PROCEEDINGS OF THE 3RD INTERNATIONAL CONFERENCE ON ISLAMIC EDUCATION AND SCIENCE DEVELOPMENT (ICONSIDE)
Fakultas Tarbiyah dan Keguruan, Universitas Islam Negeri Mataram, Indonesia
10 May 2025 | e-ISSN 3064-2310 | Volume: 3
Available online at https://proceeding.uinmataram.ac.id/index.php/iconside

RESEARCH TRENDS ON NANOSPINEL $SRFE_{12}O_{19}$ BASED ON SCOPUS DATABASE FROM 2009 TO 2025: A BIBLIOMETRIC LITERATURE REVIEW

Lalu Ahmad Didik Meiliyadi[1*], Muhammad Zainur Rahman[2], Muhammad Arif Firmansyah[3], Firda Yuslihan Amri[4], Isniawana Damayanti[5]
[1234]Universitas Islam Negeri Mataram, Mataram, Indonesia
[5]Universitas Mataram, Mataram, Indonesia
laludidik@uinmataram.ac.id

Abstract

Spinel ferrite nanoparticles are an interesting subject of study due to their excellent magnetic properties, making them widely used in electronic devices. The objective of this research is to present the development of research on SrFe12O19 nanoparticles. The data was obtained from the Scopus website over a period of 17 years (2009-2025). The data search yielded 179 relevant research articles. The results of the data analysis indicate that research on SrFe12O19 nanoparticles has not been extensively studied. This is evidenced by the average number of published research articles, which is 10.5 articles per year. The most significant development in research on SrFe12O19 nanoparticles occurred in 2022. The country that produced the most articles on SrFe12O19 nanoparticles was China, with the most affiliations producing research articles on SrFe12O19 nanoparticles published in Scopus-indexed journals originating from Chongqing University. The published articles are primarily journal articles and international conference proceedings. Visualization results using VosViewer indicate that there are still many opportunities for future research on SrFe12O19. It is hoped that this research will provide researchers with insights into the latest developments in SrFe12O19 nanoparticle research.

Keywords: Bibliometric, Nanospinel, Research Trends, Scopus Database, $SrFe_{12}O_{19}$

INTRODUCTION

Hexagonal ferrite nanoparticles have recently become a widely used material in research due to their magnetic properties (Matrana et al., 2024). These nanoparticles actually tend to modify their structure when subjected to an external magnetic field. These nanoparticles are often used as permanent magnets, higher density recording media, electromagnetic storage, as well as high frequency devices, which specifically operate at microwave frequencies (Dhingra et al., 2025b; Joy et al., 2025; Tiwari et al., 2024). These nanoparticles are considered chemically stable and thus have corrosive resistance to magnetisation (Shafaay et al., 2025). In general, these nanoparticles are a modification of ferrite with two general types, namely strontium hexaferrite ($SrFe_{12}O_{19}$) and Bariaum hexaferrite ($BaFe_{12}O_{19}$). In addition to Ba, there are also Pb metal ions as a substitute for strontium.

Strontium ferrite is a unique material due to the stability of its magnetic properties (Agustiana et al., 2025). Strontium nanoparticles have good magnetic coercivity, making it possible to have a saturation magnetic field and a larger magnetic field (Ganguly et al., 2025; Ramírez-Ayala et al., 2024). Therefore strontium ferrite nanoparticles can be used as electronic equipment that requires strong magnetic fields such as permanent magnets and magnetic storage (Dhingra et al., 2024; Yu et al., 2024). In addition, strontium ferrite also shows magnetic anisotropy so that it has control over its magnetic domain (Matran et al., 2024; Parajuli, Murali, & Vemuri, 2025).

Strontium hexaferrite is very important because it has attracted the attention of many researchers due to its unique electromagnetic properties and its application in various fields. This is due to its high saturation magnetization, high coercive force, high Curie temperature (740 K), strong magneto-crystalline anisotropy, good resistance to corrosion, and high chemical stability (Parajuli, Murali, & Samatha, 2025). There are many electronic devices that use strontium ferrite nanoparticles as their material base such as fuel cells, batteries, solar cells, sensors, perpendicular magnetic recording media, generator rotors in electric vehicles, hydrogen energy, magnetic coatings, magnetic fluids, and microwave catalysts (Dhingra et al., 2025a; Singh et al., 2025; Urbano-Peña et al., 2024).

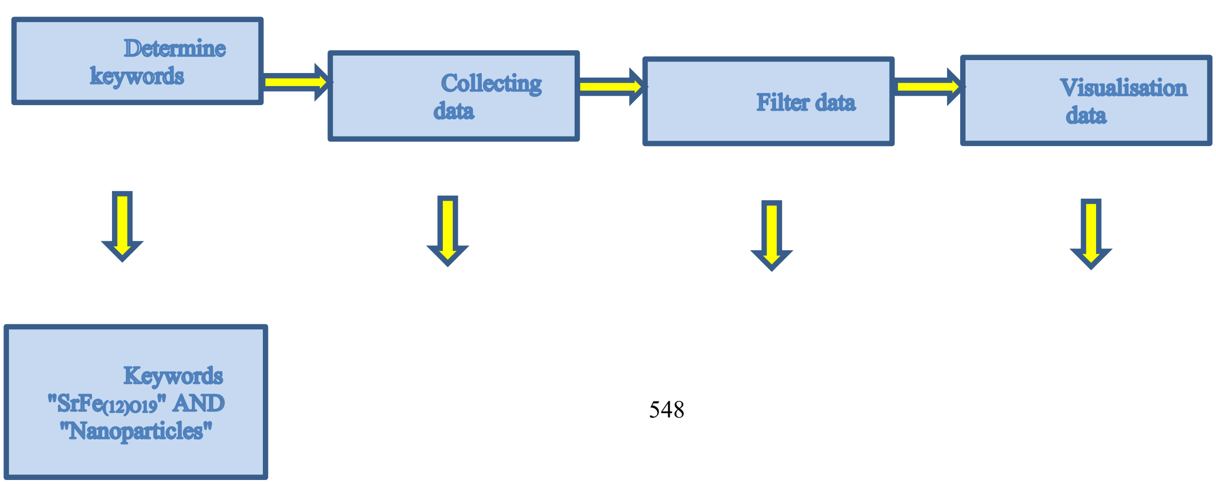
However, various studies over the past few decades have attempted to create unique strategies to improve the structural, electrical, and magnetic characteristics of strontium ferrite nanoparticles (Gupta & Roy, 2024). A common method for producing strontium ferrite materials is by using the high energy milling method (Shirmahd et al., 2024). This method requires a high sintering temperature (Yu et al., 2023). The advantage of this method is that the time required to synthesize strontium ferrite nanoparticles is relatively fast (Choi et al., 2024). The main disadvantage of this technique is the larger particle size and large energy consumption. There are several other synthesis methods such as hydrothermal, sol-gel process, coprecipitation, microwave auto combustion and sonochemistry (Bilal et al., 2024; Marjeghal et al., 2023; Rana et al., 2023).

Assessment of research activities on strontium ferrite helps to identify national and international contributions in this area, key topics covered by researchers, as well as research gaps in the area. Therefore, in this study, research on strontium ferrite was investigated. The method used is the bibliometric method because this method can map research gaps with previous research that has been done by previous researchers (Meiliyadi et al., 2025; Nandiyanto et al., 2025).

METHOD

This research uses a bibliometric approach. Data was taken from the Scopus database through the Scopus website (Nandiyanto et al., 2024). The referenced articles are English-language articles. The sources of articles used are manuscripts published in journals, conference proceedings and book chapters. Initially there were 187 articles then filtered in the last 17 years (2009-2025) so that 179 articles were analysed. The schematic diagram of the research using bibliometric analysis is shown in Figure 1 (Husaeni & Nandiyanto, 2022).

The keywords used in this study were $SrFe_{12}O_{19}$ and nanoparticles and 187 articles were found. The article data was then collected in *CSV format. The data was then filtered to remove double metadata and articles that did not match the discussion so that 179 articles were obtained. The new data was then visualised using VOSviewer edition 1.6.18 to obtain networking, overlay and density visualisations. The articles obtained based on the subject area are shown in table 1.



Figu … col … ric re

Table 1. Subject area of SrFe12O19 research as a photocatalyst

No	Subject area	Percentage (%)
1	Materials science	35.9
2	Engineering	20.6
3	Physics and Astronomy	20.6
4	Chemistry	9.9
5	Chemical Engineering	7.3
6	Energy	1.3
7	Environmental science	1.3
8	Multidisciplinary	1
9	Biochemistry, Genetics and Molecular Biology	1

Based on table 1, it appears that research on $SrFe_{12}O_{19}$ as a photocatalyst covers various fields of science with the largest dominance in *Material Science* at 35.9%. This shows that the main focus of research is on the structure, properties, synthesis, and characterisation of $SrFe_{12}O_{19}$ materials to improve their photocatalytic performance. *Engineering* and *Physics and Astronomy* each accounted for 20.6% of the total research. In engineering, research is more directed towards the application of $SrFe_{12}O_{19}$ in industrial technology and photocatalytic systems that can be practically implemented. Meanwhile, in the fields of physics and astronomy, research focuses more on understanding the physical properties, optical mechanisms, and electronic phenomena that occur during the photocatalysis process. In *Chemistry*, which has a contribution of 9.9%, research focuses more on chemical reactions that take place during the photocatalytic process, modification of the $SrFe_{12}O_{19}$ structure, and synthesis techniques to increase the efficiency of light energy conversion into chemical reactions. Meanwhile, *Chemical Engineering* accounts for 7.3% of the total research, which is oriented towards the application of $SrFe_{12}O_{19}$ on an industrial scale, optimisation of reaction processes, as well as improving the efficiency of photocatalytic systems in their utilisation for various chemical engineering purposes. Furthermore, the *Energy* and *Environmental Science* fields each contributed 1.3%. In addition, *Multidisciplinary* research accounts for 1% of the total research, indicating an interdisciplinary approach in the development of $SrFe_{12}O_{19}$ as a photocatalyst. Finally, the *Biochemistry, Genetics, and Molecular Biology* field also accounted for 1%, indicating the possibility of exploring the interaction of $SrFe_{12}O_{19}$ with biomolecules, its potential use in the biomedical field, or its impact on biological systems in the context of photocatalytic applications.

Table 2. 5 Journals to which SrFe12O19 has been published

No	Journal	Document
1	Journal of Alloys and Compounds	22
2	Ceramics International	12
3	Journal of Magnetism and Magnetic Materials	8
4	Journal of Materials Science: Materials in Electronics	8
5	Materials Technology	7

Table 2 shows that there are several journals that are the main destination for research publications on $SrFe_{12}O_{19}$ as a photocatalyst. The journal with the highest number of publications is the *Journal of Alloys and Compounds*, with 22 documents discussing this topic. This journal has a main focus on alloys and composite materials, making it a suitable platform for the publication of research related to $SrFe_{12}O_{19}$, especially in terms of its synthesis, characterisation, and application in the field of photocatalysis. In second place, *Ceramics International* recorded 12 documents discussing $SrFe_{12}O_{19}$ as a photocatalyst. This journal focuses on the development of ceramic materials, including in the aspects of design, manufacturing, and their applications in various fields of technology. Furthermore, *Journal of Magnetism and Magnetic Materials* and *Journal of Materials Science: Materials in Electronics* each have 8 documents that discuss $SrFe_{12}O_{19}$ as a photocatalyst. The existence of publications in these journals shows that in addition to photocatalytic properties, $SrFe_{12}O_{19}$ also attracts attention in magnetic and electronic aspects. Its distinctive magnetic properties make this material relevant for studies in magnetism and electronic materials, especially in multifunctional applications such as photocatalysis combined with magnetic field manipulation. Finally, *Materials Technology* has 7 documents related to $SrFe_{12}O_{19}$ research as a photocatalyst. The publications in this journal confirm that research on this material also has a strong applicative dimension, especially in material technology innovation to improve its photocatalytic efficiency and performance.

RESULTS AND DISCUSSION

Research trend on SrFe12O19 as photocatalyst

The data obtained from the Scopus database was then analysed for trends. The articles referred to are those published in the last 17 years (2009-2025). The research trends regarding SrFe12O19 nanoparticles are shown in Figure 2.

The research trend on $SrFe_{12}O_{19}$ shows a significant development over the period 2009 to 2025, as shown in Figure 2. Initially, between 2009 and 2012, the number of related studies was still relatively low with a gradual increase. However, in 2013 there was a significant spike in the number of publications, although the following year saw a slight decline. This may indicate an initial interest in $SrFe_{12}O_{19}$ as a photocatalyst, which then underwent further evaluation by researchers. Entering the period 2014 to 2019, the number of publications continued to experience a more steady increase, with the trend showing a consistent growth in the number of studies conducted. This development indicates that $SrFe_{12}O_{19}$ is starting to receive greater attention in the research world, most likely due to its properties and potential as an effective photocatalyst material. A significant increase in the number of publications starts to become more apparent from 2019, which then peaks in 2022. This shows that in this period, research on $SrFe_{12}O_{19}$ experienced a tremendous surge in interest, both in terms of academic and practical applications in the field of photocatalysis. However, after reaching the highest peak in 2022, the trend in the number of publications began to show fluctuations. In 2023, there was a sharp decline compared to the previous year, but it increased again in 2024, although it did not reach the same number as the previous peak. This fluctuation can be caused by various factors, such as a shift in research focus to other materials, limited research funding, or technical challenges that need to be overcome before $SrFe_{12}O_{19}$ can be widely applied in photocatalysis technology. Overall, research on $SrFe_{12}O_{19}$ as a photocatalyst shows a positive trend and continues to grow in the long term. Although there are some periods of fluctuation, the general trend shows a significant increase in the number of publications, especially in the last decade.

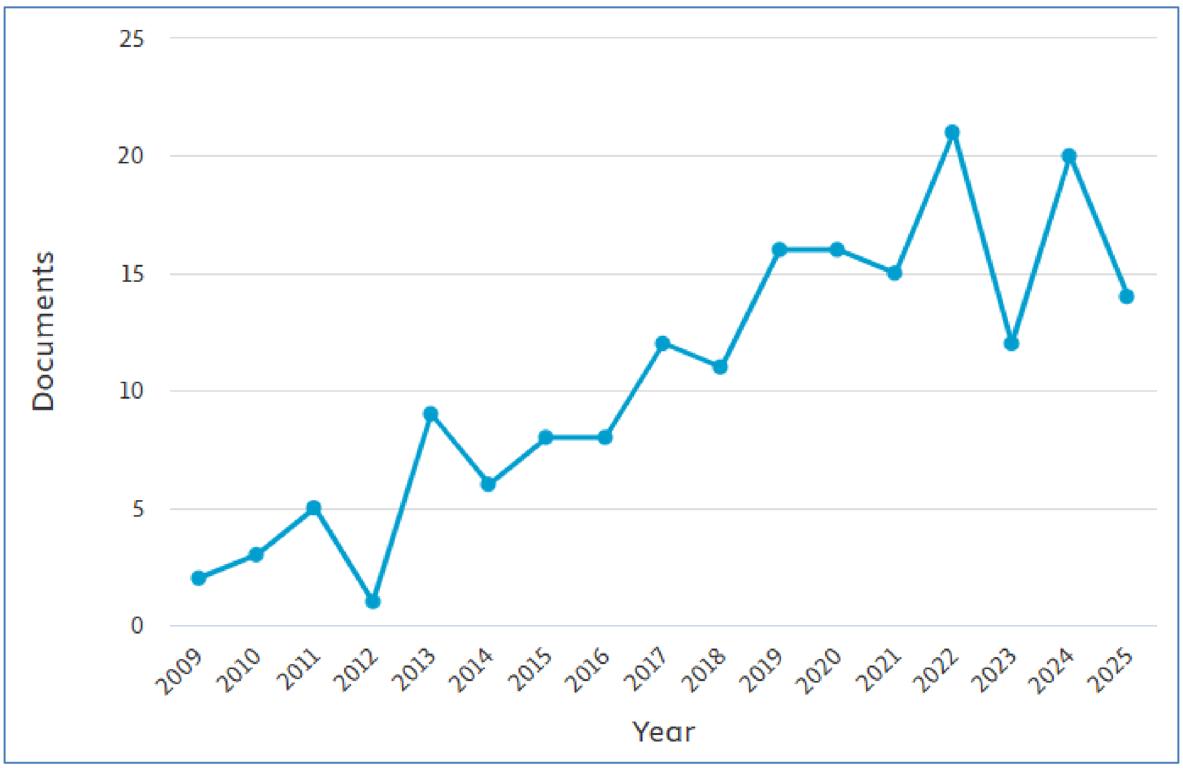


Figure 2. Research trends on $SrFe_{12}O_{19}$ nanoparticles

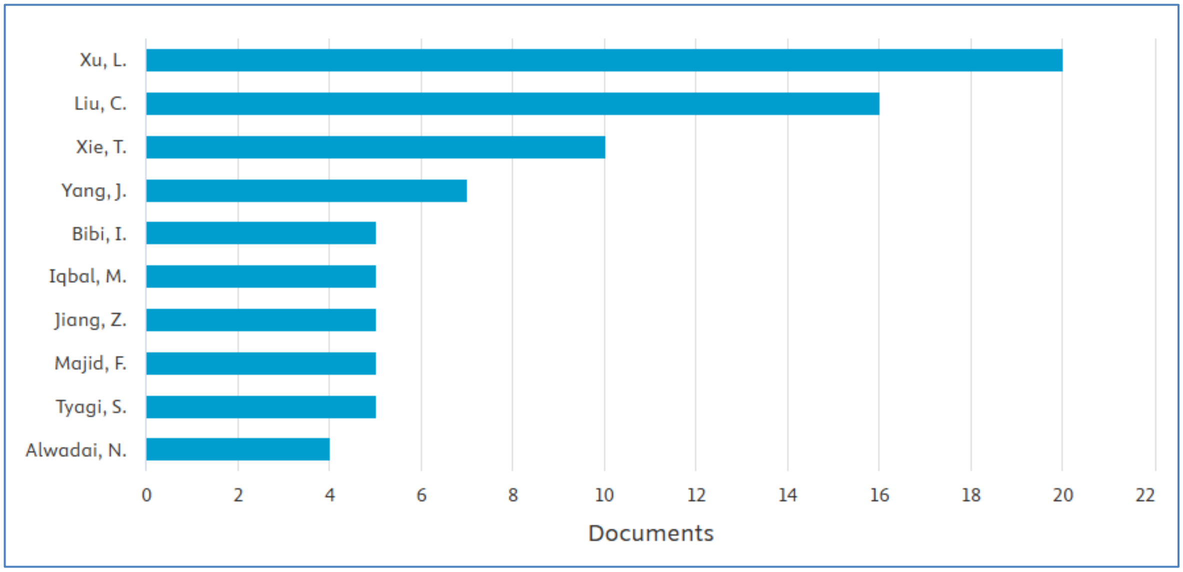


Figure 3. Researcher with the most research on $SrFe_{12}O_{19}$

Figure 3 shows the researchers with the most research on $SrFe_{12}O_{19}$. Based on Figure 3, it appears that research on $SrFe_{12}O_{19}$ has been conducted by several researchers with different numbers of publications. From the data displayed, Xu, L. is the researcher with the highest number of publications, reaching around 20 studies. The second position is occupied by Liu, C., who has produced about 16 studies in the same field. Furthermore, Xie, T. is ranked third with the number of publications around 10 studies. In addition to these three researchers, there are several other researchers who also contributed to $SrFe_{12}O_{19}$ research as a photocatalyst, such as Yang, J., Bibi, I., Iqbal, M., Jiang, Z., Majid, F., Tyagi, S., each producing 5 studies and Alwadai, N., as many as 4 studies. Although the number of their publications is less than the top three researchers. From this data, it can be concluded that Xu, L. is the most productive figure in $SrFe_{12}O_{19}$ research as a photocatalyst, followed by Liu, C., and Xie, T., who also have significant contributions to the development of science in this field.

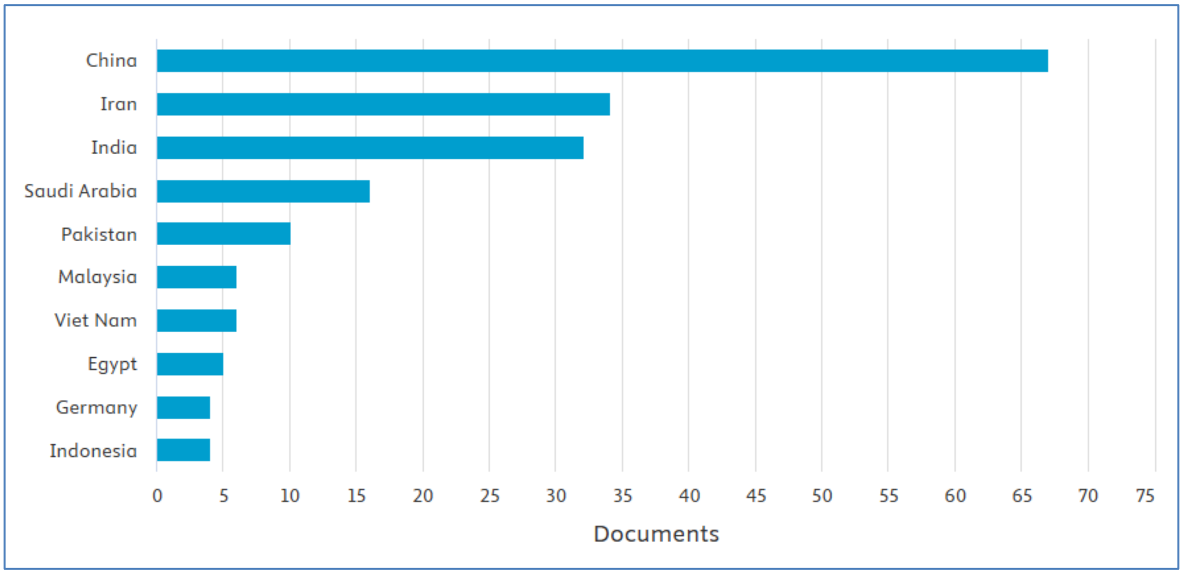


Figure 4. Countries with the most research on $SrFe_{12}O_{19}$

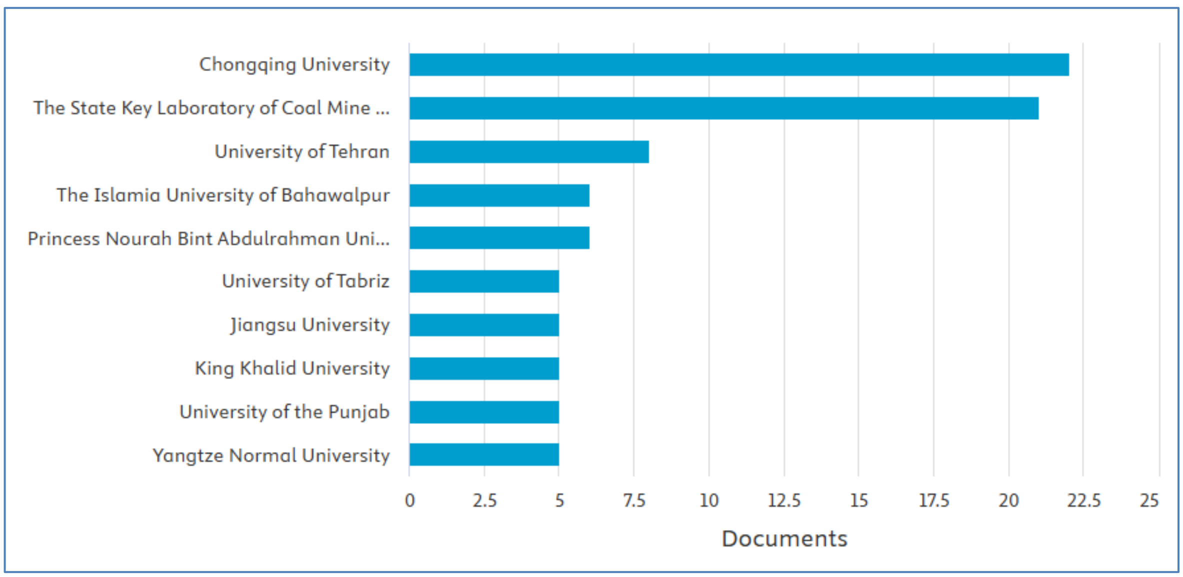


Figure 5. Researcher affiliation with research on $SrFe_{12}O_{19}$ as the most photocatalysts

Figure 4 shows the countries with the most research on $SrFe_{12}O_{19}$. Based on Figure 4, it can be seen that China is the country with the largest number of studies on $SrFe_{12}O_{19}$, with about 68 published studies. The second position is occupied by

Iran, which has about 39 research documents related to this topic. Meanwhile, India is ranked third with about 32 publications. In addition to these three countries, several other countries have also contributed to $SrFe_{12}O_{19}$ research as a photocatalyst, although with a smaller number of publications. Saudi Arabia occupies the fourth position with 16 studies. In addition, Pakistan, Malaysia, Vietnam, Egypt, Germany, and Indonesia are also recorded to have publications in this field, but the number is much lower than China, Iran, and India. From the data shown, it can be concluded that China has a dominance in research on $SrFe_{12}O_{19}$ as a photocatalyst, followed by Iran and India, which also show significant contributions in this field.

Figure 5 shows the affiliation of researchers with the most research on $SrFe_{12}O_{19}$ as a photocatalyst. Based on Figure 5, it appears that research on $SrFe_{12}O_{19}$ is dominated by several academic and research institutions with varying numbers of publications. Chongqing University occupies the top position as the institution with the highest number of documents, close to 22.5 publications. This shows that the university has great attention and contribution in the development of $SrFe_{12}O_{19}$ materials for photocatalytic applications. In the second position, The State Key Laboratory of Coal Mine also has almost the same number of publications as Chongqing University, indicating that research on $SrFe_{12}O_{19}$ as a photocatalyst also receives great attention from this laboratory, possibly in the context of energy or environmental applications. Meanwhile, the University of Tehran came in third with fewer publications than the previous two institutions. This shows that the Iranian university also plays a role in related research, albeit with a lower publication rate. Some other institutions that also contributed to this research include The Islamia University of Bahawalpur and Princess Nourah Bint Abdulrahman University, which have a relatively similar number of publications and come in fourth and fifth place. In addition, the University of Tabriz, Jiangsu University, King Khalid University, University of the Punjab, and Yangtze Normal University also participated in the study, albeit with fewer publications than the top-ranked institutions.

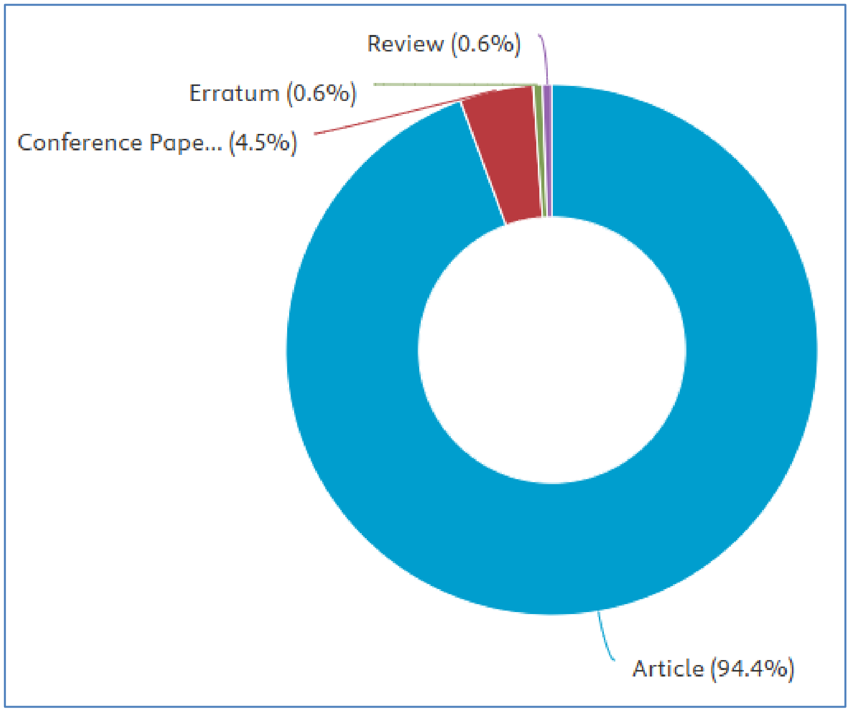


Figure 6. Types of documents published in research on $SrFe_{12}O_{19}$

Figure 6 shows the types of documents published in research on $SrFe_{12}O_{19}$. Figure 6 shows that publications related to $SrFe_{12}O_{19}$ research can be categorised into several document types. The most dominant document type is scientific articles, with 169 publications or about 94.4% of the total documents. This shows that the majority of research in this field has been published in scientific journals, which generally go through a rigorous *peer-review* process, thus signalling the credibility and high quality of the research. In addition, there were 8 publications in the form of *conference papers*, which accounted for 4.5% of the total documents. Publications in this form show that the results of research on $SrFe_{12}O_{19}$ as a photocatalyst have also been presented in various scientific forums, such as seminars and academic conferences. These forums allow researchers to discuss, exchange ideas, and get feedback before further publication in journals. Meanwhile, there is also 1 document in the erratum category (0.6%), which indicates the correction of errors that may have occurred in previous publications. In addition, there was 1 document in the form of a review (0.6%), which is likely to be a review article that summarises and analyses various studies that have been conducted related to $SrFe_{12}O_{19}$ as a photocatalyst. Overall, the dominance of scientific articles as the main form of publication indicates that research on $SrFe_{12}O_{19}$ as a photocatalyst has progressed significantly and most have been published in academic journals. Meanwhile, the existence of conference papers, erratum, and reviews also complement the diversity of publications in this field, reflecting the dynamic development of research and continuous improvement. The 10 articles with the highest number of citations are shown in table 3.

Table 3. 5 articles with the highest number of citations in $SrFe_{12}O_{19}$ research

No	Title	Authors	Year	Source	Cited by
1.	Novel heterojunction $Bi_{(2)}O_3/SrFe_{12}O_{19}$magnetic photocatalyst with highly enhanced photocatalytic activity	(Xie et al., 2013)	2013	Journal of Physical Chemistry C, 117(46), pp. 24601-24610	140
2.	Magnetic and microwave properties of $SrFe_{(12)}O_{19}/MCe_{0.04}Fe_{(1.96)}O_{(4)}$ (M = Cu, Ni, Mn, Co and Zn) hard/soft nanocomposites	(Algarou et al., 2020)	2020	Journal of Materials Research and Technology, 9(3), pp. 5858-5870	121
3.	Magnetic composite BiOCl-$SrFe_{12}O_{19}$: A novel p-n type heterojunction with enhanced photocatalytic activity	(Xie et al., 2014)	2014	Dalton Transactions, 43(5), pp. 2211-2220	107
4.	Synthesis of novel $CQDs/CeO_2/SrFe_{(12)}O_{19}$magnetic separation photocatalysts and synergic	(Wang et al., 2021)	2021	Chemical Engineering Journal	97

No	Title	Authors	Year	Source	Cited by
	adsorption-photocatalytic degradation effect for methylene blue dye removal			Advances, 6, 100089	
5.	Hierarchical brain-coral-like structure (3D) vs rod-like structure (1D): Effect on electromagnetic wave loss features of $SrFe_{(12)}O_{19}$ and $CoFe_{(2)}O_4$	(Jafarian et al., 2021)	2021	Ceramics International, 47(21), pp. 30448-30458	89

Keyword visualisation using VOSviewer

Data visualisation was performed using VOSviewer software version 1.6.17. VOSviewer is able to produce analytical data in the form of data mapping with three categories, namely networking, overlay and density. The type of analysis used is co-occurrence with the category of all keywords. The data mapping based on networking, overlay and keyword density is shown in Figure 7, Figure 8 and Figure 9 respectively.

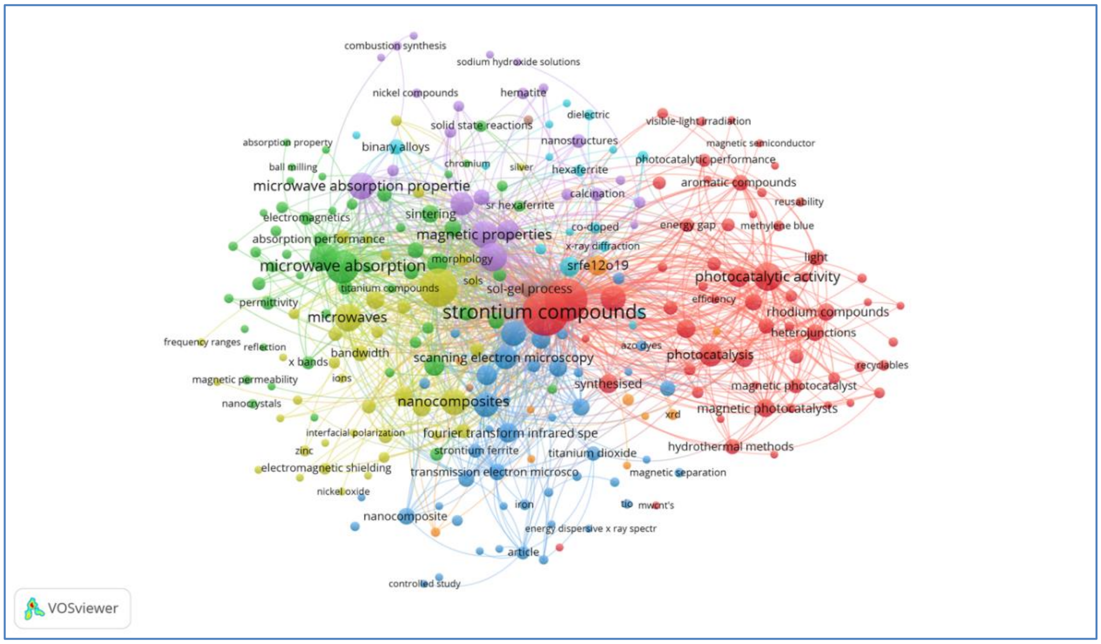


Figure 7. $SrFe_{12}O_{19}$ network visualisation

Figure 7 shows the visualisation of the $SrFe_{12}O_{19}$ network. Based on Figure 8, it can be seen that SrFe12O19-related research covers a wide range of aspects, each of which is represented with a different colour, indicating groups of interconnected topics. The red-coloured group indicates a focus on photocatalysis and photocatalytic activity. The dominating keywords in this group include *photocatalysis, photocatalytic activity, visible light radiation, rhodium compounds, magnetic photocatalysts, heterojunctions, energy gap, methyl blue, recyclables*, and *efficiency*. This confirms that research in this domain is concerned with how SrFe12O19 is used as a photocatalyst in substance degradation processes, especially in applications that utilise visible light to increase catalytic efficiency. The green coloured group highlights the microwave absorption properties of SrFe12O19. Related keywords include *microwave absorption, microwave absorption properties, absorption performance, permittivity, microwaves, bandwidth, reflection, magnetic permeability*, and *nanocrystals*. This shows that SrFe12O19 is not only studied as a photocatalyst but also as a material that can absorb microwaves, which could potentially be used in radar applications and electromagnetic devices. The purple coloured group focuses on the magnetic properties of SrFe12O19, with main keywords such as *magnetic properties, binary alloys, nickel compounds, sintering, morphology*, and *hexaferrite*. This shows that research on SrFe12O19 also pays attention to its magnetic properties related to material composition, synthesis methods such as sintering, as well as interactions with metal alloys such as nickel. Meanwhile, the blue group deals more with nanocomposites and material characterisation techniques. The main keywords in this group include *nanocomposites, scanning electron microscopy, transmission electron microscopy, fourier transform infrared spectrometry, energy dispersive x-ray spectrometry, titanium dioxide*, and *hydrothermal methods*. This indicates that $SrFe_{12}O_{19}$ research involves a variety of structural and spectroscopic characterisation methods, including the use of SEM, TEM, FTIR, and EDX to analyse the structure and composition of the resulting material. Finally, the yellow coloured group indicates studies on the interaction of SrFe12O19 with electromagnetic waves and its potential in electromagnetic shielding (EM shielding). Related keywords include *electromagnetic shielding, electromagnetic properties, interfacial polarization, permittivity, frequency ranges*, and *bandwidth*. This shows that $SrFe_{12}O_{19}$ is also studied as a material that can be used in protection against electromagnetic interference, especially in applications that require protection against microwaves. Overall, this visualisation shows that research on SrFe12O19 as a photocatalyst not only focuses on its photocatalytic activity but also extends to areas such as microwave absorption, magnetic properties, nanocomposites, and electromagnetic shielding. The different colours in this network illustrate how these aspects are interrelated, reflecting the complexity and breadth of research related to $SrFe_{12}O_{19}$ in various scientific and technological applications.

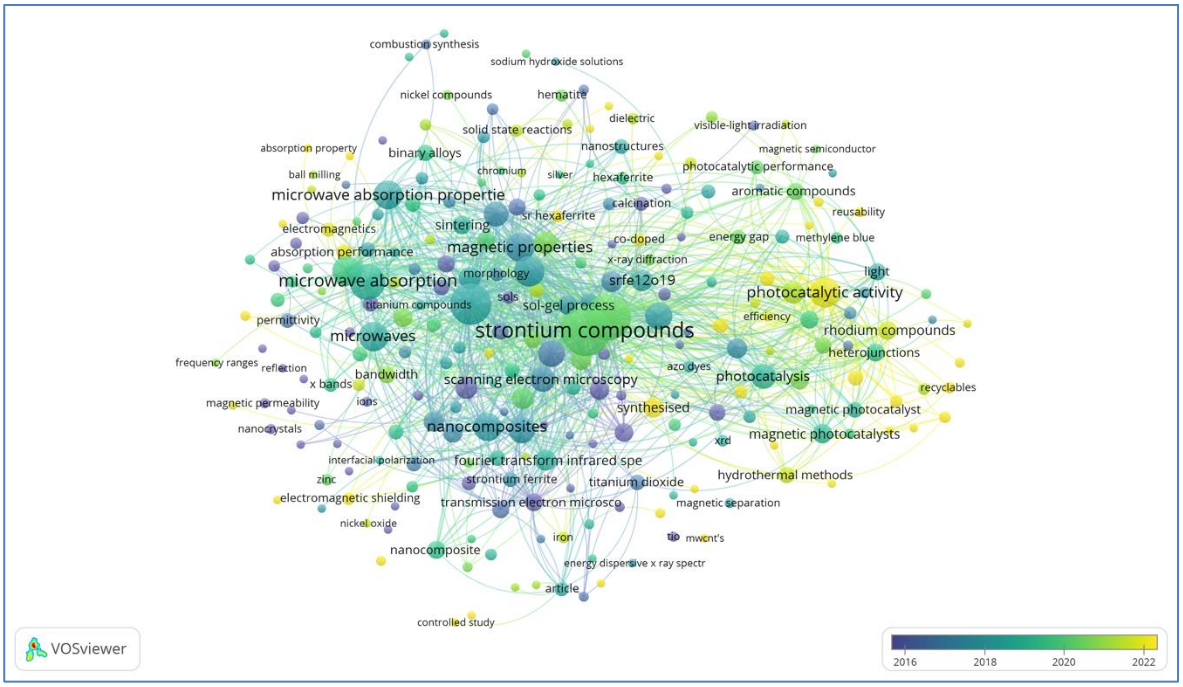


Figure 8. Visualisation of $SrFe_{12}O_{19}$ overlay as a photocatalyst

Visualisation of $SrFe_{12}O_{19}$ overlay as photocatalyst. The keyword overlay visualisation shown in this figure is the result of bibliometric analysis using VOSviewer, which shows the development of research related to $SrFe_{12}O_{19}$ as a photocatalyst. In the figure, *"strontium compounds"* is the main keyword in the centre with the largest node, indicating that this topic has a high frequency in scientific publications. The various keywords connected to it reflect the topics that have been examined in related research, including material properties, synthesis methods, characterisation, and applications in various fields. In general, there are several major clusters that can be identified in this visualisation. One important cluster is related to the *magnetic* properties of $SrFe_{12}O_{19}$, indicated by keywords such as *"magnetic properties"*, *"hexaferrite"*, and *"sintering"*. This suggests that early research focused more on characterising the magnetic properties of this material, which is often used in electromagnetic and microwave-absorbing applications. In addition, there are other clusters related to synthesis and characterisation methods, such as *"hydrothermal methods"*, *"synthesised"*, *"scanning electron microscopy"*, and *"fourier transform infrared spe"*. This indicates that various synthesis and material structure analysis techniques have been developed to study SrFe12O19 in depth. Interestingly, if we look at the overlay visualization by colour, we can see the latest research trends marked in yellow. Keywords such as *"photocatalytic activity"*, *"photocatalysts"*, *"magnetic photocatalyst"*, and *"hydrothermal methods"* appear prominently in yellow, indicating that in recent years, research on SrFe12O19 has increasingly focused on its application in the field of photocatalysis. Meanwhile, the green to blue keywords, such as *"microwave absorption"*, *"microwave absorption properties"*, and *"electromagnetic shielding"*, see more research focusing on the application of $SrFe_{12}O_{19}$ in microwave absorbers and magnetic materials. This indicates that research in this field is quite mature and has undergone a lot of exploration before finally the trend shifted towards photocatalysis. Overall, the analysis of the novelty of the research shows that $SrFe_{12}O_{19}$ has undergone a change in research focus from its magnetic properties to photocatalytic applications in recent years. This shift indicates a great opportunity for the development of new technologies in the fields of renewable energy, pollutant photodegradation, and multifunctional material applications that combine magnetic properties with photocatalytic ones.

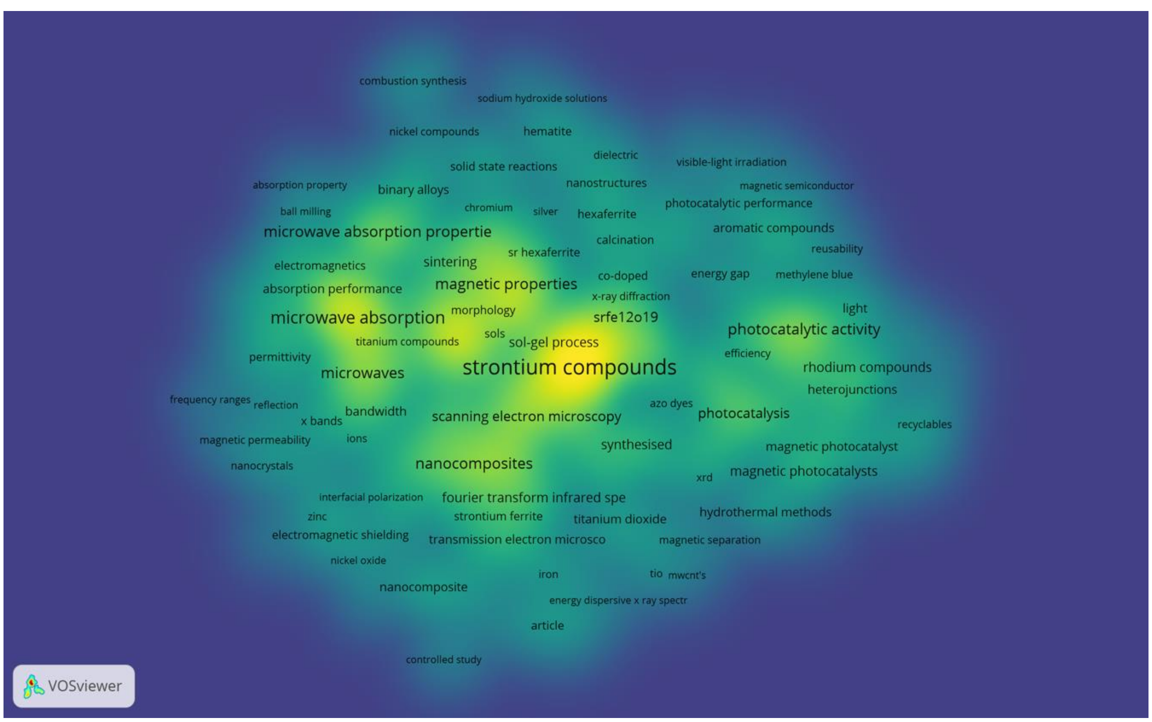


Figure 9. Visualisation of $SrFe_{12}O_{19}$ density as a photocatalyst

Figure 9 shows the visualisation of SrFe12O19 density as a photocatalyst. $SrFe_{12}O_{19}$ is a widely researched material due to its unique combination of magnetic and photocatalytic properties. In the density visualisation generated using VOSviewer software, it can be seen that research on $SrFe_{12}O_{19}$ is closely related to various aspects, including synthesis, characterisation, magnetic properties, and applications in photocatalysis. The main keywords in this visualisation are "*strontium compounds*" and "$SrFe_{12}O_{19}$", indicating that the research focus revolves around strontium compounds, especially in the form of hexaferrite. One of the main applications of SrFe12O19 highlighted in this map is its role as a photocatalyst functioning in the degradation of dyes and organic pollutants under visible light irradiation. In terms of synthesis, various methods have been used to prepare SrFe12O19 as a photocatalyst. Emerging keywords such as "*sol-gel process*", "*hydrothermal methods*", "*sintering*", and "*combustion synthesis*" indicate that different experimental approaches have been developed to obtain materials with optimal crystal structures. To ensure the success of the synthesis and understand the characteristics of the material, various analytical techniques are also used. Visualisation shows that this research involves many techniques such as *Scanning Electron Microscopy* (SEM) to observe surface morphology, *X-ray Diffraction* (XRD) to determine crystal structure, *Fourier Transform Infrared Spectroscopy* (FTIR) to identify functional groups, and *Energy Dispersive X-ray Spectroscopy* (EDX) for elemental composition analysis. From the aspect of magnetic properties, keywords such as "*magnetic properties*", "*electromagnetic shielding*", and *"magnetic permeability*" confirm that SrFe12O19 has potential in magnetic applications other than as a photocatalyst. These *magnetic* properties also allow SrFe12O19 to function as a "*magnetic photocatalyst*", which means that this material can be easily separated from the reaction solution using a magnetic field after the photocatalysis process is complete. This increases the separation efficiency and reuse of the photocatalyst, as indicated by the keywords "*recyclables*" and "*reusability*". In the context of photocatalysis, $SrFe_{12}O_{19}$ is associated with various keywords such as "*photocatalytic activity*", "*photocatalysis*", "*photocatalytic performance*", and "*visible-light irradiation*", which confirms that this research focuses on utilising $SrFe_{12}O_{19}$ as an active photocatalyst under visible light. Overall, this density analysis provides a clear picture of the research relationship related to $SrFe_{12}O_{19}$ as a photocatalyst, from its synthesis methods, characterisation techniques, magnetic properties, to its application in pollutant degradation under visible light irradiation. With its unique combination of magnetic and photocatalytic properties, $SrFe_{12}O_{19}$ shows great potential in efficient and sustainable photocatalysis applications.

CONCLUSIONS

This study successfully used bibliometric analysis to describe the development of research on $SrFe_{12}O_{19}$ nanoparticles. The database was obtained from the Scopus website over 17 periods (2009-2025). The data search yielded 179 relevant research articles. The results of the data analysis indicate that research on $SrFe_{12}O_{19}$ nanoparticles has not yet been extensively studied. This is evidenced by the average number of published research articles, which is 10.5 articles per year. The most significant development in research on $SrFe_{12}O_{19}$ nanoparticles occurred in 2022. The country that produced the most articles on $SrFe_{12}O_{19}$ nanoparticles was China, with the most affiliations producing research articles on $SrFe_{12}O_{19}$ nanoparticles published in Scopus-indexed journals originating from Chongqing University. The published articles are primarily journal articles and international conference proceedings. Visualization results using VosViewer indicate that there are still many opportunities for future research on $SrFe_{12}O_{19}$.

ACKNOWLEDGMENTS

We would like to express our gratitude to the Ministry of Religious Affairs of the Republic of Indonesia for funding this research through the 2025 BOPTN UIN Mataram Standard Output Cost research scheme (Decree No. 2304 of 2025).

REFERENCES

Agustiana, D., Ramlan, Daraz, U., & Lyu, P. (2025). The impact of magnesium oxide substituted strontium hexaferrite powder: Investigation on crystal structure and magnetic properties. *Journal of Magnetism and Magnetic Materials*, *624*, 173060. https://doi.org/10.1016/j.jmmm.2025.173060

Algarou, N. A., Y. Slimani a, M. A. A., Alahmari, F. S., Vakhitov, M. G., Klygach, D. S., Trukhanov, S. V., Trukhanov, A. V., & Baykal, A. (2020). Magnetic and microwave properties of SrFe12O19/MCe0.04Fe1.96O4 (M = Cu, Ni, Mn, Co and Zn) hard/soft nanocomposites. *Journal of Materials Research and Technology*, *9*(3), 5858–5870. https://doi.org/10.1016/j.jmrt.2020.03.113

Bilal, M., Ahmed, I., Shabbir, S., Subhani, M. U., Maraj, M., Anwar, H., & Ramiza. (2024). Structural, optical, dielectric and magnetic properties of Cd substituted copper strontium W-type hexaferrite. *Ceramics International*, *50*(10), 17228–17241. https://doi.org/10.1016/j.ceramint.2024.02.198

Choi, J.-Y., Baek, Y.-K., Lee, J.-G., Kim, Y.-D., & Kim, Y.-K. (2024). Effect of La3+and Al3+ doping on the crystal structure and magnetic properties of strontium hexaferrites. *Journal of Alloys and Compounds*, *986*, 174146. https://doi.org/10.1016/j.jallcom.2024.174146

Dhingra, A., Thakur, O. P., & Pandey, R. (2024). Enhanced magnetic properties of single domain Al-substituted strontium hexaferrite (SrFe12−xAlxO19) synthesized via hydrothermal method for permanent magnets. *Journal of Alloys and Compounds*, *1001*, 175132. https://doi.org/10.1016/j.jallcom.2024.175132

Dhingra, A., Thakur, O. P., & Pandey, R. (2025a). Magnetic properties, microwave absorption and EMI shielding study of Al-doped strontium hexaferrites. *Inorganic Chemistry Communications*, *173*, 113810. https://doi.org/10.1016/j.inoche.2024.113810

Dhingra, A., Thakur, O. P., & Pandey, R. (2025b). Synergistic enhancement of magnetic and dielectric properties of polyol-synthesised Al-substituted strontium hexaferrites for efficient energy storage applications. *Journal of Energy Storage*, *123*, 116763. https://doi.org/10.1016/j.est.2025.116763

Ganguly, K., Mahapatra, P., Mohanty, C., Das, C., Samal, A., Sahu, R. K., & Das, N. (2025). Multifunctional silver-doped strontium hexaferrite nanoparticles: Magnetic, optical, photocatalytic, and antimicrobial properties. *Chemistry of Inorganic Materials*, *5*, 100098. https://doi.org/10.1016/j.cinorg.2025.100098

Gupta, A., & Roy, P. K. (2024). Improved strontium hexaferrites: An overview of current progress in synthesis, properties, and applications. *Materials Science and Engineering: B*, *306*, 117458. https://doi.org/10.1016/j.mseb.2024.117458

Husaeni, D. F. Al, & Nandiyanto, A. B. D. (2022). Bibliometric Using Vosviewer with Publish or Perish (using Google Scholar data): From Step-by-step Processing for Users to the Practical Examples in the Analysis of Digital Learning Articles in Pre and Post Covid-19 Pandemic. *ASEAN Journal of Science and Engineering*, *2*(1), 19–46. https://doi.org/10. 17509/xxxxt.vxix

Jafarian, M., Kashani-Bozorg, S. F., Amadeh, A. A., & Atassi, Y. (2021). Hierarchical brain-coral-like structure (3D) vs rod-like structure (1D): Effect on electromagnetic wave loss features of SrFe12O19 and CoFe2O4. *Ceramics International*, *47*(21), 30448–30458. https://doi.org/10.1016/j.ceramint.2021.07.224

Joy, S. J. R., Kumar, T. P., Kalaivanan, N. S., Poonguzhali, S., Vidya, R., & Babu, D. R. (2025). Antibacterial, cytotoxicity, and seed germination studies of strontium hexaferrite nanoparticles. *Inorganic Chemistry Communications*, *174*(1), 113895. https://doi.org/10.1016/j.inoche.2025.113895

Marjeghal, M. A., Sedghi, A., & Baghshahi, S. (2023). The effect of the citric acid to metal nitrates molar ratio on the structural and magnetic properties of strontium hexaferrite nanoparticles synthesized by the sol-gel combustion method. *Journal of Alloys and Compounds*, *968*, 171765. https://doi.org/10.1016/j.jallcom.2023.171765

Matran, W. M., Mustapha, M., Nor, M. F., Mustapha, F., Alakbari, F. S., Al-shawesh, G., & Bawahab, M. (2024). Effect of microwave sintering on density, microstructural and magnetic properties of pure strontium hexaferrite at low temperatures and heating rate. *Heliyon*, *10*(20), e38766. https://doi.org/10.1016/j.heliyon.2024.e38766

Matrana, W. M., Mustaphaa, M., Nora, M. F., Mustaphad, F., Alakbarib, F. S., Al-shawesha, G., & Bawahab, M. (2024). Effect of microwave sintering on density, microstructural and magnetic properties of pure strontium hexaferrite at low temperatures and heating rate. *Heliyon*, e38766. https://doi.org/10.1016/j.heliyon.2024.e38766.

Meiliyadi, L. A. D., Arizona, K., Wahyudi, M., & Damayanti, I. (2025). Research Trend on Newton's Law Misconceptions from Scopus Database using Bibliometric. *Indonesian Journal of Educational Research and Technology*, *5*(3), 275–290. https://doi.org/10.17509/ijert.v5i3.88015

Nandiyanto, A. B. D., Fiandini, M., & Husaeni, D. N. Al. (2024). Research Trends from The Scopus Database Using Keyword Water Hyacinth and Ecosystem: A Bibliometric Literature Review. *ASEAN Journal of Science and Engineering*, *4*(1), 33–48. https://doi.org/10.17509/ajse.v4i1.60149

Nandiyanto, A. B. D., Husaeni, D. F. Al, & Husaeni, D. N. Al. (2025). Introducing Indonesian Journal of Educational Research and Technology: A Bibliometric Analysis Study. *Journal of Advanced Research Design*, *124*(1), 1–20. https://doi.org/10.37934/ard.124.1.120

Parajuli, D., Murali, N., & Samatha, K. (2025). Structural, magnetic, DC resistivity and dielectric properties of Ni-doped strontium hexaferrites SrNixFe12-xO19. *Ceramics International*, *51*(15), 20143–20163. https://doi.org/10.1016/j.ceramint.2025.02.182

Parajuli, D., Murali, N., & Vemuri, R. (2025). Silver doped strontium hexaferrites: Structural, morphological, magnetic and dielectric properties. *Inorganic Chemistry Communications*, *176*, 114191. https://doi.org/10.1016/j.inoche.2025.114191

Ramírez-Ayala, M. F., Guerrero, A. L., Pal, U., Pérez-Mazariego, J. L., Marquina, M. L., & Mendoza-Anaya, D. (2024). Effect of rare earth substitution on magnetic properties of strontium hexaferrite prepared by Pechini method. *Journal of Alloys and Compounds*, *1002*, 175388. https://doi.org/10.1016/j.jallcom.2024.175388

Rana, K., Thakur, S., Tomar, M., Gupta, V., & Thakur, A. (2023). Effect of low sintering temperature on the structural and magnetic properties of M-type strontium hexaferrite. *Journal of Magnetism and Magnetic Materials*, *587*, 171289. https://doi.org/10.1016/j.jmmm.2023.171289

Shafaay, A. S., Fayed, M. G., Mohamed, S. G., & Ghaffar, D. N. (2025). Novel and facile one-pot synthesis, characterization, and application of strontium hexaferrites as an efficient anode material for Li-ion battery. *Journal of Energy Storage*, *123*, 116736. https://doi.org/10.1016/j.est.2025.116736

Shirmahd, H., Aboutalebi, M., Seyedein, S. H., & Adeli, M. (2024). Synthesis of strontium hexaferrite (SrFe12O19) by self-propagating high-temperature synthesis (SHS) method and investigation of the effect of milling on morphology and magnetic properties. *Ceramics International*, *50*(20), 38542–38549. https://doi.org/10.1016/j.ceramint.2024.07.222

Singh, C., Nikolic, M. V., Ammar-Merah, S., Dojcinovic, M. P., Gam-Derouich, S., Naqvi, S. T. A., & Tadic, N. B. (2025). Temperature and frequency tuned study of electrical properties of M-type strontium hexaferrite. *Ceramics International*, *51*(9), 11593–11602. https://doi.org/10.1016/j.ceramint.2025.01.014

Tiwari, P. R., Singh, R. P., Bharati, K., Yadav, A. C., Bhardwaj, B., Yadav, B. C., Singh, A., & Kumar, S. (2024). Synthesis and application of strontium-doped zinc ferrite nanomaterial in humidity sensing. *Journal of the Indian Chemical Society*, *101*(12), 101439. https://doi.org/10.1016/j.jics.2024.101439

Urbano-Peña, M. de los Á., Berber-Mendoza, M. S., Palomares-Sánchez, S. A., Gutiérrez-Castañeda, E. J., & Hurtado-López, G. F. (2024). Magnetic compounds based on strontium hexaferrite for the adsorption of lead in contaminated water. *Ceramics International*, *50*(9), 14216–14222.

https://doi.org/10.1016/j.ceramint.2024.01.328

Wang, S., Gao, H., Fang, L., Hu, Q., Sun, G., Chen, X., Yu, C., Tang, S., Yu, X., Zhao, X., Sun, G., & Yang, H. (2021). Synthesis of novel CQDs/CeO2/SrFe12O19 magnetic separation photocatalysts and synergic adsorption-photocatalytic degradation effect for methylene blue dye removal. *Chemical Engineering Journal Advances*, *6*, 100089. https://doi.org/10.1016/j.ceja.2021.100089

Xie, T., Liu, C., Xu, L., Yang, J., & Zhou, W. (2013). Novel Heterojunction Bi2O3/SrFe12O19 Magnetic Photocatalyst with Highly Enhanced Photocatalytic Activity. *The Journal of Physical Chemistry C*, *117*(46), 24601–24610. https://doi.org/10.1021/jp408627e

Xie, T., Xu, L., Liu, C., Yang, J., & Wang, M. (2014). Magnetic composite BiOCl–SrFe12O19: a novel p–n type heterojunction with enhanced photocatalytic activity. *Dalton Transaction*, *43*, 2211–2220. https://doi.org/10.1039/C3DT52219A

Yu, Z., Sun, Y., Gong, H., & Shen, B. (2024). The effects of raw materials particle sizes on the solid-state reaction progress, morphology and magnetic properties of M-type strontium hexaferrites. *Ceramics International*, *50*(22), 46062–46068. https://doi.org/10.1016/j.ceramint.2024.08.449

Yu, Z., Zhou, N., Sun, Y., Chen, Z., Gong, H., & Shen, B. (2023). Preparation of high-performance M-type strontium hexaferrites by ceramic method by optimizing the particle size of raw materials. *Solid State Sciences*, *144*, 107309. https://doi.org/10.1016/j.solidstatesciences.2023.107309