A Bibliometric Analysis and Visualisation of Research Trends in Nano Cellulose and its used in Medical Engineering

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Abstract

Nano cellulose is one of the best options for reducing the impacts of plastic and its one of the important segments of the plastic industry.Thebibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "Nano cellulose" and its use in medical engineering field.All published articles related to "Nano cellulose" from "Scopus", were analyzed using the VOS viewer to develop analysis tables and visualization maps.This article had set the objective to consolidate the scientific literature regarding "Nano cellulose"and also to find out the trends related to the same.The most active authors in this research domain were Wang X, Mhaske S T, and Savadekar N.R (Refer to table 1). The overlay analysis of top countries researching Nano cellulose indicates that China and South Africa were the leading countries relating to the highest number of publications, citations, and co-authorship links (Refer to figure 5). The top journals of this research domain were identified as Carbohydrate Polymers and Nano Energy.

Keywords:Metamaterial,Nano cellulose, Bibliometric analysis, VOS viewer,

INTRODUCTION

Nano celluloses are innovative materials possessing special features of both cellulose and Nano-scale materials[1].Cellulose had been used for more than thousands of years. Nano cellulose dependent materials[2]–[4] have been used widely for manufacturing of medical implants. The world is looking for a complete substitute for materials from non-renewable sources and Cellulose are the most abundant renewable polymers on earth. A lot of scientific and academic interest had been given to the research in cellulose, especially Nano cellulose, due to its applicability in diversified areas[5] and due to its special physical, chemical, and biological properties [6]. Nano cellulose can be derived from multiple rawmaterials and the shape and size of this Nano cellulose are heavily dependent upon on nature of the precursor and hydrolysis condition [7].Nano cellulose is an important research niche in material engineering[8]. This article points out the need for future research regarding Nano cellulose. This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding Nano cellulose. This article is arranged in four sections. The first section is the introduction, followed by the discussion of the methodology by which the research was conducted. The third section deals with results and discussion. The fourth section deals with the conclusion.

1.1 Research Objectives

    a) To consolidate the literature regarding Nano cellulose

b) To find out the trends related to research in Nano cellulose

The following research questions are framed for conducting bibliometric analysis systematically.

1.2 Research Questions

a) Who are the active researchers working on Nano cellulose?
b) Which are the main organizations and countries working on Nano cellulose?
c) Which are the main journals related to Nano cellulose?

RESEARCH METHODOLOGY

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS ("Nano cellulose")on 11/01/2021. All the tables in this paper were created by using Microsoft Excel and VOS Viewer. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation.This paper had been inspired by bibliometric analysis in its presentation style, analysis, and methodology from the works[9][10][11][12][13][14].

RESULTS AND DISCUSSION

1.1 Results

This first round of search produced an outcome of324 documents, infourlanguages, out of which 283 documents were in English. The classification of document categories is shown in Figure 1. For improving the quality of the analysis, we had selected only the peer-reviewed articles and all other documents had not been considered. Thus after using filters "Article"and "English" the second round search produced an outcome of 191 English articles (both open access and others) andhad been used to conduct bibliometric analysis and visualization using VOS Viewer. The English research articles in this domain since 2006 had been shown in Figure 2.
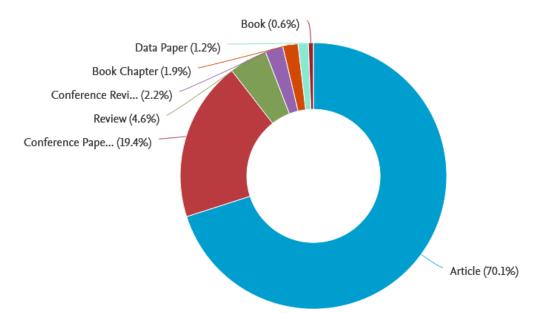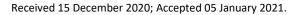

Figure 1: Classification of the documents on "Nano cellulose", Source: www.scopus.com
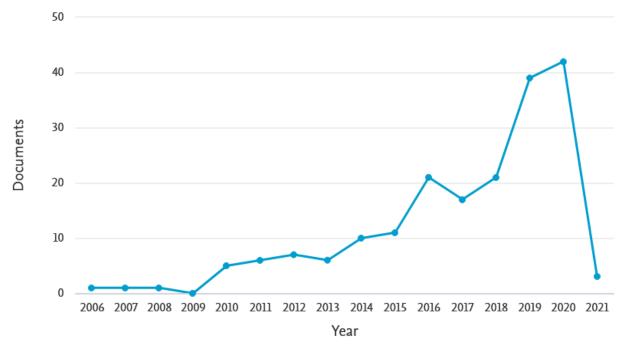
Figure 2: Period wise publication of articles, Source: WWW.scopus.com

Co-authorship analysis of top authors had been shown in figure 3. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as threeand the minimum number of citations of authors as one. This combination plotted the map of32 authors, in 13 clusters. The overlay visualization map of co-authorship analysis plotted in Figure 3, points out the major researchers with their strong co-authorship linkages and clusters involved.
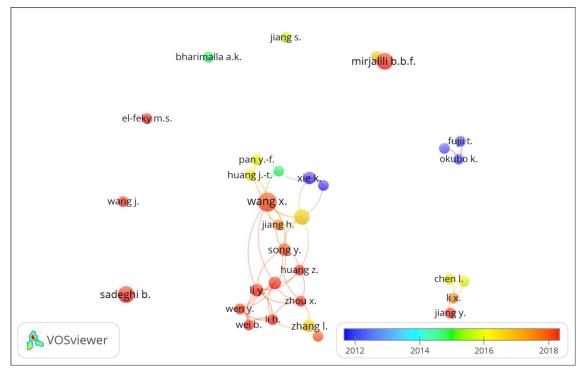

Figure 3: Co-authorship analysis on basis of authors

The citation analysis of top authors had been shown in table 1, along with co-authorship links.For the citation analysis, the parameters used were the minimum number of documents of an author as one and the minimum citations of an author as one.

Table 1: Highlights of most active authors

Description	Authors	Documents	Citations	Average citations per documents	Link strength
Authors with the highest publication and co-authorship links	Wang X.	9	91	10.11	34
Authors with the highest citation	Mhaske S.T.	2	222	111	5
	Savadekar N.R.	2	222	111	5
Authors with the highest average citation	Reddy J.P.	1	153	153	1
	Rhim J.-W.	1	153	153	1

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as15. This combination plotted the map of 18thresholds, in threeclusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.
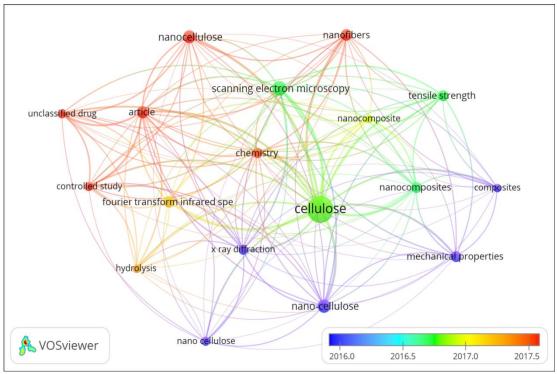

Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on "Nano cellulose" had been found out by the volume of publications and citation analysis, the parameters used are the minimum number of documents of an organization as one and the minimum number of citations of organizations as one. The leading organization in the research regarding "Nano cellulose", with the highest number of publications and citations,was the Chinese Academy of Sciences of China. The H-index figure had been drawn from Scopus analysis(Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document	h-index
Yazd university	Iran	10	106	10.6	6
Donghua University	China	10	199	19.9	8

Co-authorship analysis of the countries engaged in the research on "Nano cellulose" had been shown in Figure 5. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as four and the minimum number of citations of authors as one. This combination plotted the map of14 countries,sixclusters. The overlay visualization map of co-authorship analysis plotted in Figure 5, points out the main countries with their strong co-authorship linkages and clusters involved.
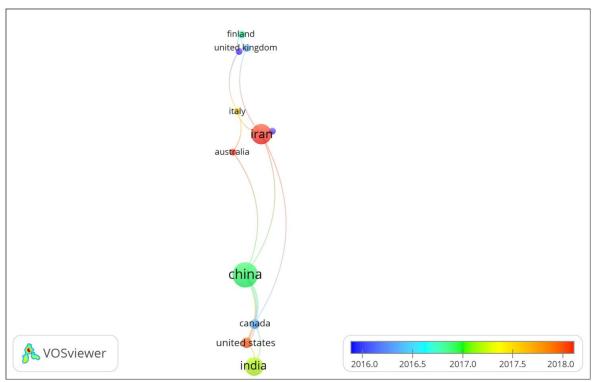

Figure 5: Co-authorship analysis on basis of countries

The citation analysis of top countries had been shown in table 3, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of acountry as one and the minimum citations of the country as one.

Table 3: Highlights of Active Countries

Description	Country	Documents	Citations	Average citations per documents	Link strength
The country with the highest publication, citations, and co-authorship links	China	54	877	16.24	11
The country with the highest average citations	South Africa	1	111	111	1

The most active countries in this research domain were China, with the highest number ofpublications, and citations,South Africa with the highest average citations.

Link analysis and citation analysis were used to identify the most active journal in this research domain. We have taken the parameters of the minimum number of documents of a journal as one and the minimum number of citations of a journal as one for the link analysis and citation analysis. Highlights of the most active and relevant journals related to "Nano cellulose" are shown in table 4. Table 4 shows the journal activity of this research domain through parameters of publication volume, citations, and co-authorship linkages.

Table 4: Analysis of journal activity

Description	Journal details	Documents	Citations	Average citations per documents	Link strength
Journal with the highest publications, citations, and co-authorship links	Carbohydrate Polymers	20	965	48.25	16
Journal with the highest average citations	Nano Energy	1	71	71	0

From the above discussion regarding the bibliometric patterns in the research regarding Nano cellulose, this research had observed a gradual increase in research interest regarding Nano cellulose from the starting of the millennium and the momentum is going on positively. This points out the relevance and potential of this research domain (Refer to Figure 2). The most active authors in this research domain were Wang X, Mhaske S T, and Savadekar N.R (Refer to table 1). The overlay analysis of top countries researching Nano cellulose indicates that

China and South Africa were the leading countries relating to the highest number of publications, citations, and co-authorship links (Refer to figure 5). The top journals of this research domain were identified as Carbohydrate Polymers and Nano Energy. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding Nano cellulose.

CONCLUSION

Nano cellulose,was an interesting research domain and the most active journals related to this research domain are Carbohydrate Polymers and Nano Energy. c This research domain offers a new avenue for researchers and future research can be on Metamaterial and Nano cellulose.

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