CHAPTER 5

BIBLIOMETRIC ANALYSIS OF STUDY CONTAINING METAL ORGANIC FRAMEWORK AND RARE EARTH ELEMENTS OR METALS IN WEB OF SCIENCE DATABASE

Nagihan KARAASLAN AYHAN[1]
Feyza GULYUZ DEMIR[2]

INTRODUCTION

Metal organic frameworks (MOFs) are structures with uniform and infinite coordination networks composed of coordinative bonds between metal ions and solid organic linkers. These structures typically contain two- or three-dimensional bonds between the metal ions and an organic linker, creating potential voids within the structure (Rowsell & Yaghi, 2004). Metal organic frameworks have properties such as large pore sizes, high apparent surface areas, and the ability to selectively take up small molecules (Rowsell & Yaghi, 2004). In recent years, studies on metal organic frameworks in different fields have increased, and different methods, including diffusion hydrothermal (solvothermal), electrochemical, mechanochemical, microwave-assisted heating and ultrasound, have been reported to produce MOFs containing organic bonds and metal centers (Haque et al., 2010; Karimi-Maleh et al., 2021; Li et al., 2017; Lu et al., 2019; Qi et al., 2008; Zhao et al., 2005). These structures are of interest in fields such as membranes, thin film devices, catalysis, and biomedical imaging (Bhoite et al., 2024; Bengsch & Neumann, 2025; Denny et al., 2016; Li et al., 2020; Jia et al., 2024; Ma et al., 2023; Parvin et al., 2024; Qian et al., 2020; Shah et al., 2018; Zhou et al., 2012). Moreover, metal organic frameworks are known to have many applications such

[1] Assoc. Prof. Dr., Munzur University, Tunceli Vocational School, Department of Chemistry and Chemical Processing Technologies, nkaraaslan@munzur.edu.tr, ORCID iD: 0000-0001-9083-9149.
[2] Scientist, Munzur University, Graduate Education Institute, Department of Strategic Raw Materials and Advanced Technology Applications, feyzagulyuz@gmail.com, ORCID iD: 0009-0001-4674-8124.

DOI: 10.37609/akya.3856.c1263

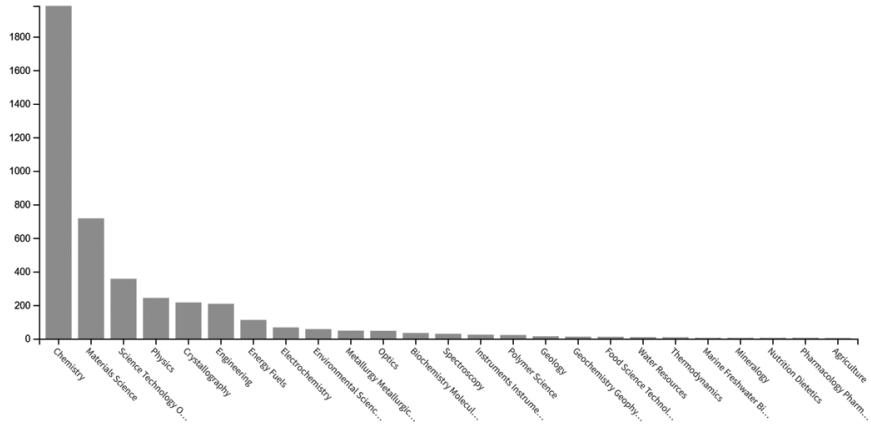

Figure 10. Distribution of studies by research area.

CONCLUSION

In the presented study, a detailed bibliometric analysis of the concepts of "metal organic framework and rare earth" was conducted and evaluated using the Web of Science database. The analyses examined publication types, fields used, authors, publication years, countries, institutions and organizations, and research areas, and the relationships between them were demonstrated, resulting in a compelling study. Furthermore, the relationship between the factors used to evaluate the study was analyzed and visualized using the Vosviewer program. It was determined that studies on metal organic framework and rare earth were primarily publication-based and concentrated in the fields of chemistry, materials, physics, environment, biochemistry, and metallurgy. Among the countries conducting the studies, China has been the most intensively researched on me.

REFERENCES

Abdollahi, A., Roghani-Mamaqani, H., Razavi, B. & Salami-Kalajahi, M. (2020). Photoluminescent and chromic nanomaterials for anticounterfeiting technologies: Recent advances and future challenges. ACS Nano, 14(1):14417-14492.

Akçay, Ö. (2025). Sturm-Liouville operatörlerünün ters spektral probleminin bibliyometrik analizi. 2025, In M. Dal, N. Dal & İ. Ay (Eds.), Bibliyometrik Analiz I, (pp. 47-60), Akademisyen yayınevi.

Anwer, A. H., Ansari, M. Z., Mashkoor, F., Zhu, S. S., Shoeb, M. & Jeong, C. (2023). Synergistic effect of carbon nanotube and tri-metallic MOF nanoarchitecture for electrochemical high-performance asymmetric supercapacitor applications and their charge storage mechanism. Journal of Alloys and Compounds, 955:170038.

Bahrani, S., Hashemi, S. A., Mousavi, S. M. & Azhdari, R. (2019). Zinc-based metal-organic frameworks as nontoxic and biodegradable platforms for biomedical applications: review study. Drug Metabolism Reviews, 51(3):356-377.

Bengsch, M. & Neumann, C. N. (2025). Metal-organic framework-specific catalysis. ChemCatChem, 17(6):e202402102.

Bhoite, A. A., Hubale, V. B., Sawant, V. A. & Tarwal, N. L. (2024). Cobalt-based metal-organic framework (Co-MOF) thin films with high capacitance for supercapacitor electrode. Journal of Materials Science, DOI 10.1007/s10853-024-09591-8.

Burkut, E. B. & Dal, M. (2023). Systematic literature review and scientific maps on eco logical architecture and eco-architecture. International Journal of Pure and Applied Sciences, 9(2):369-380.

Burkut, E. B. & Dal, M. (2024). Analysis of articles on occupational health and safety with scientific mapping techniques in WoS & Scopus database (2000-2023). *Digital International Journal Of Architecture Art Heritage*, 2024; 3(1):1-13.

Chen, Z. Y., Li, Z., Chen, J., Kallem, P., Banat, F. & Qiu, H. D. (2022). Recent advances in selective separation technologies of rare earth elements: a review. Journal of Environmental Chemical Engineering, 10(1):107104.

Cheng, Z. Y. & Lin, J. (2010). Layered organic-inorganic hybrid perovskites: structure, optical properties, film preparation, patterning and templating engineering. CrystEngComm, 12(10):2646-2662.

Crawford, S. E., Gan, X. Y., Lemaire, P. C. K., Millstone, J. E., Baltrus, J. P. & Ohodnicki, P. R. (2019). ACS Sensors, 4(8):1986-1991.

Cui, W. G., Hu, T. L. & Bu, X. H. (2020). Metal-organic framework materials for the separation and purification of light hydrocarbons. Advanced Materials, 32(3):1806445.

Denny, M. S., Moreton, J. C., Benz, L. & Cohen, S. M. (2016). Metal-organic frameworks for membrane-based separations. Nature Reviews Materials, 1(12):16078.

Dereli, A. B. (2024). Bibliometric analysis with Vosviewer. Communicata, 28:1-7.

Fonseca, R., Araujo, J. F. & Pinho, C. G. (2021). Importance of the spatial distribution of rare earth elements in the bottom sediments of reservoirs as a potential proxy for tracing sediments sources. A case ctudy in the Dominican Republic. Geosciences. 11(12):490.

Haque, E., Khan, N. A., Park, J. H. & Jhung, S. H. (2010). Synthesis of a metal-organic framework material, iron terephthalate, by ultrasound, microwave, and conventional electric heating: A kinetic study. Chemistry-A European Journal, 16(3):1046-1052.

Horcajada, P., Chalati, T., Serre, C., Gillet, B., Sebrie, C., Baati, T., Eubank, J. F., Heurtaux, D., Clayette, P., Kreuz, C., Chang, J. S., Hwang, Y. K., Marsaud, V., Bories, P. N., Cynober, L., Gil, S., Ferey, G., Couvreur, P. & Gref, R. (2010). Porous metal-organic-framework nanoscale carriers as a potential platform for drug delivery and imaging. Nature Materials, 9(2):172-178.

Huang, Y. Y., Ren, J. S. & Qu, X. G. (2019). Nanozymes: Classification, catalytic mechanisms, activity regulation, and applications. Chemical Reviews, 119(6):4357-4412.

Jia, M. M., Feng, J. H., Shao, W., Chen, Z., Yu, J. R., Sun, J. J., Wu, Q. Y., Li, Y., Xue, M. & Chen, X. M. (2024). In-situ interfacial synthesis of metal-organic framework/polyamide thin-film nanocomposite membranes with elevated nanofiltration performances. Journal of Membrane Science, 694:122418.

Karimi-Maleh, H., Yola, M. L., Atar, N., Orooji, Y., Karimi, F., Kumar, P. S., Rouhi, J. & Baghayeri, M. (2021). A novel detection method for organophosphorus insecticide fenamiphos: Molecularly imprinted electrochemical sensor based on core-shell Co_3O_4@MOF-74 nanocomposite. Journal of Colloid and Interface Science, 592:174-185.

Kreno, L. E., Leong, K., Farha, O. K., Allendorf, M., Van Duyne, R. P. & Hupp, J. T. (2012). Metal-organic framework materials as chemical sensors. Chemical Reviews, 112(2):1105-1125.

Lee, M. J., Tiwari, A. P., Ko, T. H. & Kim, H. Y. (2022). Metal-organic frameworks of rare earth metals embedded side-by-side nanofiber as a switchable luminescent sensor for Fe^{3+} and Cu^{2+} in aqueous media, Journal of Luminescence. 249:119029.

Li, D., Dai, X. P., Zhang, X., Zhuo, H. Y., Jiang, Y., Yu, Y. B., Zhang, P. F., Huang, X. L. & Wang, H. (2017). Silver nanoparticles encapsulated by metal-organic-framework give the highest turnover frequencies of 105 h-1 for three component reaction by microwave-assisted heating. Journal of Catalysis, 348:276-281.

Li, J. R., Kuppler, R. J., Zhou & H. C. (2009). Selective gas adsorption and separation in metal-organic frameworks. Chemical Society Reviews, 38(5):1477-1504.

Li, X. L., Cai, Z., Jiang, L. P., He, Z. M. & Zhu, J. J. (2020). Metal-ligand coordination nanomaterials for biomedical imaging. Bioconjugate Chemistry, 31(2):332-339.

Li, Z. H., Sun, F., Jiang, W. L., Li, X. G., Jiang, J. Q., Jin, F. Y., Lu, J. X., Yang, F. (2024). Bibliometric Analysis of Trends and Research Progress in Acid Mine Drainage Remediation from 1990 to 2023. Warer, 16(13):1826.

Liu, T. & Chen, J. (2021). Extraction and separation of heavy rare earth elements: A review. Separation and Purification Technology, 276(1):119263.

Lu, M. X., Deng, Y. J., Luo, Y., Lv, J. P., Li, T. B., Xu, J., Chen, S. W. & Wang, J. Y. (2019). Graphene aerogel-metal-organic framework-based electrochemical method for simultaneous detection of multiple heavy-metal ions. Analytical Chemistry, 91(1):888-895.

Ma, L. F., Li, D. S., Yang, G. P. & Zhang, Q. C. (2023). Editorial: Porous metal-organic framework (MOF) materials: design strategy, synthesis, sensing and catalysis. Frontiers in Chemistry, 11:1245159.

Meng, X., Wang, H. N., Song, S. Y. & Zhang, H. J. (2017). Proton-conducting crystalline porous materials. Chemical Society Reviews, 46(2):464-480.

Miro, P., Audiffred, M. & Heine, T. (2014). An atlas of two-dimensional materials. Chemical Society Reviews, 43(18):6537-6554.

Parvin, N., Kumar, V., Mandal, T. K. & Joo, S. W. (2024). Advancements in nanoporous materials for biomedical imaging and diagnostics. Journal of Functional Biomaterials, 15(8):226.

Qi, Y., Luo, F., Che, Y. X. & Zhen, J. M. (2008). Hydrothermal synthesis of metal-organic frameworks based on aromatic polycarboxylate and flexible bis(imidazole) ligands. Crystal Growth & Design, 8(2):606-611.

Qian, Q. H., Asinger, P. A., Lee, M. J., Han, G., Rodriguez, K. M., Lin, S., Benedetti, F. M., Wu, A. X., Chi, W. S. & Smith, Z. P. (2020). MOF-based membranes for gas separations. Chemical Reviews, 120(16):8161-8266.

Qiu, S. L. & Zhu, G. S. (2009). Molecular engineering for synthesizing novel structures of metal-organic frameworks with multifunctional properties. Coordination Chemistry Reviews, 253(23-24):2891-2911.

Ravipati, M., Sreekumar, A. & Badhulika, S. (2023). Bimetallic nickel/cobalt metal-organic framework-based electrochemical sensor for trace level detection of IgG in simulated human blood serum. Microchemical Journal, 195:109510.

Rowsell, J. L. C. & Yaghi O. M. (2004). Metal-organic frameworks: a new class of porous materials. Microporous and Mesoporous Materials, 73(1-2):3-14.

Safaei, M., Foroughi, M. M., Ebrahimpoor, N., Jahani, S., Omidi, A. & Khatami, M. (2019). A review on metal-organic frameworks: Synthesis and applications. TrAC Trends in Analytical Chemistry, 118:401-425.

Shah, S. S. A., Najam, T., Cheng, D., Hafeez, A., Lu, Y. & Waseem, A. (2018). Nano-metal organic frame work an excellent tool for biomedical imaging. Current Medical Imaging, 14(5):669-674.

Song, X. Z., Song, S. Y., Zhao, S. N., Hao, Z. M., Zhu, M., Meng, X., Wu, L. L. & Zhang, H. J. (2014). Single-crystal-to-single-crystal transformation of a europium(III) metal-organic framework producing a multi-responsive luminescent sensor. Advanced Functional Materials, 24(26):4034-4041.

Stassen, I., Burtch, N. C., Talin, A. A., Falcaro, P., Allendorf, M. D. & Ameloot, R. (2017). An updated roadmap for the integration of metal-organic frameworks with electronic devices and chemical sensors. Chemical Society Reviews, 46(11):3185-3241.

Sun, X. C., Yuan, K. & Zhang, Y. W. (2020). Advances and prospects of rare earth metal-organic frameworks in catalytic applications. Journal of Rare Earths, 38(8):801-818.

Tian, C. X., Zhu, L. P., Lin, F. & Boyes, S. G. (2015). Poly(acrylic acid) bridged gadolinium metal-organic framework-gold nanoparticle composites as contrast agents for computed tomography and magnetic resonance bimodal imaging. ACS Applied Materials & Interfaces, 7(32):17765-

17775.

Tuğrul, F. (2025). Bibliometric analysis on the concept of "intuitionistic fuzzy set". 2025, In M. Dal, N. Dal & İ. Ay (Eds.), Bibliometric Analysis I, (pp. 47-60), Akademisyen yayınevi.

Tuğrul, F. & Can, U. (2025). Bibliometric analysis of machine learning and fuzzy concepts: Eeb of science-based study. 2025, In M. Dal, N. Dal & İ. Ay (Eds.), Bibliometric Analysis II, (pp. 55-68), Akademisyen yayınevi.

VOSviewer, https://www.vosviewer.com/, Date of Access: 29.09.2025.

Wang, X., Yu, L., Guan, B. Y., Song, S. Y. & Lou, X. W. (2018). Metal-organic framework hybrid-assisted formation of co3o4/co-fe oxide double-shelled nanoboxes for enhanced oxygen evolution. Advanced Materials, 30(29):1801211.

Web of Science, https://www.webofscience.com/wos/woscc/basic-search, Date of Access: 29.09.2025.

Wu, M. X. & Yang, Y. W. (2017). Metal-organic framework (MOF)-based drug/cargo delivery and cancer therapy. Advanced Materials, 29(23):1606134.

Xia, W., Mahmood, A., Liang, Z. B., Zou, R. Q. & Guo, S. J. (2016). Earth-abundant nanomaterials for oxygen reduction. Angewandte Chemie-International Edition, 55(8):2650-2676.

Xiao, W., Zhou, L., Yang, P., Yan, N., Wei, C. (2023). An international comparative study of rare earth research from the perspective of bibliometrics. Heliyon, 9(5):e16075.

Younis, S. A., Bhardwaj, N., Bhardwaj, S. K., Kim, K. H. & Deep, A. (2021). Rare earth metal-organic frameworks (RE-MOFs): Synthesis, properties, and biomedical applications. Coordination Chemistry Reviews, 429:213620.

Zhang, Y., Sun, P. P., Zhang, L., Wang, Z. Z., Wang, F. M., Dong, K., Liu, Z., Ren, J. S. & Qu, X. G. (2019). Silver-infused porphyrinic metal-organic framework: surface-adaptive, on-demand nanoplatform for synergistic bacteria killing and wound disinfection. Advanced Functional Materials, 29(11):1808594.

Zhang, Y., Wang, F. M., Liu, C. Q., Wang, Z. Z., Huang, Y. Y., Dong, K., Ren, J. S. & Qu, X. G. (2018). Nanozyme decorated metal-organic frameworks for enhanced photodynamic therapy. ACS Nano, 12(1):651-661.

Zhao, B., Yi, L., Dai, Y., Chen, X. Y., Cheng, P., Liao, D. Z., Yan, S. P. & Jiang, Z. H. (2005). Systematic investigation of the hydrothermal syntheses of Pr(III)-PDA (PDA = pyridine-2,6-dicarboxylate anion) metal-organic frameworks. Inorganic Chemistry, 44(4):911-920.

Zheng, B. Z., Fan, J. Y., Chen, B., Qin, X., Wang, J., Wang, F., Deng, R. R. & Liu, X. G. (2022). Rare-earth doping in nanostructured inorganic materials. Chemical Reviews, 122(6):5519-5603.

Zheng, H. Q., Zhang, Y. N., Liu, L. F., Wan, W., Guo, P., Nyström, A. M. & Zou, X. D. (2008). One-pot synthesis of metal organic frameworks with encapsulated target molecules and their applications for controlled drug delivery. Journal of The American Chemical Society, 138(3):962-968.

Zhong, H. X., Wang, J., Zhang, Y. W., Xu, W. L., Xing, W., Xu, D., Zhang, Y. F. & Zhang, X. B. (2014). ZIF-8 derived graphene-based nitrogen-doped porous carbon sheets as highly efficient and durable oxygen reduction electrocatalysts. Angewandte Chemie-International Edition, 53(51):14235-14239.

Zhou, H. C., Long, J. R. & Yaghi, O. M. (2012). Introduction to metal-organic frameworks. Chemical Reviews, 112(2):673-674.