

# Research Trends in Weathering of Magnesium-Implants Using IT Technologies

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## Abstract

Magnesium is one of the most used metals for implants. The Review analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of “Corrosion of Magnesium-implants”. All published articles related to “Corrosion of Magnesium-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 “Corrosion of Magnesium-implants” and also to find out the trends related to the same. The leading Journals were Acta Biomaterialia and Material Science and Engineering. The most active country was China. The leading organization engaged in the research regarding corrosion of Magnesium-implants was the Ministry of Education, China. The most active authors who had made valuable contributions related to corrosion of Magnesium-implants were Zhang Y., Witte F., and Zheng Y.

**Keywords:** Magnesium-implants, Corrosion, Material engineering, Review analysis, Meta Analysis,

## 1. 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. The Bio-compatibility of Magnesium and its biodegradability had been helpful for diversified medical applications. Similarly, the high concentration of metals in body fluids, toxicity, and allergy of metals should also be considered in the cases of bio-implants. The high degradation rate and poor antibacterial properties are the main drawbacks of magnesium implants (Atrens, Liu and Zainal Abidin, 2011).

Corrosion of Magnesium implants is a major concern for magnesium implants (Atrens, 2013). However, there are pieces of evidence that the Cyto-compatible and antibacterial coating layer on magnesium implants can improve the performance of implants. Similarly, Control of magnesium alloy corrosion by bioactive calcium phosphate coating; Corrosion-controlling and osteo-compatible mg ion-integrated phytic acid (Mg-PA) coating on magnesium substrate for biodegradable implants application can reduce the negative impacts of corrosion of magnesium implants (Chen *et al.*, 2014); Construction of tantalum/poly(ether imide) coatings on magnesium implants with both corrosion protection and osseo

integration properties. Functionally gradient magnesium-based composite can be used for the temporary orthopedic implant, which can improve corrosion resistance and osteogenic properties. Plasma electrolytic oxidation to improve the corrosion resistance of magnesium-based biodegradable implants; A crack-free anti-corrosive coating strategy for magnesium implants.

Material engineering and surface engineering can play a significant role in improving the performance and life of Magnesium-implants along with measures for reducing toxicity and hypersensitivity of the metal implants. Future research can also be on surface coatings by using, metal implants using Magnesium. This Review analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding Magnesium-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 Corrosion of Magnesium-implants
- b) To find out the trends related to research in Corrosion of Magnesium-implants

### 1.2 Research Questions

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

## Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS (Magnesium implant corrosion). 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.

## Results and discussion

### 1.1 Results

This first round of search produced an outcome of 1348 documents, in ten languages, out of which 1308 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 936 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 1972.

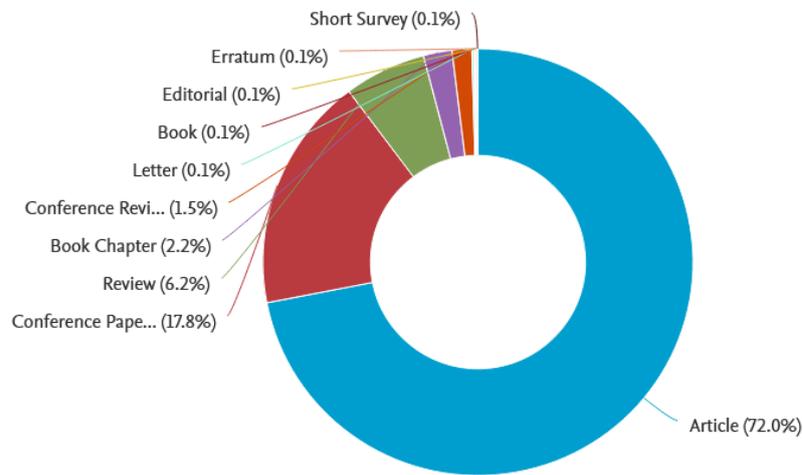


Figure 1: Classification of the documents on “Corrosion of Magnesium-implants”.

Co-authorship analysis of top authors had been shown in Table 3. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as 13 and the minimum number of citations of authors as one. This combination plotted the map of 28 authors, in eight clusters. The overlay visualization map of co-authorship analysis plotted in Table 3, 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	Zhang Y.	29	1406	48.4	194
Authors with the highest citation	Witte F.	19	6144	323.3	129
Authors with the highest links	Zheng Y.	27	2244	83.1	205

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 100. This combination plotted the map of 38 thresholds, in two clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Table 2. The leading organizations engaged in research on “Corrosion of Magnesium-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

organizations in the research regarding “Corrosion of Magnesium-implants”, with the highest number of publications and citations, were the Ministry of Education, China (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document
Ministry of Education	China	70	1297	18.5

Co-authorship analysis of the countries engaged in the research on “corrosion of Magnesium-implants” had been shown in Table 5. The overlay visualization map of co-authorship analysis plotted in Table3, 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	China	365	13560	112

The most active country in this research domain was China, with the highest number of publications, links, 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 Magnesium-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 citations, and links	Acta Biomaterialia	56	5384	96	982
Journal with the highest publications	Material Science and Engineering	63	2299	36.5	667

From the above discussion regarding the Review patterns in the research regarding corrosion of Magnesium-implants, this research had observed a gradual increase in research interest regarding corrosion of Magnesium-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 Zhang Y., Witte F., and Zheng Y. with the highest publication, citation, and co-authorship links respectively (Refer to table 1). The overlay analysis of top countries researching corrosion of Magnesium-implants indicates that China 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 Acta Biomaterialia and Material Science and Engineering. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding corrosion of Magnesium-implants.

## 2. Conclusion

Corrosion of Magnesium-implants was an interesting research domain and the most active journals related to this research domain were Acta Biomaterialia and Material Science and Engineering. The most active country was China. The leading organization engaged in the research regarding corrosion of Magnesium-implants was the Ministry of Education, China. The most active authors who had made valuable contributions related to corrosion of Magnesium-implants were Zhang Y., Witte F., and Zheng Y. with the highest publication, citation, and co-authorship links respectively. This research domain offers a new avenue for researchers and future research can be on innovations in corrosion of Magnesium-implants.

## References

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