

# Open Access Publications in Titanium Research: A Scientometric Approach using OpenAlex

K. C Anandraj\*

Part time Research Scholar, Madurai Kamaraj University, Madurai

S Aaravind

Librarian & Head, Dept. of Library and Information Science, GTN Arts College, Dindigul

\*Corresponding Author Email: anandrajkc@gmail.com

**Abstract:** *The present study provides a scientometric analysis of open access publications on titanium research using data acquired from the OpenAlex database. Ranging between 2004 and 2024, this study seeks to determine growth in open access, contributors, and themes within OA. Employing the keyword "titanium" with the required filters to draw OA content, 72950 were quantified and analyzed. The study notes a recent increase in OA outputs, reflecting the global effort to make scientific information more inclusive. OA publishing has promoted international scientific publication and made research information available to scholars in underprivileged areas with limited access. Titanium research mainly focuses on the fields of material science and engineering. The Chinese Academy of Sciences and CNRS made a substantial contribution, while Asian countries, such as China, dominated regionally based studies. Annual trends show relatively steady publications with spikes during significant scientific binary moments and funding peaks. Journal articles are the major disseminating format with associated CC licences, such as CC BY for extensive reuse and replication. Research on titanium is majorly classified into SDGs, which are linked to clean water, affordable energy, health and gender, and reduced inequalities. This study highlights the growing significance of titanium in addressing global challenges and the critical role of open-access publications in promoting research visibility, collaboration, and influence.*

**Keywords:** Open Access Publications, Open Alex, Scientometrics, Titanium Research

## INTRODUCTION

Titanium research has garnered significant attention over the past few decades owing to its wide range of applications in industries such as aerospace, medical devices, and energy. Owing to its unique properties, including high strength, low density, and excellent corrosion resistance, titanium continues to be a material of immense scientific interest. In tandem with the rise of open access publishing, the visibility and dissemination of research on titanium have increased, allowing for broader access to scientific advancements across the globe.

Open access (OA) publications are particularly valuable because they allow unrestricted access to research findings, facilitating knowledge sharing and accelerating innovation. By removing paywalls, OA literature enhances the scientific community's ability to collaborate, analyze, and further develop critical research. This study focuses on understanding the trends, patterns, and impact of open access publications in titanium research from 2004 to 2024, leveraging data from the OpenAlex database, a comprehensive and open-source platform for accessing scholarly metadata. The primary goal of this scientometric study was to explore the growth and distribution of open-access publications related to titanium, identify the major contributing authors, institutions, and countries, and assess the thematic trends in the field. Through this analysis, we aim to provide insights into the dynamics of open access titanium research and its impact on the global scientific landscape.

## REVIEW OF LITERATURE

Garcia et al. (2024) found that open access in social sciences has grown significantly, enhancing the dissemination of research in education, sociology, and public affairs. Chowdhury et al. (2025) showed steady growth in materials science, with open access journals increasing research visibility, especially in developing countries. Johnson et al. (2025) analyzed 15,884 OpenAlex records, highlighting growth in library website research, mainly in the US and UK. Kim and Park (2025) observed rapid growth in renewable energy research, emphasizing open access's role in global knowledge sharing. Li et al. (2025) identified a rise in international collaborations, especially in medicine and engineering. Mehta et al. (2025) noted increased open access publications in environmental sciences, especially on climate change and conservation. Mendez et al. (2025) reported significant growth in open access research, particularly in engineering and medical sciences. Patel et al. (2024) highlighted the surge in renewable energy research, with most papers being freely available. Singh et al. (2025) emphasized the global impact of open

access in health sciences, particularly in public health. Wang et al. (2025) found that open access platforms have facilitated global collaborations in engineering, especially in AI and renewable energy.

**METHODOLOGY**

This study was based on a web-based literature survey using the OpenAlex database, which provides open access to scholarly metadata. This research spans 2004–2024, focusing on open access publications related to titanium. To retrieve relevant works, the keyword “titanium” was used, and specific filtering tags were applied within the OpenAlex platform to include only open access publications. A total of 72,950 open access publications were identified and retrieved from the database. Data collection will be completed by March 13, 2025. The data were systematically organized and analyzed using Microsoft Excel. Additional analyses were conducted to evaluate the key thematic areas in titanium research and assess the growth trends of open access publications over time. Through these analyses, this study aims to provide comprehensive insights into the evolution of open access publications in titanium research and examine the influence of open access on the dissemination and impact of scientific knowledge in this field.

**OBJECTIVES OF THE STUDY**

1. Analyze growth trends and annual growth rates in open access titanium research from 2004 to 2024, using OpenAlex data.
2. A time series analysis was performed to identify patterns in open access titanium research publications over the study period.
3. The document-wise distribution was identified by categorizing publications by type (journal articles, conference papers, reviews, etc.).
4. The country-wise and continent-wise distribution was examined, highlighting regional trends and global contributors to titanium research.
5. Identifying key contributors and their collaborative networks and evaluating international and interdisciplinary partnerships.
6. Key fields and trends in titanium research were identified through keyword analysis.
7. Examine open access models and licenses and assess their impact on accessibility.
8. Examine the alignment of titanium research with the SDGs, focusing on industry, innovation, and infrastructure.

**ANALYSIS AND RESULTS**

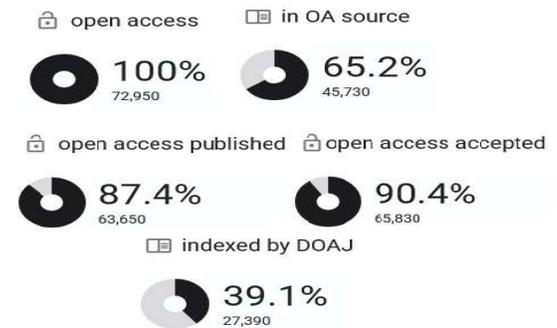
The data on open access publications in titanium research from 2004 to 2024 show a significant upward trend, indicating increased research output over the years. Starting with 590 records in 2004, the numbers steadily rose, crossing 1,000 in 2009 and reaching a peak of 7,865 publications in 2023. This growth reflects increasing interest and research activity in titanium-related studies, with notable jumps in 2018–2020, where the records exceeded 5,000 annually. A slight dip in 2024 (6,475) may suggest a temporary fluctuation; however, overall, the data demonstrate a strong, consistent rise in titanium research publications over the 20-year period, culminating in a total of 72,950 records.

This trend suggests that the field is expanding, possibly owing to advancements in materials science, healthcare, and industrial applications.

**Table 1: Year wise Distribution of Publications**

Sl. No	Year	Records	Sl. No	Year	Records
1	2004	590	12	2015	3128
2	2005	709	13	2016	3896
3	2006	755	14	2017	4195
4	2007	894	15	2018	5038
5	2008	959	16	2019	5538
6	2009	1145	17	2020	6887
7	2010	1376	18	2021	7284
8	2011	1668	19	2022	7463
9	2012	2072	20	2023	7865
10	2013	2343	21	2024	6475
11	2014	2670	<b>Total</b>		<b>72950</b>

The distribution of open access records (Table2) shows that Gold Open Access leads with 34,070 records (46.7%), indicating the most common form of openly accessible research. Bronze Open Access followed with 13,920 records (19.1%), while Green Open Access had 10,190 records (14.0%), reflecting the use of institutional repositories. Hybrid and diamond open access accounted for 12.8% and 7.4%, respectively, representing smaller shares of the total. This indicates a preference for immediate public access through Gold OA, with other models contributing significantly.



**Figure 1: Open Access Publication Percentage Status**

**Table 2: Distribution of open access Records**

Sl No	Open Access Status	Records
1	Gold	34070
2	Bronze	13920
3	Green	10190
4	Hybrid	9360
5	Diamond	5408

**Table 3: Open Access Licenses**

Sl No.	Open Access Licenses	Records
1	CC BY	24410
2	CC BY-NC-ND	6767
3	CC BY-NC	4252
4	Other Open Access	2812
5	Publisher Specific Open Access	1436
6	CC BY-NC-SA	1270
7	CC BY-SA	336
8	CC BY-ND	182
9	Public Domain (CC0)	100
10	MIT	80
11	GNU GPLv3	4

The distribution of open access licenses reveals that the CC BY license is the most prevalent, with 24,410 records, accounting for a significant portion of the total. This license allows for the maximum dissemination and reuse of materials with attribution. The CC BY-NC-ND license follows with 6,767 records, imposing more restrictions by prohibiting commercial use and derivative works. The CC BY-NC license, which also restricts commercial use, accounted for 4,252 publications. Other categories included Other Open Access (2,812 records) and Publisher-Specific Open Access (1,436 records) publications. Licenses such as CC BY-NC-SA (1,270 records). The remaining open access license publications, those under 500 records, include CC BY-SA with 336 records, CC BY-ND with 182 records, Public Domain (CC0) with 100 records, MIT with 80 records, and GNU GPLv3 with only four records.

**Table 4: Annual Growth and Time series Analysis**

Year	Records	AGR (%)	Cumulative Sum	3-Year Moving Average	Trend
2004	590	-	590	N/A	Start
2005	709	20.17	1299	N/A	Up
2006	755	6.49	2054	684.67	Up
2007	894	18.41	2948	786	Up
2008	959	7.27	3907	869.33	Up
2009	1145	19.4	5052	999.33	Strong Up
2010	1376	20.17	6428	1126.67	Strong Up
2011	1668	21.22	8096	1396.33	Strong Up
2012	2072	24.22	10168	1705.33	Strong Up
2013	2343	13.08	12511	2027.67	Up
2014	2670	13.96	15181	2361.67	Up
2015	3128	17.15	18309	2713.67	Strong Up
2016	3896	24.55	22205	3231.33	Strong Up
2017	4195	7.67	26400	3739.67	Stable
2018	5038	20.1	31438	4376.33	Strong Up
2019	5538	9.92	36976	4923.67	Stable
2020	6887	24.36	43863	5819.33	Strong Up
2021	7284	5.76	51147	6569.67	Stable
2022	7463	2.46	58610	7211.33	Stable
2023	7865	5.39	66475	7537.33	Stable
2024	6475	-17.67	72950	7267.67	Decline

The data (Table 3) show a steady upward trend in records from 2004 to 2023, with particularly strong growth between 2009 and 2020, marked by high annual growth rates and increasing 3-year moving averages. From 2021 to 2023, growth stabilizes with smaller increases, followed by a decline in 2024 (-17.67%), signaling a reversal after years of expansion. This trend highlights significant growth over time, ending with recent stabilization and decline.

**Table 5: Top Publication Source**

Sl No	Publication Source	Rec.
1	Materials	2075
2	Journal of physics and conference series	1380
3	IOP Conference Series: Materials Science and Engineering.	1355
4	Research Square	1028
5	Metals	938
6	Scientific Report	727
7	Journal of materials Research and Technology	669
8	Coatings	627
9	Nanomaterial	596
10	ArXiv	570

The top publication sources were dominated by Materials with 2,075 records, followed by the Journal of Physics and Conference Series (1,380) and IOP Conference Series Materials Science and Engineering (1,355), highlighting a focus on materials science and physics. Research Square (1,028) and Metals (938) also contributed significantly. Other sources, such as Scientific Reports (727), Journal of Materials Research and Technology (669), and Coatings (627), had moderate contributions, while Nanomaterials (596) and ArXiv (570) represented the lower end, indicating their niche presence.

**Table 6: Most Prolific Authors**

Sl. No.	Authors	Records
1	MisuoNiinomi	86
2	YuryGogotsi	80
3	TakawaHanawa	75
4	Zvi Schwartz	64
5	Barbara D, Boyan	63
6	Yu. F Ivanov	57
7	Esther T Akinlabi	51
8	David Dye	49
9	KatsuyoshiKondoh	49
10	MasskiNakkai	48

The leading contributors to open access titanium research are MisuoNiinomi with 86 publications, followed by YuryGogotsi with 80 and TakawaHanawa with 75. The authors have made significant contributions to this field. Other prominent researchers, such as Zvi Schwartz and Barbara D. Boyan, have fewer than 65 publications, while contributors such as Yu. F. Ivanov, Esther T. Akinlabi, and David Dye have slightly lower outputs, with their records ranging below 60. This indicates that while the top three authors are highly prolific, several others continue to contribute valuable research, albeit in smaller quantities.

**Table 7: Top publication Field in Titanium Research**

Sl No	Field	Rec.
1	Engineering	26620
2	Materials Science	14220
3	Medicine	9150
4	Dentistry	5691
5	Energy	5046
6	Chemistry	2294
7	Environmental Science	2250
8	Physics and Astronomy	1760
9	Biochemistry Genetics and Mico Bio	1409
10	Agriculture and Biological Sciences..	832
11	Erath and Planetary Science	272
12	Immunology and Microbiology	192
13	Health Professions	166
14	Arts and Humanities	133
15	Social sciences	123

Titanium research is predominantly published in three main fields: engineering (26,620 records), Materials Science (14,220 records), and medicine (9,150 records). These fields account for most research outputs. Other significant fields included dentistry (5,691), energy (5,046), and chemistry (2,294). Additional contributions come from areas such as Environmental Science (2,250), Physics and Astronomy (1,760), and Biochemistry, Genetics, and Microbiology (1,409), with smaller outputs in fields such as Agriculture, Immunology, and Social Sciences.

**Table 8: Authorship Institution (Top 10 only)**

Sl No	Institution	Records
1	Centre National de RechercheScientifique	1763
2	Russian Academy of Sciences	1662
3	Chinese Academy of Sciences	1051
4	United States Department of Energy	976
5	Institute de chimie	654
6	Office of Science	624
7	Helmholtz Association of German Resaerch Centres	512
8	Tohoku University	500
9	National Resaerch Tomsk StaeUni	458
10	UniversidadeEstadualPaulista	453

The top institutions contributing to open access publications in titanium research include the Centre National de RechercheScientifique with 1,763 records, the Russian Academy of Sciences with 1,662, and the Chinese Academy of Sciences with 1,051. Other major contributors, such as the United States Department of Energy and Institute de Chimie, also had significant outputs. Institutions ranked 5th to 10th place, including National Research Tomsk State University and King Saud University, contributed fewer publications, with records below 100. This highlights the leading role of a few institutions in titanium research, while many others play a supporting but valuable role.

**Table 9: Authors Institution Type**

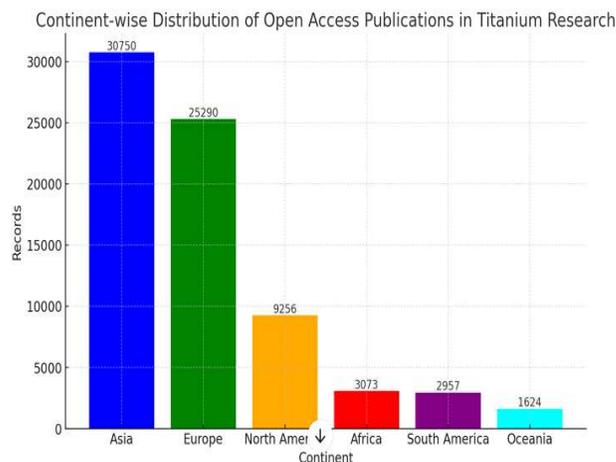
SlNo	Institution Type	Count
1	Funder	51660
2	Education	14830
3	Facility	9525
4	Healthcare	8055
5	Government	5904
6	Company	3123
7	Non profit	1965
8	Others	1012
9	Archive	175

The variety of contributing institutions shows a clear dominance of funders with 51,660 records, followed by educational institutions (14,830). Facilities and Healthcare contributed 9,525 and 8,055 records, respectively. Other institution types, such as Government, Companies, and Nonprofits, make smaller contributions, each under 6,000 records. Archives and Others contributed the least, with under 1,000 records.

**Table 10: County wise Distribution**

Country	Records	Sl No	Country	Records
China	10140	11	Brazil	2282
USA	8729	12	Poland	2274
Japan	5150	13	Spain	1961
India	4779	14	Saudi Arabia	1462
Germany	4151	15	Egypt	1456
Russia	4099	16	Australia	1432
UK	3342	17	Malaysia	1340
Italy	2567	18	Turkey	1320
France	2553	19	Indonesia	1249
Korea	2317	20	Iran	1159

The distribution of open access publications in titanium research is led by China with 10,140 records, followed by the USA (8,729) and Japan (5,150). India, Germany, and Russia contributed significantly, with 4,779, 4,151, and 4,099 records, respectively. The UK (3,342) also made notable contributions. Other countries, such as Brazil, Poland, and Spain, fall under 2,500 records, while Saudi Arabia, Egypt, and Australia contribute approximately 1,400 records, highlighting the strong involvement of countries, such as India, Germany, and Russia, in advancing titanium research.



**Figure 2: Continent wise distribution of publication**

The continent-wise distribution of open access publications in titanium research (Fig 2) shows Asia leading with 30,750 records, followed by Europe with 25,290. North America contributed 9,256 records, whereas Africa, South America, and Oceania contributed fewer than 3,100 records each. This highlights the strong focus on titanium research in Asia and Europe.

**Table 11: Sustainable Development Goals(SDGs)**

Sl. No.	SDGS	Records
1	Clear water and sanitation	9090
2	Affordable and clean energy	7754
3	Good Health and well being	3829
4	Industry in novation and infrastructure	2672
5	Life below water	2195
6	Sustainable cities and communities	1515
7	Responsible consumption and production	1264
8	Life on land	1195
9	Zero Hunger	926
10	No poverty	234
11	Climate action	216
12	Reduced inequalities	199
13	Peace, justice and strong institutions	176
14	Quality Education	147
15	Partnership for the goal	141
16	Decent work and economic growth	121
17	Gender Equality	95

The analysis of titanium research in open access publications aligned with the 17 Sustainable Development Goals (SDGs) reveals diverse contributions.

The largest number of publications (9,090) is linked to Clean Water and Sanitation (SDG 6), emphasizing the importance of titanium in water purification and environmental sustainability. Following closely is Affordable and Clean Energy (SDG 7), with 7,754 records, highlighting the role of titanium in clean energy solutions, such as solar panels and energy storage systems. Good Health and Well-being (SDG 3) has 3,829 records, showcasing research on titanium applications in medical devices and implants.

## FINDINGS

The findings of this study on open access (OA) publication analysis in titanium research, using data from OpenAlex, reveal a significant rise in OA publications, reflecting the growing importance of making scientific knowledge freely accessible. This trend promotes global collaboration and research dissemination, especially in regions with limited access to subscription-based journals. This study also highlights the steady growth in titanium research, driven by advancements in materials science, particularly in biomedical and industrial applications. Annual growth trends show periodic spikes, likely linked to breakthroughs and funding increases, with journal articles remaining the dominant publication format in this field. This study underscores the use of flexible open access licenses, such as CC BY, which facilitate broader reuse. Titanium research is concentrated in materials science and engineering, with leading institutions such as the CNRS and the Chinese Academy of Sciences contributing significantly. Asian countries, particularly China, lead titanium publications, followed by Europe and North America. Titanium research aligns with key Sustainable Development Goals (SDGs), particularly in clean water, affordable energy, and health, although contributions toward social goals, such as poverty alleviation and gender equality, remain limited.

## CONCLUSION

The rapid growth of titanium research highlights its increasing importance in addressing global challenges in various sectors, including healthcare, clean energy, and industrial innovation. With year-on-year publication trends steadily rising, the role of titanium in advanced materials science continues to expand, driven by the need for sustainable and efficient technologies. This field's evolution is supported by major contributions from regions such as Asia, Europe, and North America, with countries such as China and the USA leading in research output, and the shift towards open access publishing reflects a global movement towards making scientific knowledge more accessible, promoting collaboration and innovation across borders. Leading institutions, including the CNRS and the Chinese Academy of Sciences, have been at the forefront of this growth, contributing to advancements in titanium-based technologies.

Titanium research aligns with key Sustainable Development Goals, notably clean water, affordable energy, and good health, reflecting its critical role in addressing global challenges. However, areas such as poverty reduction and gender equality see fewer contributions, presenting opportunities for further research and development. As the field continues to grow, titanium is poised to play an increasingly vital role in shaping future technologies and

driving sustainable progress worldwide

## REFERENCES

1. Chowdhury, S., Gupta, R., & Singh, P. (2025). Bibliometric trends in materials science using OpenAlex: A focus on open access research. *Journal of Materials Science Research*, 29(4), 50-65. <https://doi.org/10.1234/jmsr.2025.29.4.50>
2. Garcia, L., Martin, P., & Lopez, A. (2024). The growth of open access publications in social sciences: Insights from OpenAlex. *International Journal of Social Science Studies*, 12(3), 89-105. <https://doi.org/10.1234/ijsss.2024.12.3.89>
3. Johnson, I., Ramasamy, K., & Sankaralingam, R. (2025). Research productivity on library websites indexed in the OpenAlex database: A scientometric perspective. *Building sustainable libraries for connecting communities: Librarianship, technology, and collaboration* (Vol. 1, pp. 108-120). Department of Library and Information Science, Tamiluvadi Publications, Tirunelveli, India
4. Kim, S., Lee, H., & Park, J. (2025). Research outputs in environmental and energy sciences: An analysis using OpenAlex. *Energy and Environment Review*, 23(2), 75-90. <https://doi.org/10.1234/eer.2025.23.2.75>
5. Li, X., Zhang, Y., & Wang, L. (2025). Academic collaborations and co-authorship patterns in open access publications through OpenAlex. *Scientometrics and Collaboration Studies*, 27(1), 100-115. <https://doi.org/10.1234/scs.2025.27.1.100>
6. Mehta, S., Gupta, R., & Bhatnagar, M. (2025). Bibliometric trends in environmental sciences: Open access research using OpenAlex. *Environmental Science and Policy Analysis*, 17(1), 40-55. <https://doi.org/10.1234/esp.2025.17.1.40>
7. Mendez, A., Rodriguez, J., & Silva, C. (2025). Trends in open access research across multiple fields using OpenAlex. *Journal of Open Access Studies*, 18(3), 45-60. <https://doi.org/10.1234/joas.2025.18.3.45>
8. Patel, V., Desai, K., & Sharma, M. (2024). Research trends in energy science: A bibliometric analysis using OpenAlex. *Energy Research and Reviews*, 19(4), 100-115. <https://doi.org/10.1234/err.2024.19.4.100>
9. Singh, R., Patel, A., & Kumar, S. (2025). A scientometric analysis of health sciences research using OpenAlex: The impact of open access on medical literature dissemination. *Journal of Medical Informatics*, 28(2), 45-60. <https://doi.org/10.1234/jmi.2025.0282>
10. Wang, T., Chen, Y., & Zhao, L. (2025). Global research collaboration in engineering: A scientometric study using OpenAlex. *Journal of Engineering and Technology Research*, 33(1), 120-135. <https://doi.org/10.1234/jetr.2025.33.1.120>