

A review on use of IT in Surface Coating of Vanadium-Implants

P.Suresh, Professor, Department of Mechanical & Chemical Engineering, Galgotias University

Abstract

Vanadium is one of the most used metals for implants. Analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of “Surface coating of Vanadium-implants”. All published articles related to “Surface coating of Vanadium-implants” from “Scopus”, were analyzed using the Meta Analysis to develop analysis tables and visualization maps. This article had set the objective to consolidate the scientific literature regarding “Surface coating of Vanadium-implants” and also to find out the trends related to the same. The leading Journals were the Surface and Coating Technology and Journal of Biomedical Materials research. The most active country was the United States of America. The leading organization engaged in the research regarding surface coating of Vanadium implants was the Chinese Academy of Sciences, China. The most active authors who had made valuable contributions related to the Surface coating of Vanadium implants were Simka W. and Ziegler.

Keywords: Vanadium-implants, Surface coating, Material engineering, Review analysis, Meta Analysis,

Introduction

An engineered medical device to replace a missing or damaged biological structure is known as an implant. Different types of metals and materials are used to create implants (Priyanka *et al.*, 2014). Various types of implants had been used in modern medicine and include dental implants (Bhola *et al.*, 2010) dental crown (Er and Unsaldi, 2013) sensory implants, neurological implants, cardiovascular implants, orthopedic implants (Er and Unsaldi, 2013), contraceptive implants, and cosmetic implants.

Vanadium implants range from orthopedic implants, knee implants, dental implants (Zagury *et al.*, 2007). The major issues associated with implants of Vanadium are the hypersensitivity and toxicity of the metal; development of systematic dermatitis and implant failure; Vanadium can be used for biomaterials and researchers had found that vanadium doesn't have any adverse effect on red blood cells and can improve the anti-bacterial functions of the implant Corrosion of Vanadium-implants is also an issue to be addressed.

Various types of surface engineering and surface coating can be conducted in Vanadium–implants to improve their performance and longevity. Material engineering and surface engineering can play a significant role in improving the performance and life of Vanadium –implants along with measures for reducing toxicity and hypersensitivity of the metal. Thermal and chemical modifications in Vanadium implants can improve the performance of the implant. (MacDonald *et al.*, 2004). Titanium oxide coatings over vanadium implants can enhance wound healing around implants (Jarrell, Dolly and Morgan, 2009). The high anti-bacterial properties of Vanadium helps to use vanadium pentoxide/polymer biocomposite for implant-coating applications. Similarly, Vanadium Nitride can also be used for surface coating of implants.

This Review analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding corrosion of Vanadium-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 Review analysis systematically.

1.1 Research Objectives

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

1.2 Research Questions

- a) Who are the active researchers working on the Surface coating of Vanadium-implants?
- b) Which are the main organizations and countries working on the Surface coating of Vanadium-implants?
- c) Which are the main journals on the Surface coating of Vanadium-implants?

1. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS-KEY(Coating-Vanadium-implant). All the tables in this paper were created by using Microsoft Excel and Meta Analysis. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation. This paper had been inspired by Review analysis in its presentation style, analysis, and methodology from the works

2. Results and discussion

2.1 Results

This first round of search produced an outcome of 303 documents, in six languages, out of which 290 documents were in English. The classification of document categories is shown in Table 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 232 English articles (both open access and others) and had been used to conduct Review analysis and visualization using Meta Analysis. The English research articles in this domain since 1980 had been shown in Figure1.

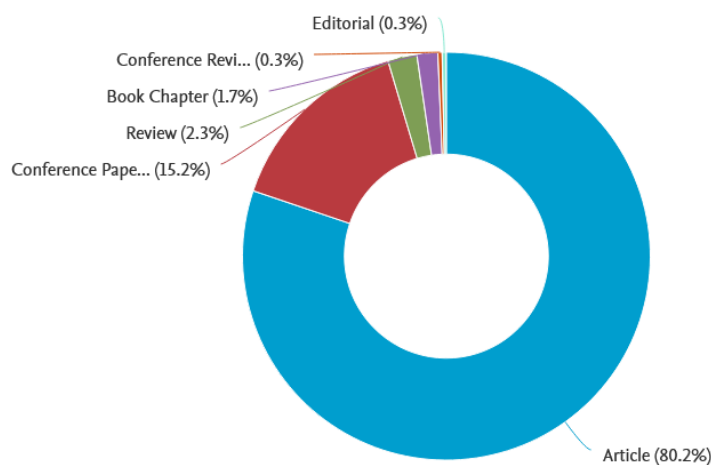


Figure 1: Classification of the documents on “surface coating of Vanadium -implants”

Co-authorship analysis of top authors had been shown in Table1. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as three and the minimum number of citations of authors as one. This combination plotted the map of 35 authors, in 15 clusters. The overlay visualization map of co-authorship analysis plotted in Table1, points out the major researchers with their strong co-authorship linkages and clusters involved.

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	Simka W.	5	70	14	28
Authors with the highest citations	Ziegler	2	230	115	8

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 30. This combination plotted the map of 30 thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Table 2. The leading organizations engaged in research on “Surface coating of Vanadium -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 “Surface coating of Vanadium -implants”, with the highest number of publications and citations, was the Chinese Academy of Sciences, China (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document
Chinese Academy of Sciences	China	7	19	2.7

Co-authorship analysis of the countries engaged in the research on “surface coating of Vanadium -implants” plotted in Table 3, points out the main countries with their strong co-authorship linkages and clusters involved. 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 leading publication, citations, and co-authorship links	United States of America	37	1008	8

The most active country in this research domain was the United States of America, with the leading 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 “surface coating of

Vanadium -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	Links
Journal with the highest publications	Surface and Coating Technology	21	324	15.4	4
Journal with highest co-authorship and citations	Journal of Biomedical Materials research	12	578	48	10

From the above discussion regarding the Review patterns in the research regarding surface coating of Vanadium implants, this research had observed a gradual increase in research interest regarding surface coating of Vanadium 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 Table 2). The most active authors in this research domain were Simka W. and Ziegler with the highest publication and co-authorship links; and citations respectively (Refer to table 1). The overlay analysis of top countries researching surface coating of Vanadium 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 Table 5). The top journals of this research domain were identified as the Surface and Coating Technology and Journal of Biomedical Materials research. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding surface coating of Vanadium implants.

3. Conclusion

Surface coating of Vanadium implants was an interesting research domain and the most active journals related to this research domain were the Surface and Coating Technology and Journal of Biomedical Materials research. The most active country was the United States of America. The leading organization engaged in the research regarding surface coating of Vanadium implants was the Chinese Academy of Sciences, China. The most active authors who had made valuable contributions related to the Surface coating of Vanadium implants were Simka W. and Ziegler. This research domain offers a new avenue for researchers and future research can be on innovations in the surface coating of Vanadium -implants.

References

1. Er, Y. and Unsaldi, E. (2013) 'The production of nickel-chromium-molybdenum alloy with open pore structure as an implant and the investigation of its biocompatibility in vivo', *Advances in Materials Science and Engineering*, 2013. doi: 10.1155/2013/568479.
2. Farhat, T. *et al.* (2013) 'Research in congenital heart disease: A comparative Review analysis between developing and developed countries', *Pediatric Cardiology*, 34(2), pp. 375–382. doi: 10.1007/s00246-012-0466-6.
3. Jarrell, J. D., Dolly, B. and Morgan, J. R. (2009) 'Controlled release of vanadium from titanium oxide coatings for improved integration of soft tissue implants', *Journal of Biomedical Materials Research - Part A*, 90(1), pp. 272–281. doi: 10.1002/jbm.a.32093.
4. Aluminum-vanadium implant materials: Effects on surface properties, glycoprotein adsorption, and MG63 cell attachment', *Biomaterials*, 25(16), pp. 3135–3146. doi: 10.1016/j.biomaterials.2003.10.029.
5. Priyanka, P. *et al.* (2014) *Role of nanogrooves on the performance of ultra-fine grained titanium as a bio-implant*, *Advanced Nanomaterials: Synthesis, Properties, and Applications*. Apple Academic Press. doi: 10.1201/b16966.
6. Singh, H. and Kumar, R. (2013) 'Measuring the utilization index of advanced manufacturing technologies: A case study', in *IFAC Proceedings Volumes (IFAC-PapersOnline)*. Saint Petersburg: IFAC Secretariat, pp. 899–904. doi: 10.3182/20130619-3-RU-3018.00395.
7. Zagury, R. *et al.* (2007) 'Histomorphometric analyses of bone interface with titanium-aluminum- vanadium and hydroxyapatite-coated implants by biomimetic process', *Implant Dentistry*, 16(3), pp. 290–296. doi: 10.1097/ID.0b013e3180e9d9ed.