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Bibliometric Computational Mapping Analysis of Publications on Zirconium Nanoparticles

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Abstrak

Penelitian ini mengkaji perkembangan penelitian mengenai nanopartikel Zirkonium melalui pendekatan bibliometrik dengan analisis pemetaan komputasional menggunakan VOSviewer. Data artikel jurnal diperoleh dari database Google Scholar menggunakan aplikasi Publish or Perish. Kata kunci yang digunakan untuk mencari jurnal terkait adalah zirkonium, nanopartikel, kimia. Ada 999 artikel jurnal yang terkait dengan kata kunci. Kisaran artikel jurnal yang dicari dari database Google Scholar adalah 10 tahun terakhir (2012 – 2022). Hasil penelitian menunjukkan bahwa nanopartikel zirkonium dapat dipisahkan menjadi 2 istilah yaitu nanopartikel dan zirkonium. Istilah zirconium yang termasuk dalam cluster 1 dengan total 271 link, total link strength 1970, dan 343 kemunculan, dan term kedua adalah nanopartikel yang termasuk dalam cluster 2 dengan total 270 link, total link strength 2556, dan kemunculan 445. Hasil analisis perkembangan penelitian dalam 11 tahun terakhir menunjukkan sedikit fluktuasi. Pada tahun 2012 – 2013 terjadi peningkatan jumlah penelitian dari 34 menjadi 62 (28 penelitian). Terjadi penurunan dari tahun 2016-2017. Penurunan ini terlihat dari jumlah publikasi tahun 2016 (94 publikasi) hingga tahun 2017 (86 publikasi). Perkembangan penelitian nanopartikel zirkonium meningkat dalam 5 tahun terakhir, sebelum mengalami penurunan drastis pada tahun 2022. Hasil penelitian menunjukkan bahwa peluang penelitian nanopartikel zirkonium masih berpeluang cukup tinggi dan berkaitan dengan istilah lainnya untuk dieksplor lebih lanjut.
Kata kunci: Bibliometrik, Analisis Pemetaan Komputasi, Nanopartikel Zirkonium, VOSviewer.

Abstract

This study examines the development of research on Zirconium nanoparticles through a bibliometric approach with computational mapping analysis using VOSviewer. Journal article data was obtained from the Google Scholar database using the Publish or Perish application. The keywords used to search related journals are zirconium, nanoparticles, chemistry. There were 999 journal articles related to keywords. The range of journal articles searched from the Google Scholar database is the last 10 years (2012 – 2022). The results show that research zirconium nanoparticles can be separated into 2 terms: nanoparticle and zirconium. The term zirconium which included in cluster 1 with 271 links total, 1970 total link strength, and 343 occurrences, and the second term is nanoparticles which belongs to cluster 2 with a total of 270 links, a total link strength of 2556, and occurrences of 445. The results of the analysis of research developments in the last 11 years show a slight fluctuation. In 2012 – 2013 there was an increase in the number of studies from 34 to 62 (28 studies). It decreased from 2016-2017. This decline can be seen from the number of publications in 2016 (94 publications) to 2017 (86 publications). The development of zirconium nanoparticles research increased in the last 5 years, before a drastic decline in 2022. The results of the study indicate that the opportunity for research on zirconium nanoparticle still has a high enough chance and is linked to other terms.

Keywords: Bibliometric, Computational Mapping Analysis, Zirconium Nanoparticle, VOSviewer.

1. Introduction

Nanoparticle chemistry is a relatively young branch of chemical research. Nanoparticles were utilized in construction materials, pigments, and stained glass well before their nature and properties were uncovered and understood. For more than a century, transition metal nanoparticles were widely used as heterogeneous catalysts and generated impressive revenues for petrochemical companies. Despite these all-pervading examples, nanoparticle chemistry did not evolve into a rigorous academic field

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until the end of the 20th century, when the availability of electron microscopy and other modern characterization techniques equipped researchers with tools suitable for analyzing nanometer sized objects. However, in the field of research, it is still uncertain whether the branch of nanoparticle is still in great demand or not, especially in the field of research. [1]

There is one analytical technique that can be used to determine the development of research in the field of nanoparticles, namely bibliometric analysis. Bibliometric analysis is defined as a statistical evaluation of published scientific articles, books, or the chapters of a book, and it is an effectual way to measure the influence of publication in the scientific community. [2]

There have been many studies on bibliometric analysis, including bibliometric analysis in economics [3-7], bibliometric analysis in research on chemistry [8, 9] and chemical engineering [10-12], bibliometric analysis in research on materials [13], Vocational school [14], Scientific publications [15], Special Needs Education [16], Publication of Techno-Economic Education [17], Engine performance [18], Dataset portrays decreasing number of scientific publication [19], Application in robotic hand systems [20], Research effectiveness in a subject area among top class universities[21], Educational Research [22], Management bioenergy [23], Magnetite Nanoparticle [24], Nanocrystalline Cellulose Production Research [25], and Nano Metal-Organic Frameworks Synthesis [26].

However, research on computational mapping of bibliometric analysis of published data in the field of zirconium nanoparticle which has been carried out specifically to determine the development of the research has not been carried out. Especially bibliometric analysis for research in the last 11 years in the period 2012 to 2021 through the VOSviewer application.

Therefore, this research was conducted to carry out computational research on mapping bibliometric analysis of articles indexed by Google Scholar using VOSviewer software. This research was conducted with the hope that it can be a reference for researchers to conduct and determine the research themes to be taken, especially those related to the field of zirconium nanoparticle.

2. Method

The article data used in this study was based on research from publications that have been published in Google Scholar indexed journals. We selected Google Scholar in this study because the Google Scholar database is an open source. To obtain research data, a manager reference application was used, namely Publish or Perish. Publish or Perish software was used to conduct a literature review on our chosen topic. Detailed information for using and installing the software and step-by-step process for obtaining data is explained in our previous studies [27] and detailed information about library searches in searching for data on Google Scholar is described in a previous study conducted by Azizah et al. [28].

The research was carried out through several stages:

(i) Collection of publication data using the publish or perish application,
(ii) Processing of bibliometric data for articles that had been obtained using the Microsoft Excel application,
(iii) Computational mapping analysis of bibliometric publication data using the VOSviewer application, and
(iv) Analysis of the results of computational mapping analysis.

The article data search on Publish or Perish is used to filter publications using the keyword "Zirconium nanoparticle" based on the publication's title requirements. The papers used were published between the years of 2012 and 2022. All data was obtained in September 2022. The articles that have been collected and match the criteria for this study's analysis were then exported into two file types: research information systems (.ris) and comma separated value format (*.csv).

VOSviewer was also be used to visualize and evaluate trends using bibliometric maps. The article data from the source database was then mapped. VOSviewer was employed to create 3 variations of mapping publications, namely network visualization, density visualization, and overlay visualization based on the network (co-citation) between existing items. When creating a bibliometric map, the

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keyword frequency was set to be found at least 5 times. Therefore, obtained 278 terms and keywords that are less relevant were removed.

3. Results and Discussion

3.1. Publication data search results

Based on the data search through application reference manager Publish or Perish from the Google Scholar database, 999 data articles were obtained in the form of article metadata consisting of the author's name, title, year, journal name, publisher, number of citations, article links, and related URLs. Table 1 shows some examples of published data used in the VOSviewer analysis of this study. The data samples taken were the 20 best articles that had the highest number of citations. The number of citations from all articles used in this study is 31446, the number of citations per year is 3144.60, the number of citations per article is 31.48, the average author in the articles used is 4.31, 84 articles have h-index, and 128 articles have g-index.

Table 1. Zirconium nanoparticles publication data.

No	Authors	Title	Year	Cites	Refs
1	F Vermoortele et al.	Synthesis modulation as a tool to increase the catalytic activity of metal–organic frameworks: the unique case of UiO-66 (Zr)	2013	824	[29]
2	D Feng et al.	Construction of ultrastable porphyrin Zr metal–organic frameworks through linker elimination	2013	771	[30]
3	W Morris et al.	Nucleic acid–metal organic framework (MOF) nanoparticle conjugates	2014	374	[31]
4	TF Liu et al.	Topology-guided design and syntheses of highly stable mesoporous porphyrinic zirconium metal–organic frameworks with high surface area	2015	319	[32]
5	X Dou et al.	Remediating fluoride from water using hydrous zirconium oxide	2012	286	[33]
6	P Li et al.	Encapsulation of a nerve agent detoxifying enzyme by a mesoporous zirconium metal–organic framework engenders thermal and long-term stability	2016	270	[34]
7	W Xiong et al.	Adsorption of phosphate from aqueous solution using iron-zirconium modified activated carbon nanofiber: performance and mechanism	2017	248	[35]
8	Y Liu et al.	Amine-functionalized lanthanide-doped zirconia nanoparticles: optical spectroscopy, time-resolved fluorescence resonance energy transfer biodetection, and targeted …	2012	241	[36]
9	Q Lin et al.	New heterometallic zirconium metalloporphyrin frameworks and their heteroatom-activated high-surface-area carbon derivatives	2015	237	[37]
10	T Witoon et al.	CO_2 hydrogenation to methanol over Cu/ZrO_2 catalysts: Effects of zirconia phases	2016	231	[38]
11	S Yuan et al.	Linker installation: engineering pore environment with precisely placed functionalities in zirconium MOFs	2016	230	[39]
12	H Cui et al.	Strong adsorption of arsenic species by amorphous zirconium oxide nanoparticles	2012	224	[40]

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13	H Bacelo et al.	Performance and prospects of different adsorbents for phosphorus uptake and recovery from water	2020	221	[41]
14	Y Kwon et al.	Selective activation of methane on single-atom catalyst of rhodium dispersed on zirconia for direct conversion	2017	216	[42]
15	X Luo et al.	Nanocomposites of graphene oxide-hydrated zirconium oxide for simultaneous removal of As (III) and As (V) from water	2013	213	[43]
16	E Zong et al.	Adsorptive removal of phosphate ions from aqueous solution using zirconia-functionalized graphite oxide	2013	188	[44]
17	XD Du et al.	Robust photocatalytic reduction of Cr (VI) on UiO-66-NH2 (Zr/Hf) metal-organic framework membrane under sunlight irradiation	2019	179	[45]
18	KE Dekrafft et al.	Zr-and Hf-based nanoscale metal–organic frameworks as contrast agents for computed tomography	2012	169	[46]
19	S Zinatloo-Ajabshir et al.	Facile route to synthesize zirconium dioxide (ZrO2) nanostructures: structural, optical and photocatalytic studies	2016	168	[47]
20	X Min et al.	Ultra-high capacity of lanthanum-doped UiO-66 for phosphate capture: Unusual doping of lanthanum by the reduction of coordination number	2019	168	[48]

3.2. Research development in the field of zirconium nanoparticles

Table 2 shows the development of research in the field of zirconium nanoparticles published in the Google Scholar indexed journal. Based on the data shown in Table 2, it can be seen that the number of researches in zirconium nanoparticles is 993 articles from 2012-2022. In 2012 there were 40 articles, in 2013 there were 61 articles, in 2014 there were 58 articles, in 2015 there were 61 articles, in 2016 there were 94 articles, in 2017 there were 86 articles, in 2018 there were 98 articles, in 2019 there were 117 articles, in 2020 there were 133 articles, in 2021 there were 149 articles, and in 2022 there were 96 articles. From the number of publications, it can be seen that research on zirconium nanoparticles is relatively increasing every year.

Figure 1 shows the development of zirconium nanoparticles research for the last 10 years in the range of 2012 to 2022. Based on Fig. 1, it is known that the development of research related to zirconium nanoparticles has decreased from 2016-2017. This decline can be seen from the number of publications in 2016 (94 publications) to 2017 (86 publications). The development of zirconium nanoparticles research increased in the last 5 years, before a drastic decline in 2022. The data shows that the popularity of research on zirconium nanoparticles is relatively stable and the interest in zirconium nanoparticles keeps inclining.

Table 2. Publication

Year of Publications	Number of Publications
2012	40,0
2013	61,0
2014	58,0
2015	61,0
2016	94,0
2017	86,0

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2018	98,0
2019	117,0
2020	133,0
2021	149,0
2022	96,0
Total	993,0
Average	**90,3**

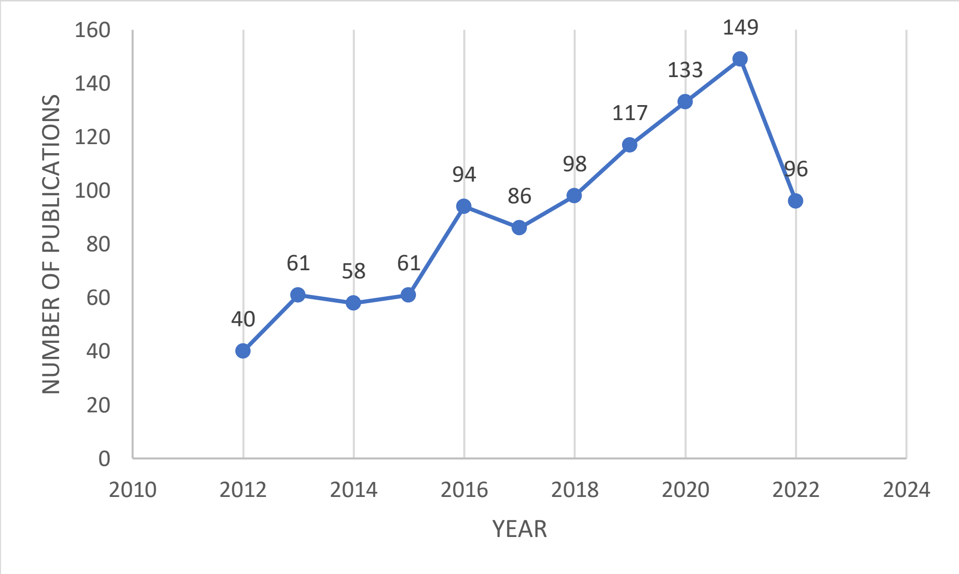

Fig 1. Level of development in zirconium nanoparticles research.

3.3. Visualization of zirconium nanoparticles topic area using VOSviewer

Computational mapping was performed on the article data. VOSviewer was used in computational mapping. From the results of computational mapping, 278 items was founded. Each item found related to zirconium nanoparticles from the data

(i) Cluster 1 has 56 items, and marked in red, the 56 items are adsorbent, adsorption, adsorptive removal, amorphous zirconium oxide nano, amount, aqueous medium, aqueous solution, arsenate, arsenite, comparison, composite, decomposition, determination, development, efficient removal, extraction, facile synthesis, first time, fluoride, fluoride removal, FTIR, hydrous zirconium oxide, hydrous zirconium oxide nanoparticle, iii, ion, iron, magnetic nanoparticle, membrane, nanotechnology, novel, oxide nanoparticle, paper, pattern, phosphate, phosphate adsorption, presence, recovery, release, removal, simultaneous removal, solution, sturdy, tetracycline, treatment, type, value, wastewater, water, zeolite, zirconium, zirconium nanoparticle, zirconium oxide, zirconium oxide nanoparticle, zirconium phosphate, zirconium salt, zrp.

(ii) Cluster 2 has 55 items, and marked in green, the 55 items are activity, addition, alloy, catalyst, catalyst activity, ce x zr, ceria zirconia, cerium, chemical state, co2 methanation, concentration, condition, content, deposition, dielectric property, doping, effect, element, evolution, fabrication, growth, high surface area, high temperature, impact, increase, investigation, lattice, low temperature, mechanical property, microstructure, molar ratio, nanopartice, oxidation, oxide, particle size, present study, process, property, ratio, silica, size, solgel, species, table, thermal stability, titanium, x o, yttria, zirconia, zirconium cation, zirconium concentration, zirconium content, zr content, zr species, zr x o.

(iii) Cluster 3 has 52 items, and marked in blue, the 52 items are active site, antibacterial activity, attention, calcination temperature, carbnon, ce zr, characteristic, chemical, chemical bond,

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degradation, dopant, dye, enhancement, evaluation, existence, formation, incorporation, influence, lanthanum, metal oxide nanoparticle, methylene, model, modification, morphology, number, o atom, oil, oxygen, oxygen vacancy, performance, photocatalyst, photocatalyst activity, photocatalyst degradation, photocatalyst property, photodegradation, physiochemical properties, polymer, precursor, reduction, research, stabilization, synergystic effect, thin film, use, work, zirconium atom, zirconium metalorganic, zirconium oxychloride, zr co, zr doping.

(iv) Cluster 4 has 43 items, and marked in yellow, the 43 items are atom, bond, catalytic transfer hydrogen, change, chemical stability, cluster, C02, c02 hydrogenation, construction, defect, encapsulation, functionalization, hydrogen, hydrogenation, hydrolysis, interaction, ligand, metal organic framework, metalorganic framework, methanol, mof, mofs, node, particle, pd nanoparticle, platinum nanoparticle, porphyrin, production, reaction, reactivity, role, senes, site, stability, structure, uio, zirconium hydroxide, zirconium metal organic, zirconium mofs, zr atom, zr mof, zr mofs, zr oh.

(v) Cluster 5 has 41 items, and marked in purple, the 41 items are analysis, antimicrobial activity, application, band, characterization, chemical composition, complex, fig, figure, green synthesis, rmcrowave, mode, monoclinic, monoclinic zirconia, nanocomposite, nanocrystal, optical property, organic pollutant, peak, poly, preparation, present work, sample, sol gel synthesis, spectrum, sulfated zirconia, synthesis, tetragonal zirconia nanoparticle, vibration, zirconia nanoparticle, zirconium dioxide, zirconium dioxide nanoparticle, zirconium n propoxide, zr o, zr o bond, zr o zr, zro, zro2, zro2 nanoparticle, zrocl, zrozr.

(vi) Cluster 6 has 19 items, and marked in light blue, the 19 items are case, chitosan, coating, fact, kinetic, layer, mixture, nano, powder, shape, solgel synthesis, surface, tetragonal zirconia, time, x rd, zr 3d, zr Ion, zr nanoparticle.

(vii) Cluster 7 has 9 items, and marked in orange, the 9 items are binding energy, electron, form, mechanism, range, sol gel method, state, temperature, zirconium species,

(viii) Cluster 8 has 3 items, and marked in brown, the 3 items are group, zirconia particle, zroh,

The relationship between one term and another is shown in each existing cluster. Labels are given to each term with coloured circles. The size of the circle for each term varies depending on the frequency of occurrence of the term [11]. The size of the label circle shows a positive correlation with the occurrence of the term in the title and abstract [13]. The more often the term is found, the larger the label size [27]. The mapping visualization analysed in this study consists of 3 parts: network visualization (see Fig. 2), density visualization (see Fig. 3), and overlay visualization (see Fig. 4)[49].

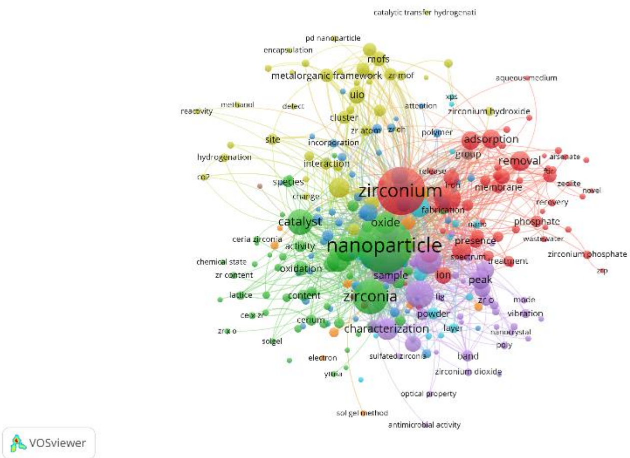

Fig. 2. Network visualization of zirconium nanoparticles keyword.

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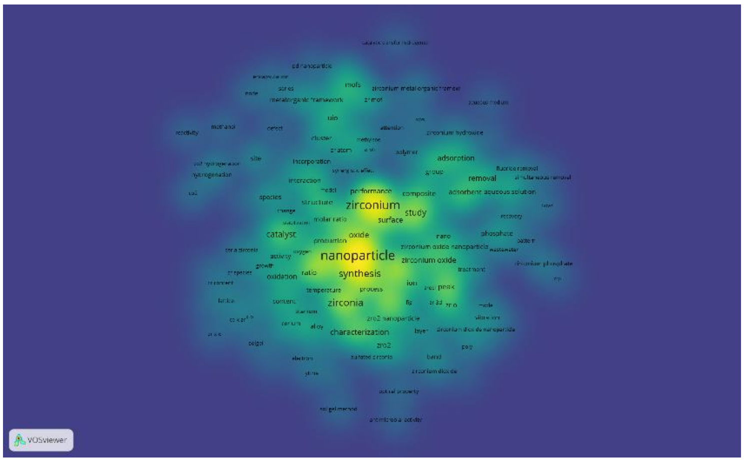

Fig. 3. Density visualization of zirconium nanoparticles keyword.

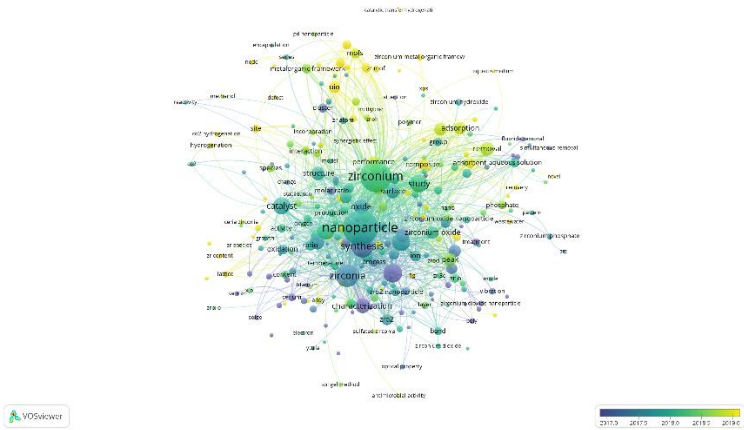

Fig. 4. Overlay visualization of zirconium nanoparticles keyword.

We can see the relationship between terms on Figure 2. The relationship between terms is depicted in an interconnected network. Figure 2 shows the cluster of each term which is frequently researched and related to the research topic of zirconium nanoparticles. From the clusters included in the network visualization, this can be seen that research in zirconium nanoparticles can be broken down into 2 fields, namely the zirconium term which is included in cluster 1 with 271 links total, total link strength of 1970 , and 343 occurrences (see Fig. 5). The second term is nanoparticle in cluster 2 with 270 links total, 2566 total link strength, and 445 occurrences (see Fig. 6)

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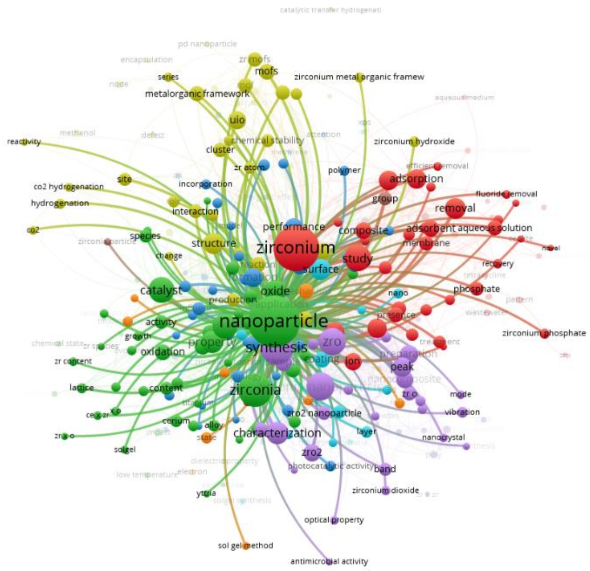

Fig. 5. Network visualization of zirconium term.

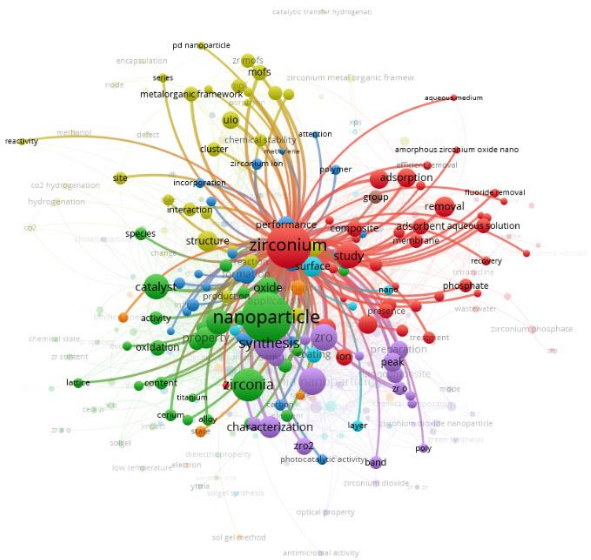

Fig. 6. Network visualization of nanoparticle term.

4. Conclusion

The purpose of this study was to perform computational mapping analysis on the bibliometric data of research articles. The publication theme taken in this research is "Zirconium ". The articles used are taken from the Google Scholar database via Publish or Perish. The library data used in this study include titles and abstracts. From the search results, as many as 999 relevant articles were published in the range of 2012 to 2022. The results showed that zirconium research has fluctuated over the past 11 years. It decreased from 2016-2017. This decline can be seen from the number of publications in 2016 (94 publications) to 2017 (86 publications). The development of zirconium nanoparticles research increased in the last 5 years, before a drastic decline in 2022. The results of the study indicate that the opportunity for research on zirconium nanoparticle still has a high enough chance and is linked to other terms.

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