Scientometric Analysis of Materials' Highly Cited Papers(1979-2008)

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Introduction

Although there are many ways to study scientific activity scientifically, scientometric analysis provides a well-proven means of achieving this goal (Garfield, 1979). Highly-cited articles are interesting, because of the potential association between high citation and high quality research. In recent years, highly-cited articles have become a common criterion for scientific research evaluation (Ding 2010, Lefaivre 2010, Persson 2010, Ding 2011).This study conducts a thorough scientometric analysis of the materials field by collecting data from Web of Science (WoS). It seeks to identify and analyse the top 1000 highly-cited articles and evaluates the research performance of materials by identifying the most productive countries, institutions, authors and journals.

Methods and Materials

The WoS electronic database was used to compile a citation history of papers published in materials for the period of 1979–2008. This study utilized 624039 articles published in 464 journals with 4680906 citations from WoS. This work used indicators such as total articles, total citation rates, and numbers of domestic articles and international articles to measure scientific output.

Results and Discussion

Country Analysis

Table 1 lists the number of high-impact articles using indicators such as total number of articles, total citation rates, and numbers of domestic and international articles. From this table one can see in more details how the differences among countries have been developed. The USA has the most high-impact articles, followed by Japan, Germany, the UK and France. The USA has 621 high-impact articles, representing 61.85% of the total number of high-impact articles in materials analysed in this study. The USA also has 532 domestic articles. Our evidence confirms that the USA is the world leader in materials. Taiwan, New Zealand, Norway, Czechoslovakia and USSR have been particularly noticeable that they only have domestic articles. Further analysis shows that out of the total 1004 high impact articles, only 142 are international articles, which indicates that international collaboration plays a small role in high impact articles in materials. This is also consistent with the study by Persson (2010).

Table 1. Ranks of countries in terms of number of high-impact articles between 1979 and 2008.

Country	*TA*	*TCR*	*DA*	*IA*
USA	621	184836	532	89
Japan	124	38536	106	18
Germany	82	24810	55	27
UK	74	19433	42	32
France	40	11454	28	12
Canada	25	5641	16	9
China	19	4826	10	9
Switzerland	18	5216	10	8
Netherlands	18	5845	10	8
Sweden	17	4965	8	9
Spain	12	2783	6	6
Israel	12	3497	3	9
South Korea	11	2756	5	6
Australia	10	4863	8	2
India	8	1897	3	5
Russia	8	1806	0	8
Singapore	7	1879	6	1

Note: TA=total articles, TCR=total citation rates, DA=domestic articles, IA=international articles.

As shown in Table 1, China has 19 high-impact articles, 10 of which are domestic articles. The number of China's domestic

articles had kept increasing since 1988, 9 of which were published during the last score years especially. An important reason for the rapid growth of the scope and the strength in the study of materials lies in the consistent push by the Chinese government policies.

Institution Analysis

Let us look at the number of articles by institution. Sixty-two articles have at least one author at Univ. Calif. Santa Barbara and 49 have at least one author at MIT. Further analysis of the top 10 institutions indicates that the institutions in the USA (7 out of 10) constitute the majority, and only 3 universities outside the USA are on the list: the Tohoku Univ., Kyoto Univ. and Univ. Cambridge

This work uses Pajek to analyse the collaboration networks of institutions which produce high impact articles in materials. It shows that interagency collaboration is very common, and that, frequently, other American institutions are the collaboration partners. From the partner numbers and quantity of articles, the top five most active institutions in the collaboration networks of institutions are Harvard Univ., Univ. Calif. Berkeley, MIT, Univ. Cambridge, and Univ. Calif. Santa Barbara.

Author Analysis

There are 7 authors who come from the USA, three authors who come from Japan, one author who comes from the UK in the top 11 authors.

Furthermore, the comparison among the single-author articles and collaborative articles written by the top 11 authors shows only Evans AG, Inoue A, Ashby MF, Suresh S and Langdon TG have single author articles, implying that domestic collaboration plays an important and extensive role in materials.

Journal Analysis

An analysis of publications' journals shows that the 1004 high-impact articles are densely distributed in only 78 journals. Table 2 lists the top five journals in which researchers published their high impact articles in materials between 1979 and 2008.

Table 2. The distribution of top five journals

Journal	TA	TCR	IF
Advanced Materials	113	32345	8.379
Acta Materialia	108	31841	3.760
Journal of the American Ceramic Society	93	28993	1.944
Chemistry of Materials	83	23516	5.368
Journal of Biomedical Materials Research	55	15307	2.816

The 113 articles in Advanced Materials (impact factor 8.379) have accumulated 32345 citations for an average of 286.24 citations per article. It is not always the case that high-impact articles appear in high-impact journals. For example, 93 articles in the Journal of the American Ceramic Society (impact factor 1.944) have received at least 173 citations. One of these articles has been cited 1741 times. Further analysis shows that the 452 articles in the top five journals amount to 45.02% of the entire number of high-impact articles studied, implying that high-impact articles in journals are distributed in a very concentrated fashion.

Analysis of the Highest-Impact Articles

To get a better understanding of how articles are cited, and in particularly the high-impact articles, the highest-impact article is analysed in detail. The article is "Efficiency of ab-initio total energy calculations for metals and semiconductors using a plane-wave basis set" written by Kresse G. and Furthmüller J. Kresse G. was associated with the Technische Universität Wien, Austria and Furthmüller J was associated with the Friedrich-Schiller-Universität Jena, Germany. The article was published in Computational Materials Science in 1996, has been cited 4617 times, and ranks No. 1 in total citations. Figure 2 presents the trend of citations received by the article between 1997 and 2008. The number of citations per year has been increasing stably since

1997 and especially after 2002. Further investigation shows that the paper accumulated 960 citations in 2008, illustrating that the research work of the article has received sustained attention.

Conclusions

This study intends to highlight and acknowledge the articles attracting the most citations. There are some valuable insights to be gained by taking this restricted approach.

In materials, international collaboration produces a small portion of the highest-impact articles. The USA is the world leader in materials, followed by Japan, Germany, the UK and France. China has maintained the highest growth rate in materials research since 1990. Institutions in the USA (7 out of 10) form the majority. There are 7 authors who come from the USA, three authors who come from Japan and one author who come from the UK in the top 11 authors. Among these, five authors from the USA, the UK and Japan respectively have single-author articles, implying that the independent research ability of researchers in the USA, the UK and Japan is more prominent than those in other countries, and that domestic collaboration plays an important and extensive role in materials. The 1004 highest-impact articles are densely distributed in 78 journals, and 452 of these are in top five journals.

The results presented in this study identify the leading countries, institutions, authors, what research is important and where the field is heading by analysing the highest-impact articles in materials. The next stage of this study will invite experts in the field to explain the results from the scientometric analysis.

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