Research trend on erbium-doped tellurite glasses based on scopus database

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Abstract. This paper aims to analyse the research trend of erbium-doped tellurite glasses. To this aim, this paper applied bibliometric analysis. The comprehensive research document on the topic of erbium-doped tellurite glasses in the Scopus database is 695 documents. The result revealed that scientific publication on erbium-doped tellurite glasses has been increasing. China contributed the most documents on erbium-doped tellurite glasses. The visualization of the research trend on erbium-doped tellurite glasses assisted with VOSviewer software and resulted in four primary clusters: (1) the red cluster show the keywords about the synthesized and fabrication, (2) the blue cluster show the keywords about the characterization, (3) the green cluster show the user or the application of the glass with each characteristic of materials, (4) the yellow cluster show the way to analyse energy based on the parameters owned by erbium-doped tellurite glasses. The research findings are the networking of the keywords on the research of erbium doped tellurite glasses in all clusters. It means that this research is comprehend knowledge and need to be more investigate to further research.

Keywords: *Bibliometric analysis, Erbium-doped tellurite glasses, VOSviewer*

1 Introduction

There are various glasses, such as phosphate glass, fluoride, germanate, silicate borate, and tellurite glass [1-4]. Recently, tellurite glass is in great demand by researchers in photonic. Many kind of composition synthesize and characterize to get the best materials based on the aim of applications. The forming glass need combination with the network modifying elements [5-6], such as alkali metals, alkali earth, heavy metals, transition metals, or oxides [7]. Some researchers used the properties of rare earth ion to develop the glass materials composition, such as Neodymium, Erbium, and others.

Each component in the glass composition has characteristics —similarly, the addition of erbium ion doping on the composition of the glass-forming material. Erbium is one of the lanthanides with the most negligible concentration of nuclear spins, with only the ^{167}Er $I=7/2$ isotope being magnetic, which is present in 23% of natural abundance [7]. Erbium is believed to increase the optical absorption of light and produce energy peaks when the glass sample is made to measure its optical absorption using a spectrophotometer. This ability of erbium helps the optical pumping when the material becomes a laser amplifier. Therefore, erbium doped tellurite glasses were developed for application as

a laser host, optical amplifier, potential high energy capacitor, and so on [8-13].

These constituent components produce various types of erbium-doped tellurite glass that are designed, fabricated, and tested for characterization for specific applications. Research results related to erbium doped tellurite glasses are published as scientific articles indexed by multiple databases. One of the reputable scientific research publication databases is Scopus. Based on the Scopus database, researchers can explore information on research developments in various fields, including research on the topic of erbium doped tellurite glasses.

Many authors around the world have researched erbium-doped tellurite glasses, for example, in China (253 documents), India (77 documents), Malaysia (70 papers), Brazil (64 articles), United Kingdom (48 pieces), and other countries. It is less number of authors from Indonesia that concern about this topic. Only four (4) research documents from Indonesia are Marzuki, Jauhariyah, Fausta, Yuniano, Riyatun, Purwanto, Cari, Widanarto [14-17]. Indeed, only a few studies focused on the research trend of erbium-doped tellurite glasses.

Bibliometric analysis is the most trending method for mapping relevant research to find novelties or reporting research trends on specific topics. This method is used to evaluate a paper's contribution to advancing

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knowledge [18-20]. The indicators that have been frequently used to analyse the trends are the research fields, document sources, distribution of countries and institutions, top authors, the number of citations, and author keywords [18-23]. This study aims to analyse the trend in erbium-doped tellurite glasses research. Scoping the research trend may help researchers comprehend the landscape of global research on erbium-doped tellurite glasses. It explores the trend on total documents every year, the top ten authors globally, the top ten affiliations globally, the top ten research sources, and the visualization results of the research trend on erbium-doped tellurite glasses.

2 Method

It is literature study to explore the research trend on erbium doped tellurite glasses. The bibliometric method is used to explore and report the research trend on erbium-doped tellurite glasses. Scopus database used in this study with search strategy: TITLE-ABS-KEY (erbium AND doped AND tellurite AND glass es). There are 695 documents for all years. The data

were documented in the form of (.csv) and (.ris). Microsoft Excel and VOSViewers were used to process data report and visualization, then analysed. Microsoft Excel helps to visualize the trend on total document every year, the ten top authors in the world, the ten top affiliations in the world, the ten top research sources. The visualization results of the research trend on erbium doped tellurite glasses helped by VOSviewer [24]. Then, analysed, give the conclusion and recommendations.

3 Results and Discussion

Based on the keyword “erbium doped tellurite glasses” on the scopus search engine, there are 695 documents for all years. The information of total document per year in the scopus database show in Fig. 1. Starting on 1976, the first research document about erbium doped tellurite glasses, research on this topic began to be in demand in the 2000s. The increase in research documents was quite volatile and reached the maximum number in 2013, after that it decreased and has fluctuated until now (see Fig. 1).

Fig. 1. The trend of research on erbium doped tellurite glasses based on the total document per year.

Fig. 2. The source document type for the publication research on erbium doped tellurite glasses.

Meanwhile, the number of articles based on document type of sources indicated the dominant of articles in the journals (513 documents or 73.92%), conference paper (161 documents or 23.20%), conference review (13 documents or 0.87%), review (6 documents or 0.87%), and book chapter 91 document or 0.14%). See Fig. 2. Most of documents used English as the language (644). The rest documents used Chinese (50) and Japanese (1) language.

Fig. 3 show the top ten countries contributor on the research on the topic of erbium doped tellurite glasses. Based this information, the researchers in the field of erbium doped tellurite glasses can study with authors from China. This information also shows that the development of research in the field of erbium doped tellurite glasses is very growing in China. Research contributions by Chinese researchers reached 253 documents, more than three times the number of contributions from the second contributor, India (77 documents). If we then ask, is there any contribution from Indonesia in research in the field of erbium doped tellurite glasses? Yes, there are 4 research documents in the Indonesian-affiliated Scopus database. Research in this field is very rare in Indonesia, although it has developed very rapidly in China. If the Fig. 3 show the top ten country contributor, the Fig. 4 show the top ten

affiliation of authors research on erbium doped tellurite glasses. The institution that made the biggest contribution to the research on erbium doped tellurite glasses was the Chinese Academy of Sciences (89). Followed by Ningbo University (77), Shanghai Institute of Optics and Fine Mechanics Chinese Academy of Sciences (62), Universiti Teknologi Malaysia (50), University of Leeds (33), and the next five institutions as shown in Fig. 4.

Fig. 3. The top ten country contributor on the research on erbium doped tellurite glasses

Fig. 4. The top ten authors affiliation on the research of erbium doped tellurite glasses.

Fig. 5 shows the top authors research on erbium doped tellurite glasses. While Fig. 6 shows top ten sources of scientific research publication on erbium doped tellurite glasses. All of this information can be used as a reference for researchers who focus on the research field of erbium doped tellurite glasses when looking for accurate and reliable references. Authors who have a large number of documents can be traced their work to

be studied in depth or as reference material for comparison when other researchers develop research in the field of erbium doped tellurite glasses. The sources of scientific publications are listed in Fig. 6. These top ten sources of scientific publications can be used as a reference when conducting scientific searches, or as a publication destination for researchers in this field.

Fig. 5. The top ten authors in the world on the research on erbium doped tellurite glasses.

Fig. 6. The top ten of publication source on erbium doped tellurite glasses research.

Fig. 8. The network visualization of the research on erbium doped tellurite glasses.

Fig. 9. Density visualization of the research on erbium doped tellurite glasses.

There are 695 documents related to erbium-doped tellurite glasses in the Scopus database. The visualization of the research trend on erbium-doped tellurite glasses assisted with VOSviewer software [24].

This effort is useful for finding the novelty of the research. Fig. 8 indicates the whole picture of research on erbium-doped tellurite glasses. Researchers in the world produce four (4) clusters. The red clusters show the

research on the synthesis and fabrication of erbium doped tellurite glasses. The blue cluster show the characterization process on erbium doped tellurite glasses. The green cluster discussed the application or the use of erbium doped tellurite glasses. While the yellow cluster discussed the energy analysis based on the parameters owned by erbium doped tellurite glasses.

In the Fig. 8, the circle size shows the the positively correlated with the appearance of the keyword on the title and abstract. The line show the networking for every linked text and the keywords appear together [25]. The shorter the distance, the stronger relationship. Fig. 9 show the density visualization of the research on erbium doped tellurite glasses. The yellower the more discussion about it, the more green the less discussion about it [25]. Based on those visualizations, most keywords about the material synthesized application are frequently discussed in the green cluster. Emission cross section, broadband, emission, bandwidth, upconversion, etc are the indicator to what application the glass material developed. For example amplifier, fiber, tellurite glass fiber, optical fiber, and so on.

For the red cluster, erbium doped tellurite glass and density is the most frequently discuss. The other frequently discussed in the red cluster are the technique for fabrication process, such as enhancement, presence, quenching, nanoparticle. In the process of synthesize of erbium-doped tellurite, we also notice the amorphous nature, so we can choose the right network modifier [26]. To identify the properties of the sample of erbium doped tellurite glasses, we need some physical characterization analysed method such XRD, DSC, and others. Another characterization on the optical properties of erbium-doped tellurite glasses are absorption spectra, fluorescence intensity, fluorescence, branching ratio, and others.

(a)

(b)

(c)

(d)

Fig. 10. The visualization for each cluster: (a) red cluster, (b) green cluster, (c) blue cluster, and (c) yellow cluster.

Fig. 10 show the visualization for each cluster. It show that every cluster have networking with another cluster. It means that we need the comprehensive knowledge about the materials composition, the properties of each composition, the glass science knowledge, the technique of fabrication or synthesized and characterize the glass, also for what purpose the glass sample was developed. It is a comprehensive set of knowledge that must be understood before deciding on the initial plan for the composition of erbium doped tellurite glasses to be developed. In fact, if we take a closer look at the existing documents in the Scopus database, various types of glass with various

compositions have been developed that combine certain elements to modify the glass that has been developed to produce properties that are superior to the application objectives of the material developed.

4 Conclusion

Based on the information found, the research on erbium-doped tellurite glasses increased until the maximum in 2013 and decreased until now. Erbium-doped tellurite glasses growing, and China is the most contributor country. Chinese Academy of Science leads the institution contributor in the research of erbium-doped tellurite glasses. Sahar placed first in the top ten authors of publication on erbium-doped tellurite glasses. Proceedings of SPIE The International Society for Optical Engineering is the publication who published the most number of research results on the topic of erbium doped tellurite glasses. The mapping of the keywords shows four main clusters in the research of erbium-doped tellurite glasses. The red cluster shows the keywords about the synthesized and fabrication. The blue cluster shows the keywords for the characterization of erbium-doped tellurite glasses. Meanwhile, the green cluster shows the used or the application of the glass with each characteristic of materials. Then, the yellow cluster shows how to analyse energy based on the parameters owned by erbium-doped tellurite glasses. The research findings are the networking of the keywords on the research of erbium doped tellurite glasses in all clusters. It means that this research are comprehend knowledge and need to be more investigate fo further research.

References

1. B. Mysisen, Eur. J. Mineral. **15** 781-802 (2003)
2. Muresan, M. D. Bularda, C. Popa, L. Baia, and S. Simon, Rom. Journ. Phys. **51** 231-237 (2006)
3. M. Pal, B. Roy, M. Pal, Journal of Modern Physics **2** 1062-1066 (2011)
4. M. R. Dousti, R. J. Amjad, M.R. Sahar, Z. M. Zabidi, A. N. Alias, and A. S. S. de Camargo, J. Non Cryst. Solids **429** 70-78 (2015)
5. V. P. Tuyen, B. Sengthong, V. X. Quang, P. V. Do, H. V. Tuyen, L. X. Hung, N. T. Thanh, M. Nogami, T. Hayakawa and B. T. Huy, J. Lumin **178** 27-33 (2016)
6. N. Elkhoshkhany, S. Y. Marzuok, N. Moataz N and S. H. Kandil, J. Non Cryst Solids **08** 011 (2018)
7. G. Aromi and O. Roubeaou, *Handbook on the Physics and Chemistry of Rare Earths: Chapter 309 - Lanthanide molecules for spin-based quantum technologies* **56** 1-54 (2019)
8. A. Marzuki, R. A. Zikri, M. N. R. Jauhariyah, and D. E. Fausta, J. Phys. Conf. Ser. **1912** 012038 (2021)
9. M. N. Azlan, S. Z. Shafinas, M. K. Halimah, and A. B. Suriani, Journal of Materials Science: Materials in Electronics **30**(19) 18015-18024 (2019)
10. P. Nandi and G. Jose, Optics Communications **265**(2) 588-593 (2006)
11. Tanabe, Setsuhisa, Hanada, Teiichi, Journal of the Communications Research Laboratory **46**(3) 275-277 (1999)
12. J. I. Mackenzie, G. S. Murugan, T. Suzuki, Y. Ohishi, A. W. Yu, and J. B. Abshire, CLEO: Applications and Technology pp. ATu2G.7 (2012)
13. J. I. Mackenzie, G. S. Murugan, T. Suzuki, Y. Ohishi, A. W. Yu, and J. B. Abshire, Conference on Lasers and Electro-Optics (CLEO) 6325383 (2012)
14. A. Marzuki and D. E. Fausta, IOP Conference Series: Materials Science and Engineering **333** (1) 012015 (2018)
15. A. Marzuki, M. Yunianto, Riyatun, and H. Purwanto, Key Engineering Materials **772** 85-89 (2018)
16. M. N. R. Jauhariyah, Cari, and A. Marzuki, Materials Science Forum **864** 37 – 41 (2016)
17. W. Widanarto, M. R. Sahar, S. K. Ghoshal, R. Arifin, M. S. Rohani, and K. Hamzah, Journal of Magnetism and Magnetic Materials **326** 123 – 128 (2013)
18. H. Chen and Y. S. Ho, Renewable and Sustainable Energy Reviews **49** 12-20 (2015)
19. W. T. Chou and Y. S. Ho, Scientometrics **73** 3-17 (2007)
20. L. Yang, T. Sun, and Y. Liu, International Journal of Emerging Technologies in Learning **12**(6) 178-186 (2017)
21. K. Y. Chuang, Y. L. Huang, and Y. S. Ho, Scientometrics **72** 201-212 (2007)
22. B. Dong, G. Xu, X. Luo, Y. Cai, and W. Gao, Scientometrics **93** 1101-1117 (2012)
23. N. Suprpto, B. K. Prahani, and U. A. Deta, Library Philosophy and Practice (e-journal) 6-2021 (2021)
24. N. J. van Eck and L. Waltman, *VOSviewer manual*. Retrieved from https://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.8.pdf (2018)
25. H. Liao, M. Tang, L. Luo, C. Li, F. Chiclana, and H. J. Zeng, Sustainability **10**(2) 166 (2018)
26. R. A. H. El-Mallawany, *Tellurite Glasses Handbook: Physical Properties and Data* (USA: CRC Press LLC) (2002)