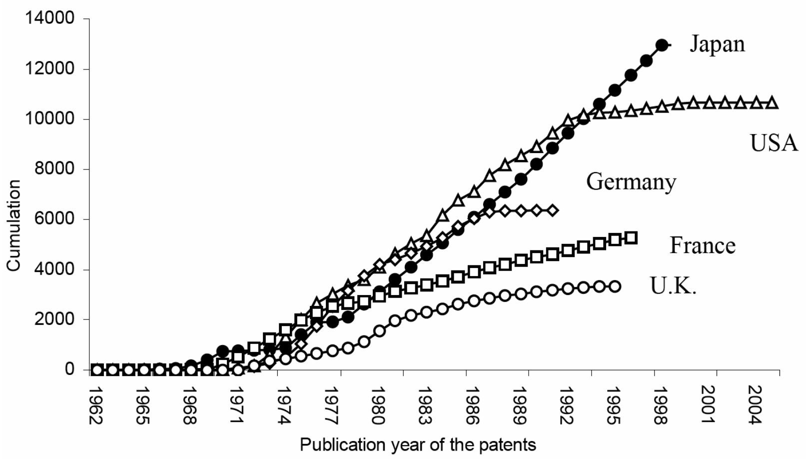
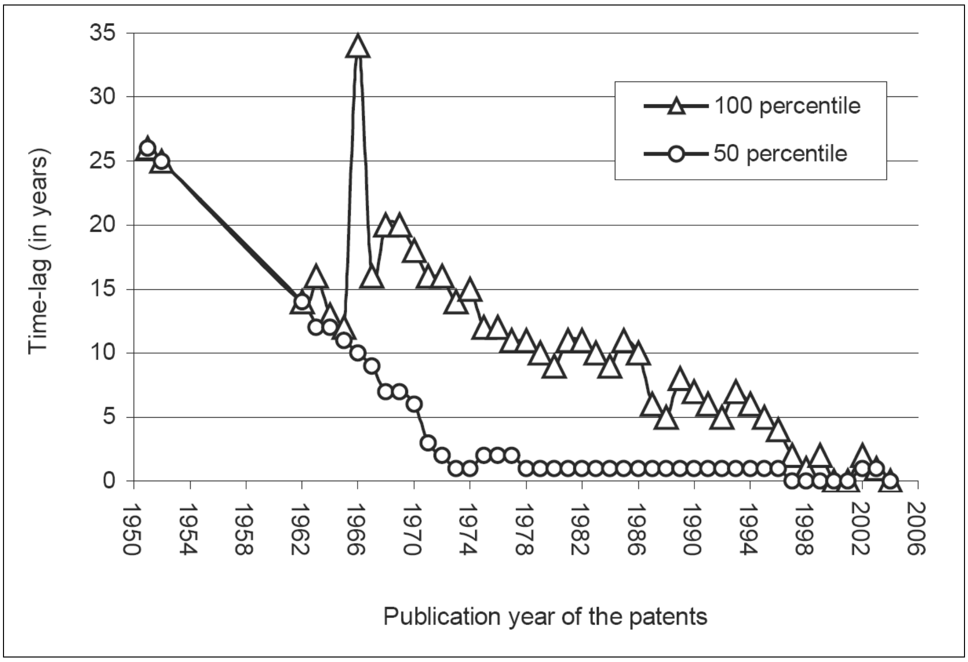


Table 4 The language-wise distribution of patents in the INIS database (1970–2006)

Language	*No. of patents*	*Percentage*
English	16 609	35.75
Japanese	12 953	27.88
German	6527	14.05
French	5317	11.44
Russian	1708	3.67
Czech	1445	3.11
Dutch	947	2.04
Swedish	228	0.49
Norwegian	158	0.34
Slovak	156	0.34
Bulgarian	129	0.28
Polish	78	0.17
Danish	65	0.14
Romanian	65	0.14
Hungarian	62	0.13
Portuguese	5	0.01
Mongolian	3	0.01
Finnish	3	0.01
Italian	2	0.0
Lithuanian	1	0.0
Total	46 461	100.0

Figure 4 The trend of time lag (in years) of patents for 50% and 100% of the patents included in the INIS database (1970–2006)



5.6 Pioneer first inventors and patronising first inventors

Patent productivity is highly concentrated in a relatively small number of talented individuals. There were 95 588 inventors (authorships) who produced 46 461 patents. The number of inventors ranged from 1 to 20 for each patent. The inventors may either be first inventors or co-inventors. The first inventors are considered the scientific mentors. They may be classified as 'patronising first inventors', *i.e.*, those who contribute less as first inventor and more as co-inventor or they may be 'pioneer first inventors', *i.e.*, those who contribute more as first inventor and less as co-inventor (Gupta, 2004).

Table 5 indicates the contribution analysis of the top 20 inventors, of whom 16 are pioneer first inventors and four, patronising first inventors.

5.7 Content analysis

The INIS' subject classification scheme was used for the content analysis. Since the inception of the INIS in 1970, its subject categories and scope descriptions (in conformity with the International Classification System for Physics developed by the International Council for Scientific and Technical Information) were used. In January 2000, these subject categories have been replaced by the new INIS and Energy Technology Data Exchange (ETDE) subject categorisation scheme (International Atomic Energy Agency, 2002). Since the new categories are very broad, those patents classified by the new scheme were converted into the old classification scheme and included in the study.

Table 5 The contribution analysis of the top 20 inventors in the INIS database (1970–2006)

Inventor	*As first inventor*	*As sole inventor*	*As co-inventor*	*Total patents*
Ueda, Makoto (pioneer)	46	65	29	140
Schoening, J. (patronising)	33	2	86	121
Jabsen, F.S. (pioneer)	18	97	0	115
Schabert, H.P. (pioneer)	50	20	28	98
Matal, O. (pioneer)	53	6	30	89
Arnold, D.M. (patronising)	29	18	35	82
Sykora, D. (pioneer)	27	40	1	68
Elter, C. (pioneer)	44	0	23	67
Yoshioka, Ritsuo (patronising)	5	24	28	57
Nakatsuka, Masafumi (patronising)	9	35	11	55
Hida, Kazuki (pioneer)	17	21	17	55
Givens, W.W. (pioneer)	13	35	4	52
Hounsfield, G.N. (pioneer)	8	39	2	49
Shirakawa, Toshihisa (pioneer)	9	35	5	49
Bevilacqua, F. (pioneer)	16	28	2	46
Anthony, A.J. (pioneer)	17	26	3	46
Kimura, Tadashi (pioneer)	31	0	13	44
Baatz, H. (pioneer)	30	4	0	34
Shallenberger, J.M. (pioneer)	27	1	5	33
Stiefel, M. (pioneer)	8	21	0	29
Total				1329

All the subject categories of the patents were downloaded for analysis. The patents were given up to three subject categories by INIS. The patents with one subject category accounted for 92.8% (43 135 patents), 7% (3223 patents) was with two subject categories and 0.2% (103 patents) was with three subject categories.

Engineering and Technology (Category E) accounted for 62.4% of the patents and Chemistry, Materials and Earth Sciences (Category B), 13.9% (Table 6). Table 7 depicts the interdisciplinarity of the patents with two subject categories. The highest number of patents of an interdisciplinary nature was 930 of Category B: Chemistry, Materials and Earth Sciences and Category E: Engineering and Technology, 658 were of Category C: Life and Environmental Sciences and Category E: Engineering and Technology.

Table 6 The subject classification of patents in the INIS database (1970–2006)

INIS subject category	*No. of patents*	*Percentage*
E: Engineering and Technology	29 000	62.4
B: Chemistry, Materials and Earth Sciences	6443	13.9
D: Isotopes and Isotope and Radiation Applications	2894	6.2
G: Physics	2532	5.5
C: Life and Environmental Sciences	2158	4.6
F: Other aspects of nuclear and non-nuclear energy	108	0.2
Multisubjects	3326	7.2
Total	46 461	100

Table 7 The disciplinary and interdisciplinary contents of patents in INIS database (1970–2006)

*	*B*	*C*	*D*	*E*	*F*	*G*	*Total*
B	*6443*	272	423	930	9	251	8328
C		*2158*	103	658	7	7	2933
D			*2894*	239	1	74	3208
E				*29 000*	66	181	29 247
F					*108*	2	110
G						*2532*	2532
Total	6443	2430	3420	30 827	191	3047	*46 358*

Note: * INIS subject categories in the first column and the row is as per Table 6.

6 Conclusion

The proportion of patents in the INIS database from 1970 to 2006 was only 1.66% (46 461). The patents were contributions of 34 countries and one organisation – the Commission of the European Communities. The major contributions were by Japan (27.9%), the USA (23%), Germany (13.7%), France (11.3%) and the UK (7.2%). The contributions of these five countries steadily declined, with no patents being contributed by Japan since 2000, the USA since 2001 (only one and two patents added in 2004 and 2005, respectively), Germany since 1992, France since 1997 and the UK since 1996. The 46 461 patents were published in 20 languages, of which 35.7% were in English, 27.9% were in Japanese, 14.1% were in German and 11.4% were in French. The time-lag index of patents appearing in the INIS database improved considerably over 37 years. The number of inventors of these 46 461 patents were 95 588, of which Makoto Ueda ranked first by contributing 140 patents, J. Schoening ranked second (121 patents) and F.S. Jabsen ranked third (115 patents).

Of the 20 inventors, 16 were 'pioneer first inventors' (those who contribute more as first inventor and less as co-inventor) and 4 were 'patronising first inventors' (those who contribute less as first inventor and more as co-inventor). The subject-wise distribution of the 46 461 patents indicated that 43 135 (92.8%) of the patents were with a single subject, of which 29 000 were on the Engineering and Technology category. Of the multidisciplinary patents, 3223 were of two subject categories and 103 patents were of three subject categories.

Though bibliographic databases are powerful tools for scientometric studies, one has to be aware of certain limitations (such as the coverage of a subject field) as far as world literature is concerned, the span of time for retrospective searches, time lag appearing in the database, lack of complete bibliographic details in all records and variations and inconsistencies in the records. The coverage of literature in a given database compared to the world literature in a particular field may be limited due to various reasons. Even in databases covering world literature, publications of the country of the producer and countries of the same region or language often show better coverage than others. Some countries give better coverage to certain types of literature than others. INIS does not suffer from such a bias because it is created by its member states and organisations that follow definite rules and regulations that are jointly decided by them. Its coverage and quality, therefore, depends on the efforts of the participating states and organisations.

One should also bear in mind the serious limitations to the use of patent data, the most glaring being the laws and policies governing the countries from time to time.

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