

A Bibliometric Analysis and Visualisation of Research Trends in Corrosion of Implants

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Abstract

Corrosion of medical implants is a serious issue in the medical sector. The bibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of “corrosion of implants”. All published articles related to “corrosion of implants” 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 “corrosion of implants” and also to find out the trends related to the same. The most active journal in this research domain was Material Science and Engineering C and Biomaterials. The most active country was the United States of America. The leading organizations engaged in the research regarding the Corrosion of implants were the Ministry of Education China and Rush University Medical Centre, United States of America. The most active authors who had made valuable contributions related to pacemaker batteries were Jacob J.J and Mathew M.T.

Keywords: Bio-implants, Corrosion, Material engineering, Bibliometric analysis, VOS viewer,

INTRODUCTION

Medical implants are manmade medical devices for replacing missing or damaged biological structures. Most of the innovations and advances in material engineering and surface engineering play a key role in developing modern implants [1]. Various types of implants had been used in modern medicine and include sensory implants, neurological implants, cardiovascular implants, orthopedic implants, contraceptive implants, and cosmetic implants. Some latest developments related to implants include bioactive glass/ bioglass coating, surface texturing, and additive manufacturing to improve the quality, life, and performance of implants [2].

Different types of metals and materials [3]–[6] are used to create implants and the most popularly used metals and alloys for bio-implants are stainless steel, cobalt-chromium alloy, and Titanium [7][8]. Corrosion of material of implants is a major challenge in implantation [9]. The major remedial measures against corrosion of implants are to bulk alloy stainless steel with Titanium and Nitrogen; bioceramic coating etc [10]. The issue of corrosion of bio-implants (made of uncoated stainless steel) due to simulated body fluids of the human body is an important issue addressed in all bio implantations and Titanium Nitride coating by using physical vapor deposition method was found effective against corrosion of implantations [11]. Laser treatment can also be considered for dealing with the corrosion of implants. Surface melting by laser treatment would reduce the corrosion [6] potential of bio-implants [12][13][14][15][16][17][18][19]. Another alternative for facing corrosion of implants is by Boride coating on the Ti-6Al-4V alloy [20][21][22]. Calcium coating of bio-implants [23]; using integrated anodization and thermal oxidation for improving bio-implants

[24] using Friction Stir Processing (FSP) for developing corrosion-resistant surfaces [25][26]; Hexagonal boron nitride impregnated silane composite coating for corrosion resistance of magnesium alloys [27]; IBAD SiNx coatings were found resistant to corrosion but too thin according to their porosity[28]; Sol-gel coatings on Ti6Al4V Titanium alloy implants [29][30]. Bio implant performance is heavily dependent upon cell behavior and by surface topography, the performance of bio-implants can be improved [31][32]. Oxynitrides coating on stainless steel [33] and zirconia (ZrO₂) film on stainless steel [34][35] had been found corrosion-resistant and suitable for bio implantations; Zr-based metallic glass for prospective biomedical applications [36].

This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding the corrosion of bio-implants. This article is arranged into 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. The following research objectives and research questions were framed for conducting bibliometric analysis systematically.

1.1 Research Objectives

- a) To consolidate the literature regarding corrosion of implants
- b) To find out the trends related to research in corrosion of implants

1.2 Research Questions

- a) Who are the active researchers working on the corrosion of implants?
- b) Which are the main organizations and countries working on the corrosion of implants?
- c) Which are the main journals related to corrosion of implants?

RESEARCH METHODOLOGY

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE (implant corrosion) on 18/01/2021. 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 [37]–[43].

RESULTS AND DISCUSSION

Results

This first round of search produced an outcome of 688 documents, in seven languages, out of which 630 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 475 English articles (both open access and others) and had been used to conduct bibliometric analysis and visualization using VOS Viewer. The English research articles in this domain since 1952 had been shown in Figure 2.

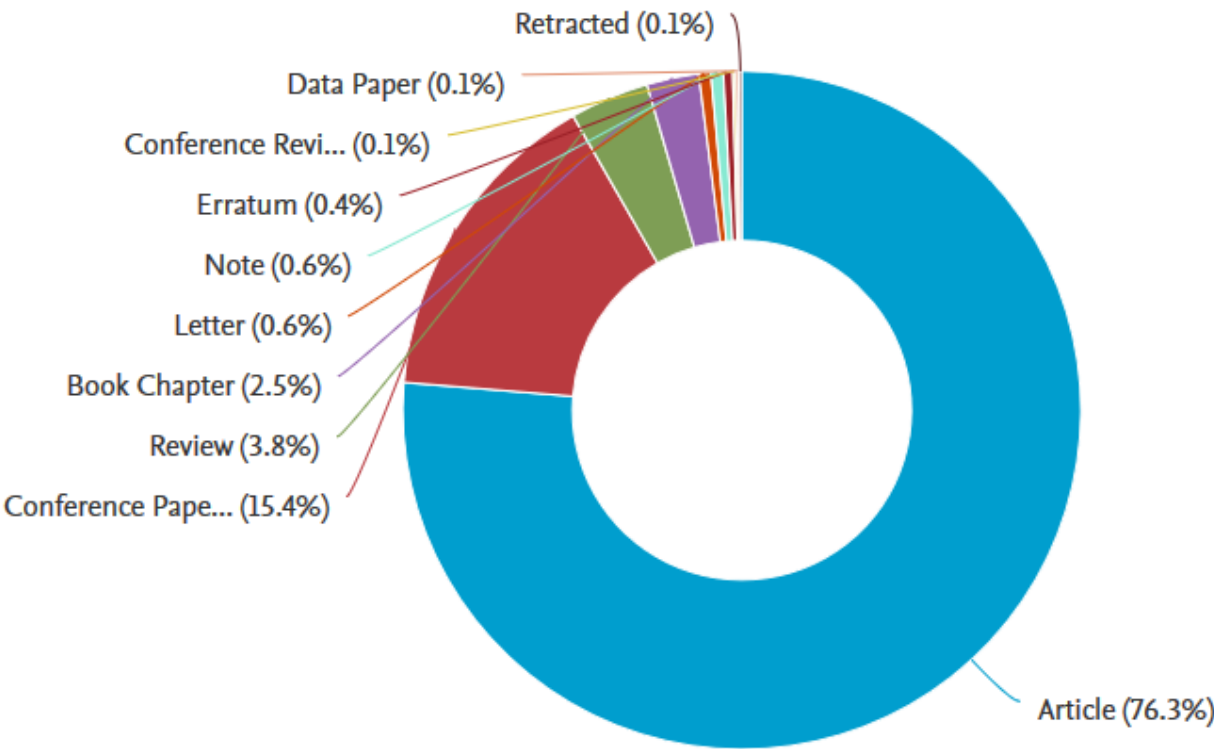


Figure 1: Classification of the documents on “Corrosion of implants”, Source: www.scopus.com

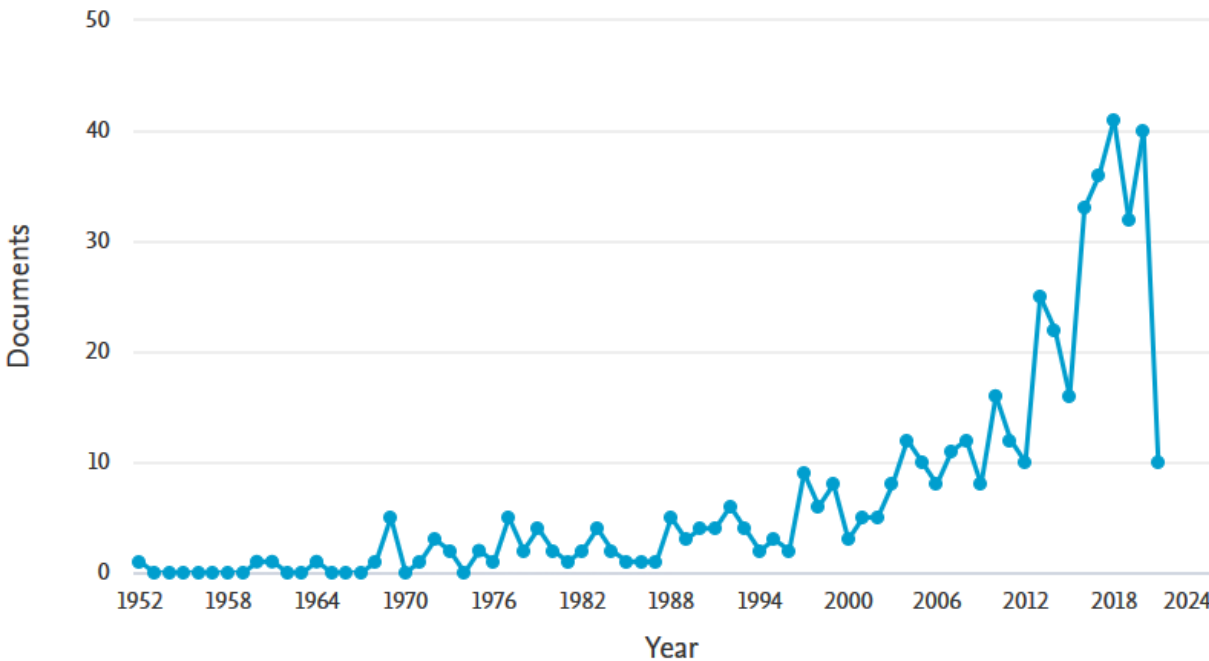


Figure 2: Period wise publication of articles, Source: WWW.scopus.com

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 four and the minimum number of citations of authors as one. This combination plotted the map of 35 authors, in 17 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.

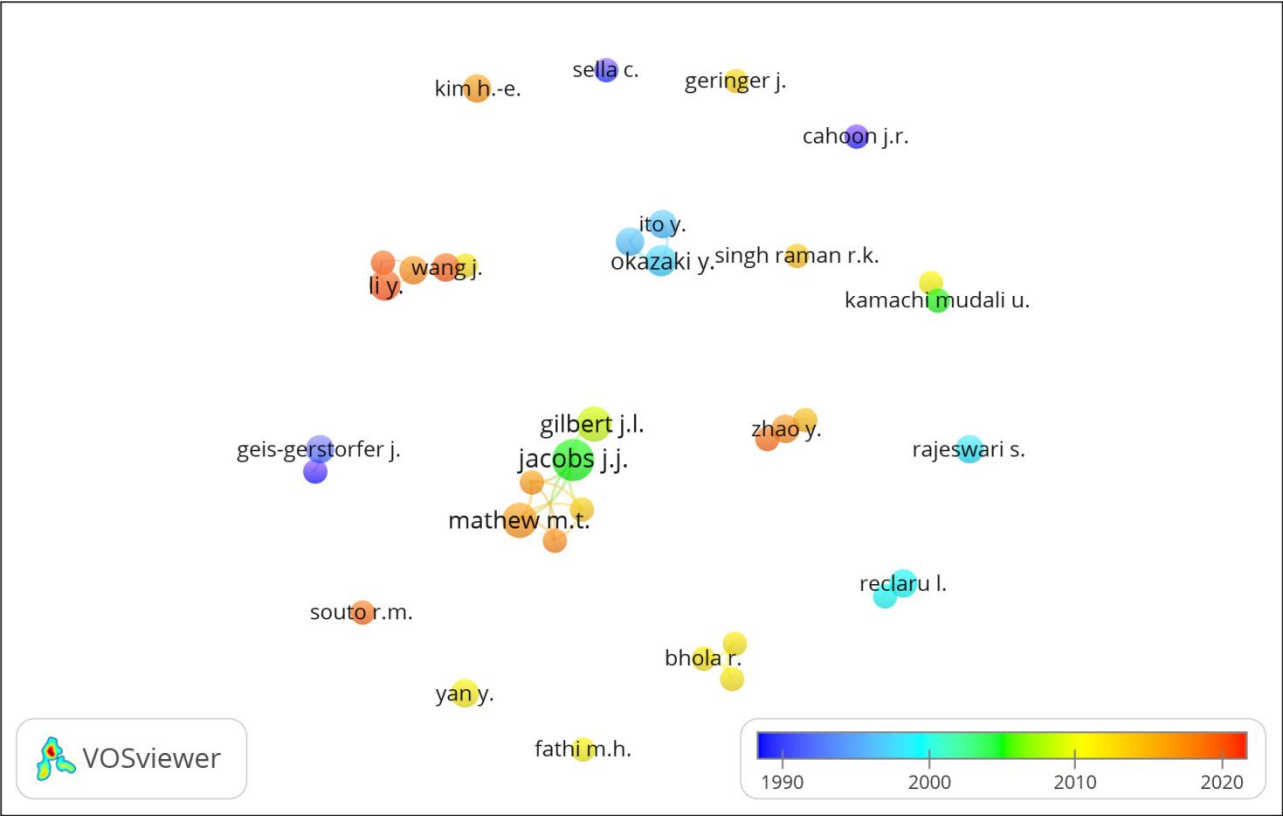


Figure 3: Co-authorship analysis on basis of authors

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 citations	Jacob J.J	11	1129	102.6	39
Authors with the highest co-authorship links	Mathew M.T	08	138	17.3	44

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 50. This combination plotted the map of 24 thresholds, in four clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.

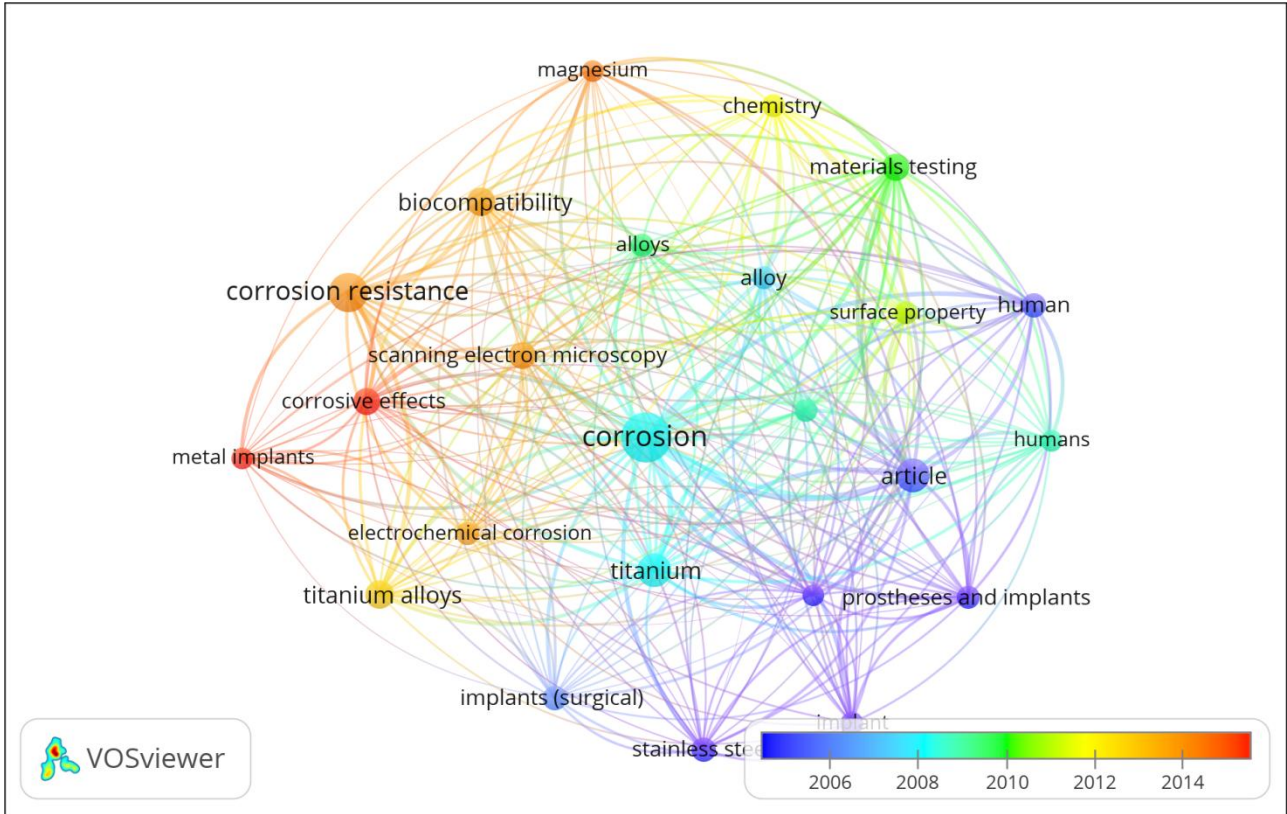


Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on “Corrosion of implants” 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 “Corrosion of implants”, with the highest number of publications and citations, were the Ministry of Education China and Rush University Medical Centre, United States of America. (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document
Ministry of Education in China	China	10	107	10.7
Rush University Medical Centre	United States of America	10	971	97.1

Co-authorship analysis of the countries engaged in the research on “Corrosion of implants” had been shown in Figure 5. 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.

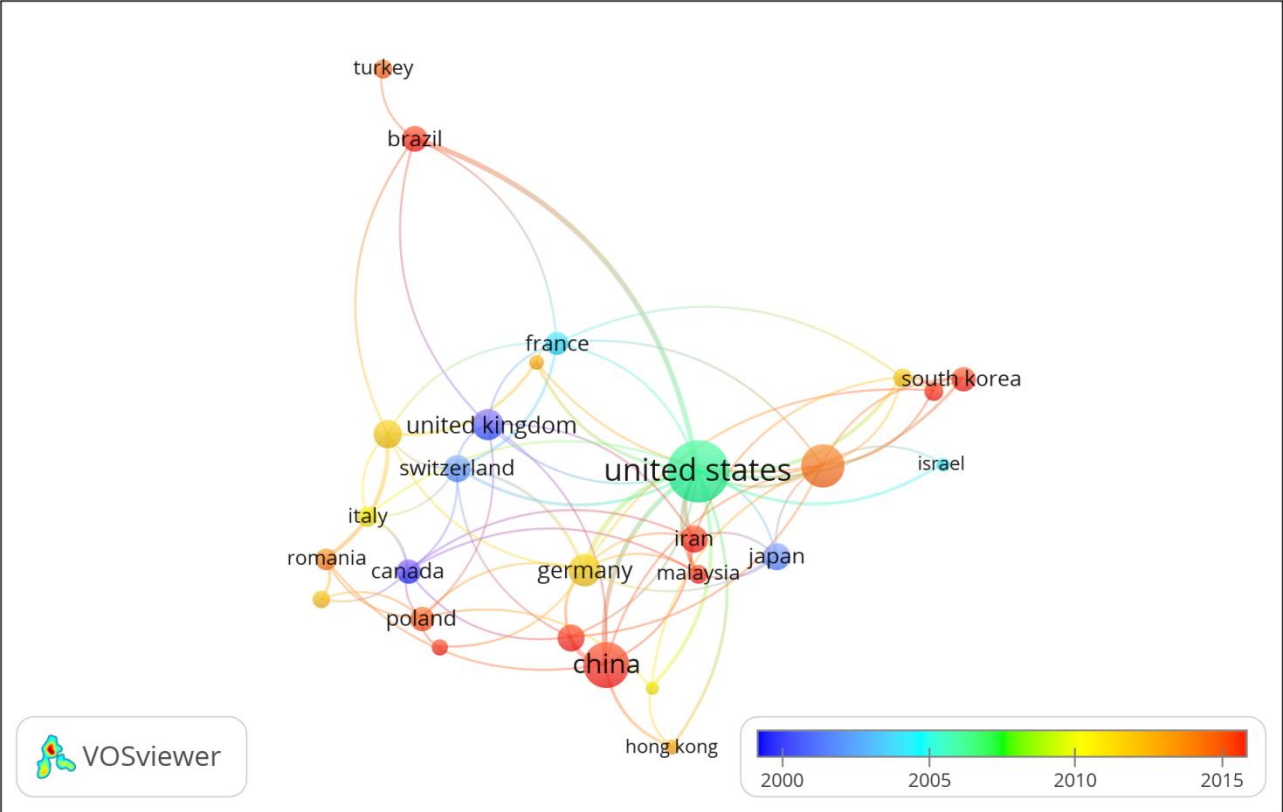


Figure 5: Co-authorship analysis on basis of countries

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 a country as one and the minimum citations of the country as one.

Table 3: Highlights of Active Countries

Description	Country	Documents	Citations	Link strength
The country with the highest publication, citations, and co-authorship links	United States of America	98	3655	48

The most active country in this research domain was the United States of America, with the highest number of publications, and 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 “Corrosion of implants” 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
Journal with the highest publications, and co-	Material Science and Engineering C	24	747	18

authorship links				
Journal with the highest citation	Biomaterials	11	1043	26

From the above discussion regarding the bibliometric patterns in the research regarding Corrosion of implants, this research had observed a gradual increase in research interest regarding Corrosion of implants 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 Jacob J.J and Mathew M.T with the highest publication, citation, and co-authorship links (Refer to table 1). The overlay analysis of top countries researching corrosion of implants indicates that the United States of America was the leading country relating to the highest number of publications, citations, and co-authorship links (Refer to figure 5). The top journal of this research domain was identified as the Material Science and Engineering C and Biomaterials. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding the Corrosion of implants.

CONCLUSION

Corrosion of implants was an interesting research domain and the most active journal related to this research domain were Material Science and Engineering C and Biomaterials. The most active country was the United States of America. The leading organizations engaged in the research regarding the Corrosion of implants were the Ministry of Education China and Rush University Medical Centre, United States of America. The most active authors who had made valuable contributions related to pacemaker batteries were Jacob J.J and Mathew M.T. This research domain offers a new avenue for researchers and future research can be on innovations in the Corrosion of implants.

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