DAFTAR PUSTAKA

[1] A. Bembibre *et al.*, “Visible-light driven sonophotocatalytic removal of tetracycline using Ca-doped ZnO nanoparticles,” *Chem. Eng. J.*, vol. 427, p. 132006, Jan. 2022, doi: 10.1016/j.cej.2021.132006.

[2] K. R. Basavalingiah, S. Harishkumar, Udayabhanu, G. Nagaraju, D. Rangappa, and Chikkahanumantharayappa, “Highly porous, honeycomb like Ag–ZnO nanomaterials for enhanced photocatalytic and photoluminescence studies: green synthesis using Azadirachta indica gum,” *SN Appl. Sci.*, vol. 1, no. Shelar, S. G., Mahajan, V. K., Patil, S. P., Sonawane, G. H. (2020). Effect of doping parameters on photocatalytic degradation of methylene blue using Ag doped ZnO nanocatalyst. SN Applied Sciences, 2(5), 1–10. https://doi.org/10.1007/s42452-020-2634-2, pp. 1–13, 2019, doi: 10.1007/s42452-019-0863-z.

[3] M. H. Elsayed *et al.*, “Direct sunlight-active Na-doped ZnO photocatalyst for the mineralization of organic pollutants at different pH mediums,” *J. Taiwan Inst. Chem. Eng.*, vol. 115, pp. 187–197, 2020, doi: 10.1016/j.jtice.2020.10.018.

[4] N. K. Divya and P. P. Pradyumnan, “Materials Science in Semiconductor Processing Solid state synthesis of erbium doped ZnO with excellent photocatalytic activity and enhanced visible light emission,” *Mater. Sci. Semicond. Process.*, vol. 41, pp. 428–435, 2016, doi: 10.1016/j.mssp.2015.10.004.

[5] P. Basnet, D. Samanta, T. I. Chanu, and S. Chatterjee, “Visible light facilitated degradation of alternate dye solutions by highly reusable Mn-ZnO nano-photocatalyst,” *J. Alloys Compd.*, vol. 867, p. 158870, 2021, doi: 10.1016/j.jallcom.2021.158870.

[6] L. Khezami, K. K. Taha, I. Ghiloufi, and L. El Mir, “Adsorption and photocatalytic degradation of malachite green by vanadium doped zinc oxide nanoparticles,” *Water Sci. Technol.*, vol. 73, no. 4, pp. 881–889, 2016, doi: 10.2166/wst.2015.555.

[7] X. Zhang, Y. Chen, S. Zhang, and C. Qiu, "High photocatalytic performance of high concentration Al-doped ZnO nanoparticles," *Sep. Purif. Technol.*, vol. 172, pp. 236–241, Jan. 2017, doi: 10.1016/j.seppur.2016.08.016.

[8] R. Saleh and N. F. Djaja, "Transition-metal-doped ZnO nanoparticles: Synthesis, characterization and photocatalytic activity under UV light," *Spectrochim. Acta - Part A Mol. Biomol. Spectrosc.*, vol. 130, pp. 581–590, 2014, doi: 10.1016/j.saa.2014.03.089.

[9] I. Ahmad *et al.*, "Rare earth co-doped ZnO photocatalysts: Solution combustion synthesis and environmental applications," *Sep. Purif. Technol.*, vol. 237, no. August, p. 116328, 2020, doi: 10.1016/j.seppur.2019.116328.

[10] M. Fu, Y. Li, S. Wu, P. Lu, J. Liu, and F. Dong, "Sol-gel preparation and enhanced photocatalytic performance of Cu-doped ZnO nanoparticles," *Appl. Surf. Sci.*, vol. 258, no. 4, pp. 1587–1591, 2011, doi: 10.1016/j.apsusc.2011.10.003.

[11] I. Ahmad, "Inexpensive and quick photocatalytic activity of rare earth (Er, Yb) co-doped ZnO nanoparticles for degradation of methyl orange dye," *Sep. Purif. Technol.*, vol. 227, no. April, p. 115726, 2019, doi: 10.1016/j.seppur.2019.115726.

[12] A. N. Kadam, T. G. Kim, D. S. Shin, K. M. Garadkar, and J. Park, "Morphological evolution of Cu doped ZnO for enhancement of photocatalytic activity," *J. Alloys Compd.*, vol. 710, pp. 102–113, 2017, doi: 10.1016/j.jallcom.2017.03.150.

[13] G. A. S. Josephine and A. Sivasamy, "Nanocrystalline ZnO doped Dy2O3 a highly active visible photocatalyst: The role of characteristic f orbital's of lanthanides for visible photoactivity," *Appl. Catal. B Environ.*, vol. 150–151, pp. 288–297, May 2014, doi: 10.1016/j.apcatb.2013.11.004.

[14] D. Toloman, A. Mesaros, A. Popa, T. D. Silipas, S. Neamtu, and G. Katona, "V-doped ZnO particles: synthesis, structural, optical and photocatalytic properties," *J. Mater. Sci. Mater. Electron.*, vol. 27, no. 6, pp. 5691–5698, 2016, doi: 10.1007/s10854-016-4480-y.

[15] J. J. Macías-Sánchez *et al.*, "Synthesis of nitrogen-doped ZnO by sol-gel

method: Characterization and its application on visible photocatalytic degradation of 2,4-D and picloram herbicides," *Photochem. Photobiol. Sci.*, vol. 14, no. 3, pp. 536–542, 2015, doi: 10.1039/c4pp00273c.

[16] I. N. Reddy *et al.*, "Excellent visible-light driven photocatalyst of (Al, Ni) co-doped ZnO structures for organic dye degradation," *Catal. Today*, vol. 340, pp. 277–285, 2020, doi: 10.1016/j.cattod.2018.07.030.

[17] N. Narayanan and N. K. Deepak, "Downshifter / Photocatalyst Ce doped AC Degradation Products," *Solid State Sci.*, 2018, doi: 10.1016/j.solidstatesciences.2018.02.017.

[18] R. Mohan, K. Krishnamoorthy, and S. J. Kim, "Enhanced photocatalytic activity of Cu-doped ZnO nanorods," *Solid State Commun.*, vol. 152, no. 5, pp. 375–380, 2012, doi: 10.1016/j.ssc.2011.12.008.

[19] U. Alam, T. A. Shah, A. Khan, and M. Muneer, "One-pot ultrasonic assisted sol-gel synthesis of spindle-like Nd and V codoped ZnO for efficient photocatalytic degradation of organic pollutants," *Sep. Purif. Technol.*, vol. 212, pp. 427–437, 2019, doi: 10.1016/j.seppur.2018.11.048.

[20] K. Rekha, M. Nirmala, M. G. Nair, and A. Anukaliani, "Structural, optical, photocatalytic and antibacterial activity of zinco xide and manganese doped zinc oxide nanoparticles," *Phys. B Condens. Matter*, vol. 405, no. 15, pp. 3180–3185, 2010, doi: 10.1016/j.physb.2010.04.042.

[21] D. Neena, M. Humayun, W. Zuo, C. S. Liu, W. Gao, and D. J. Fu, "Hierarchical hetero-architectures of in-situ g-C3N4-coupled Fe-doped ZnO micro-flowers with enhanced visible-light photocatalytic activities," *Appl. Surf. Sci.*, vol. 506, p. 145017, 2020, doi: 10.1016/j.apsusc.2019.145017.

[22] R. Ullah and J. Dutta, "Photocatalytic degradation of organic dyes with manganese-doped ZnO nanoparticles," *J. Hazard. Mater.*, vol. 156, no. 1–3, pp. 194–200, 2008, doi: 10.1016/j.jhazmat.2007.12.033.

[23] Y. Lu, Y. Lin, D. Wang, L. Wang, T. Xie, and T. Jiang, "A high performance cobalt-doped ZnO visible light photocatalyst and its photogenerated charge transfer properties," *Nano Res.*, vol. 4, no. 11, pp. 1144–1152, 2011, doi: 10.1007/s12274-011-0163-4.

[24] R. M. Mohamed, M. A. Al-Rayyani, E. S. Baeissa, and I. A. Mkhalid, “Nano-sized Fe-metal catalyst on ZnO-SiO2: (photo-assisted deposition and impregnation) Synthesis routes and nanostructure characterization,” *J. Alloys Compd.*, vol. 509, no. 24, pp. 6824–6828, 2011, doi: 10.1016/j.jallcom.2011.03.098.

[25] P. Caregnato, K. R. Espinosa Jiménez, and P. I. Villabrille, “Ce-doped ZnO as photocatalyst for carbamazepine degradation,” *Catal. Today*, vol. 372, no. July, pp. 183–190, 2021, doi: 10.1016/j.cattod.2020.07.031.

[26] M. Rostami, “Photodecomposition and adsorption of hazardous organic pollutants by Ce-doped ZnO @ Ce-doped TiO 2 -N / S-dual doped RGO ternary nano-composites photocatalyst for water remediation,” *J. Mol. Struct.*, vol. 1185, pp. 191–199, 2019, doi: 10.1016/j.molstruc.2019.02.094.

[27] D. Zhang, S. Liang, S. Yao, H. Li, J. Liu, and Y. Geng, “Separation and Puri fi cation Technology Highly e ffi cient visible / NIR photocatalytic activity and mechanism of Yb 3 + /,” *Sep. Purif. Technol.*, vol. 248, no. May, p. 117040, 2020, doi: 10.1016/j.seppur.2020.117040.

[28] O. Bechambi, M. Chalbi, W. Najjar, and S. Sayadi, *Photocatalytic activity of ZnO doped with Ag on the degradation of endocrine disrupting under UV irradiation and the investigation of its antibacterial activity*, vol. 347. Elsevier B.V., 2015. doi: 10.1016/j.apsusc.2015.03.049.

[29] J. Akhtar, M. B. Tahir, M. Sagir, and H. S. Bamufleh, “Improved photocatalytic performance of Gd and Nd co-doped ZnO nanorods for the degradation of methylene blue,” *Ceram. Int.*, vol. 46, no. 8, pp. 11955–11961, 2020, doi: 10.1016/j.ceramint.2020.01.234.

[30] B. Ramasamy, J. Jeyadharmarajan, and P. Chinnaiyan, “Novel organic assisted Ag-ZnO photocatalyst for atenolol and acetaminophen photocatalytic degradation under visible radiation: performance and reaction mechanism,” *Environ. Sci. Pollut. Res.*, vol. 28, no. 29, pp. 39637–39647, 2021, doi: 10.1007/s11356-021-13532-2.

[31] B. M. Rajbongshi and S. K. Samdarshi, “Cobalt-doped zincblende-wurtzite mixed-phase ZnO photocatalyst nanoparticles with high activity in visible

spectrum," *Appl. Catal. B Environ.*, vol. 144, pp. 435–441, 2014, doi: 10.1016/j.apcatb.2013.07.048.

[32] B. Poornaprakash *et al.*, "Effect of Eu3+ on the morphology, structural, optical, magnetic, and photocatalytic properties of ZnO nanoparticles," *Superlattices Microstruct.*, vol. 123, pp. 154–163, Nov. 2018, doi: 10.1016/j.spmi.2018.07.010.

[33] M. Khairy and W. Zakaria, "Effect of metal-doping of TiO2 nanoparticles on their photocatalytic activities toward removal of organic dyes," *Egypt. J. Pet.*, vol. 23, no. 4, pp. 419–426, 2014, doi: 10.1016/j.ejpe.2014.09.010.

[34] H. Chaker, A. E. Attar, M. Djennas, and S. Fourmentin, "A statistical modeling-optimization approach for efficiency photocatalytic degradation of textile azo dye using cerium-doped mesoporous ZnO: A central composite design in response surface methodology," *Chem. Eng. Res. Des.*, vol. 171, pp. 198–212, Jul. 2021, doi: 10.1016/j.cherd.2021.05.008.

[35] I. Ahmad *et al.*, "The role of synthesis method in hydrogen evolution activity of Ce doped ZnO/CNTs photocatalysts: A comparative study," *Int. J. Hydrogen Energy*, vol. 46, no. 59, pp. 30320–30333, Aug. 2021, doi: 10.1016/j.ijhydene.2021.06.148.

[36] M. Khuili, N. Fazouan, H. A. El Makarim, E. H. Atmani, D. P. Rai, and M. Houmad, "First-principles calculations of rare earth (RE=Tm, Yb, Ce) doped ZnO: Structural, optoelectronic, magnetic, and electrical properties," *Vacuum*, p. 109603, 2020, doi: 10.1016/j.vacuum.2020.109603.

[37] A. Rahman and R. Jayaganthan, "Synthesis, Characterization and Photocatalytic Studies of La, Dy-doped ZnO nanoparticles," *Trans. Indian Inst. Met.*, vol. 70, no. 4, pp. 1063–1074, 2017, doi: 10.1007/s12666-016-0897-5.

[38] Y. Fang *et al.*, "Rare-earth doping engineering in nanostructured ZnO: a new type of eco-friendly photocatalyst with enhanced photocatalytic characteristics," *Appl. Phys. A Mater. Sci. Process.*, vol. 124, no. 9, p. 0, 2018, doi: 10.1007/s00339-018-2044-0.

[39] L. Zammouri *et al.*, "Synthesis of YAG:Ce/ZnO core/shell nanoparticles

with enhanced UV-visible and visible light photocatalytic activity and application for the antibiotic removal from aqueous media," *J. Mater. Res.*, vol. 34, no. 8, pp. 1318–1330, 2019, doi: 10.1557/jmr.2019.25.

[40] D. Akyüz, "rGO-TiO2-CdO-ZnO-Ag photocatalyst for enhancing photocatalytic degradation of methylene blue," *Opt. Mater. (Amst).*, vol. 116, no. April, p. 111090, 2021, doi: 10.1016/j.optmat.2021.111090.

[41] M. Slušná *et al.*, "Photocatalytic activity of Sn-doped ZnO synthesized via peroxide route," *J. Phys. Chem. Solids*, vol. 160, no. July 2021, 2022, doi: 10.1016/j.jpcs.2021.110340.

[42] A. Šutka *et al.*, "Co doped ZnO nanowires as visible light photocatalysts," *Solid State Sci.*, vol. 56, pp. 54–62, 2016, doi: 10.1016/j.solidstatesciences.2016.04.008.

[43] N. C. Birben, M. C. Paganini, P. Calza, and M. Bekbolet, "Photocatalytic degradation of humic acid using a novel photocatalyst: Ce-doped ZnO," *Photochem. Photobiol. Sci.*, vol. 16, no. Shelar, S. G., Mahajan, V. K., Patil, S. P., Sonawane, G. H. (2020). Effect of doping parameters on photocatalytic degradation of methylene blue using Ag doped ZnO nanocatalyst. SN Applied Sciences, 2(5), 1–10. https://doi.org/10.1007/s42452-020-2634-2, pp. 24–30, 2017, doi: 10.1039/c6pp00216a.

[44] S. Roguai and A. Djelloul, "Structural, microstructural and photocatalytic degradation of methylene blue of zinc oxide and Fe-doped ZnO nanoparticles prepared by simple coprecipitation method," *Solid State Commun.*, vol. 334–335, no. March, p. 114362, 2021, doi: 10.1016/j.ssc.2021.114362.

[45] T. Munawar, F. Mukhtar, M. Shahid, and K. Mahmood, "Structural , optical , electrical , and morphological studies of rGO anchored direct dual-Z-scheme ZnO-Sm 2 O 3 – Y 2 O 3 heterostructured nanocomposite : An efficient photocatalyst under sunlight," *Solid State Sci.*, vol. 106, no. May, p. 106307, 2020, doi: 10.1016/j.solidstatesciences.2020.106307.

[46] V. S. Bhamare, R. M. Kulkarni, and B. Santhakumari, "5% Barium doped zinc oxide semiconductor nanoparticles for the photocatalytic degradation of

Linezolid: synthesis and characterisation," *SN Appl. Sci.*, vol. 1, no. Shelar, S. G., Mahajan, V. K., Patil, S. P., Sonawane, G. H. (2020). Effect of doping parameters on photocatalytic degradation of methylene blue using Ag doped ZnO nanocatalyst. SN Applied Sciences, 2(5), 1–10. https://doi.org/10.1007/s42452-020-2634-2, pp. 1–12, 2019, doi: 10.1007/s42452-018-0114-8.

[47] T. Ghrib *et al.*, "Effects of Terbium Doping on Structural, Optical and Photocatalytic Properties of ZnO Nanopowder Prepared by Solid-State Reaction," *J. Inorg. Organomet. Polym. Mater.*, vol. 31, no. 1, pp. 239–250, 2021, doi: 10.1007/s10904-020-01761-w.

[48] A. Mondal, N. Giri, S. Sarkar, S. Majumdar, and R. Ray, "Tuning the photocatalytic activity of ZnO by TM (TM = Fe, Co, Ni) doping," *Mater. Sci. Semicond. Process.*, vol. 91, no. December 2018, pp. 333–340, 2019, doi: 10.1016/j.mssp.2018.12.003.

[49] N. T. Hanh *et al.*, "Monocrotophos pesticide effectively removed by novel visible light driven Cu doped ZnO photocatalyst," *J. Photochem. Photobiol. A Chem.*, vol. 382, no. April, 2019, doi: 10.1016/j.jphotochem.2019.111923.

[50] T. K. Pathak, E. Coetsee-Hugo, H. C. Swart, C. W. Swart, and R. E. Kroon, "Preparation and characterization of Ce doped ZnO nanomaterial for photocatalytic and biological applications," *Mater. Sci. Eng. B Solid-State Mater. Adv. Technol.*, vol. 261, no. November 2019, p. 114780, 2020, doi: 10.1016/j.mseb.2020.114780.

[51] X. Han *et al.*, "Surfactant-assisted synthesis of ZnO-Au nanostructure with good dispersibility," *J. Alloys Compd.*, vol. 477, no. 1–2, pp. 661–664, 2009, doi: 10.1016/j.jallcom.2008.10.083.

[52] L. T. V. Ha, L. M. Dai, D. N. Nhiem, and N. Van Cuong, "Enhanced Visible-Light Photocatalytic Activity of C/Ce-Codoped ZnO Nanoellipsoids Synthesized by Hydrothermal Method," *J. Electron. Mater.*, vol. 45, no. 8, pp. 4215–4220, 2016, doi: 10.1007/s11664-016-4570-x.

[53] K. S. Prashanth *et al.*, "Solar light sensitive hybrid Ce4+/3+doped perovskite magnesium zirconate nano cubes for photocatalytic hydrogen evolution and

organic pollutant degradation in water," *J. Environ. Chem. Eng.*, vol. 9, no. 4, Aug. 2021, doi: 10.1016/j.jece.2021.105364.

[54] G. Vijayaprasath, P. Soundarrajan, and G. Ravi, "Synthesis of ZnO Nanosheets Morphology by Ce Doping for Photocatalytic Activity," *J. Electron. Mater.*, vol. 48, no. 1, pp. 684–695, 2019, doi: 10.1007/s11664-018-6763-y.

[55] S. Karidas, B. K. Veena, N. Pujari, P. Krishna, and V. Chunduru, "Photodegradation of Methylene Blue (MB) using Cerium-doped Zinc Oxide nanoparticles," *Sadhana - Acad. Proc. Eng. Sci.*, vol. 45, no. 1, 2020, doi: 10.1007/s12046-020-01329-x.

[56] N. Asses, L. Ayed, N. Hkiri, and M. Hamdi, "Congo Red Decolorization and Detoxification by Aspergillus Niger: Removal Mechanisms and Dye Degradation Pathway," *Biomed Res. Int.*, vol. 2018, 2018, doi: 10.1155/2018/3049686.

[57] D. M. C. G. Lima, T. P. C. Costa, T. Emri, I. Pócsi, B. Pupin, and D. E. N. Rangel, "Fungal tolerance to Congo red, a cell wall integrity stress, as a promising indicator of ecological niche," *Fungal Biol.*, vol. 125, no. 8, pp. 646–657, 2021, doi: 10.1016/j.funbio.2021.03.007.

[58] C. Arab, R. El Kurdi, and D. Patra, "Efficient removal of Congo red using curcumin conjugated zinc oxide nanoparticles as new adsorbent complex," *Chemosphere*, vol. 276, p. 130158, 2021, doi: 10.1016/j.chemosphere.2021.130158.

[59] K. Indira *et al.*, "Photocatalytic degradation of congo red dye using nickel–titanium dioxide nanoflakes synthesized by Mukia madrasapatna leaf extract," *Environ. Res.*, vol. 202, no. May, p. 111647, 2021, doi: 10.1016/j.envres.2021.111647.

[60] G. Sharma *et al.*, "Utilization of Ag2O–Al2O3–ZrO2 decorated onto rGO as adsorbent for the removal of Congo red from aqueous solution," *Environ. Res.*, vol. 197, no. December 2020, p. 111179, 2021, doi: 10.1016/j.envres.2021.111179.

[61] T. Elkar *et al.*, "Structural and optical investigation of (V, Al) doped and co-

doped ZnO nanopowders: Tailored visible luminescence for white light emitting diodes," *Superlattices Microstruct.*, vol. 122, pp. 349–361, 2018, doi: 10.1016/j.spmi.2018.07.015.

[62] Y. Jerlin Jose, M. Manjunathan, and S. Joseph Selvaraj, "Highly photocatalyst efficient in LEDs/solar active and reusable: Sm–ZnO–Ag nanoparticles for methylene blue degradation," *J. Nanostructure Chem.*, vol. 7, no. Shelar, S. G., Mahajan, V. K., Patil, S. P., Sonawane, G. H. (2020). Effect of doping parameters on photocatalytic degradation of methylene blue using Ag doped ZnO nanocatalyst. SN Applied Sciences, 2(5), 1–10. https://doi.org/10.1007/s42452-020-2634-2, pp. 259–271, 2017, doi: 10.1007/s40097-017-0236-3.

[63] N. F. Andrade Neto, J. M. P. Silva, R. L. Tranquilin, E. Longo, M. R. D. Bomio, and F. V. Motta, "Stabilization of the γ-Ag2WO4 metastable pure phase by coprecipitation method using polyvinylpyrrolidone as surfactant: Photocatalytic property," *Ceram. Int.*, vol. 46, no. 10, pp. 14864–14871, 2020, doi: 10.1016/j.ceramint.2020.03.012.

[64] A. Bouddouch *et al.*, "Photocatalytic and photoluminescence properties of CePO4 nanostructures prepared by coprecipitation method and thermal treatment," *Optik (Stuttg).*, vol. 238, no. July 2020, p. 166683, 2021, doi: 10.1016/j.ijleo.2021.166683.

[65] C. R. Michel, M. A. Lopez-Alvarez, and A. H. Martínez-Preciado, "Novel UV sensing and photocatalytic properties of nanostructured LiCoO2 prepared by the coprecipitation method," *J. Photochem. Photobiol. A Chem.*, vol. 403, no. March, p. 112842, 2020, doi: 10.1016/j.jphotochem.2020.112842.

[66] S. Jian, Z. Tian, K. Zhang, G. Duan, W. Yang, and S. Jiang, "Hydrothermal Synthesis of Ce-doped ZnO Heterojunction Supported on Carbon Nanofibers with High Visible Light Photocatalytic Activity," *Chem. Res. Chinese Univ.*, vol. 37, no. 3, pp. 565–570, 2021, doi: 10.1007/s40242-021-1114-6.

[67] A. Ardiansyah, R. Rahmat, M. Azlan, H. Heryanto, and D. Tahir, "Nanocrystal composites cement/BaCO3/Fe2O3 for improved X-ray

shielding characteristics: Stability structural properties," *J. Mater. Res.*, vol. 37, no. 23, pp. 4114–4123, 2022, doi: 10.1557/s43578-022-00775-z.

[68] S. Meena *et al.*, "Enhanced sunlight driven photocatalytic activity and electrochemical sensing properties of Ce-doped MnFe2O4 nano magnetic ferrites," *Ceram. Int.*, vol. 47, no. 10, pp. 14760–14774, May 2021, doi: 10.1016/j.ceramint.2020.11.105.

[69] M. Ahmad *et al.*, "Enhanced photocatalytic activity of Ce-doped ZnO nanopowders synthesized by combustion method," *J. Rare Earths*, vol. 33, no. 3, pp. 255–262, 2015, doi: 10.1016/S1002-0721(14)60412-9.

[70] A. M. Kasumov, K. A. Korotkov, V. M. Karavaeva, M. M. Zahornyi, A. I. Dmitriev, and A. I. Ievtushenko, "Photocatalysis with the Use of ZnO Nanostructures as a Method for the Purification of Aquatic Environments from Dyes," *J. Water Chem. Technol.*, vol. 43, no. Shelar, S. G., Mahajan, V. K., Patil, S. P., Sonawane, G. H. (2020). Effect of doping parameters on photocatalytic degradation of methylene blue using Ag doped ZnO nanocatalyst. SN Applied Sciences, 2(5), 1–10. https://doi.org/10.1007/s42452-020-2634-2, pp. 281–288, 2021, doi: 10.3103/s1063455x21040044.

[71] M. Faisal, A. A. Ismail, A. A. Ibrahim, H. Bouzid, and S. A. Al-Sayari, "Highly efficient photocatalyst based on Ce doped ZnO nanorods: Controllable synthesis and enhanced photocatalytic activity," *Chem. Eng. J.*, vol. 229, pp. 225–233, 2013, doi: 10.1016/j.cej.2013.06.004.

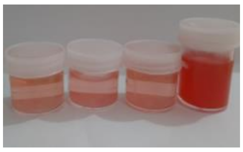
[72] P. Franco, O. Sacco, I. De Marco, D. Sannino, and V. Vaiano, "Photocatalytic Degradation of Eriochrome Black-T Azo Dye Using Eu-Doped ZnO Prepared by Supercritical Antisolvent Precipitation Route: A Preliminary Investigation," *Top. Catal.*, vol. 63, no. 11–14, pp. 1193–1205, 2020, doi: 10.1007/s11244-020-01279-y.

[73] A. M. Nasir *et al.*, "Recent progress on fabrication and application of electrospun nanofibrous photocatalytic membranes for wastewater treatment: A review," *J. Water Process Eng.*, vol. 40, no. October 2020, p. 101878, 2021, doi: 10.1016/j.jwpe.2020.101878.

LAMPIRAN

Lampiran 1. Dokumentasi Penelitian


ZnO a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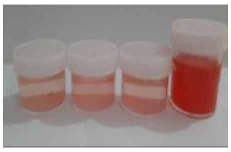
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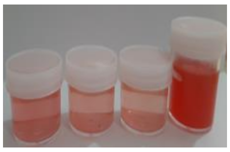
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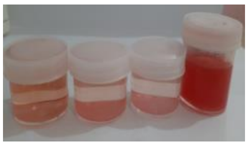
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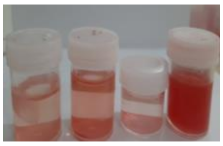
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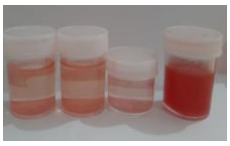
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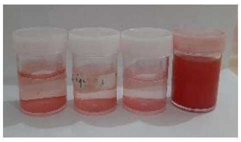
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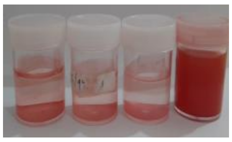
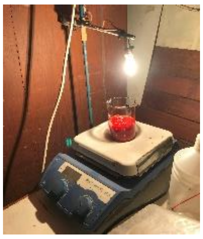

ZnO-3%Ce c


ZnO-5%Ce c


Persiapan Sampel


Metode Kopresipitasi


Proses fotokatalis


Menyaring memisahkan katalis dan polutan

Lampiran 2. Data XRF

SAMPLE ANALYSIS REPORT THERMO FISHER SCIENTIFIC
ARL QUANT'X EDXRF ANALYZER UNIQUANT(TM) STANDARDLESS METHOD

C:\UQed\USER\Quant'X\Job\JOB.844 2023-11-06
Cerium#auh

Quant'X Rh end window 50kV
C:\UQed\USER\Quant'X\Appl\AnySampleAir.kap 2008-06-13
Calculated as : Elements Matrix (Shape & ImpFc) : 12|Cr-Fe-Ni
X-ray path = Air Film type = No supporting film
Case number = 0 All known
Eff.Diam. = 13.0 mm Eff.Area = 132.7 mm2
KnownConc = 0 %
Rest = 0 % Viewed Mass = 1000.00 mg
Dil/Sample = 0 Sample Height = 5.00 mm

El	m/m%	StdErr
Ce	86.370	0.06
Ni	11.666	0.033
Ca	1.489	0.024
Sm	0.365	0.028
Zn	0.073	0.011

KnownConc= 0 REST= 0 D/S= 0
Sum Conc's before normalisation to 100% : 644.9 %

Lampiran 3

Lampiran 3.1 Perhitungan Ukuran Kristal

$$D=\frac{k\lambda}{\beta \cos\theta}$$

Dimana, D adalah ukuran kristal, k adalah konstanta Scherrer (0,9), λ adalah Panjang gelombang untuk radiasi sinar x (untuk Cu adalah 0,154 nm), β adalah *The Full Width at Half Maximum* (FWHM), dan θ adalah sudut difraksi.

	2 theta (deg)	**2 theta (rad)**	**theta**	**k**	**Wavelenght (nm)**	**FWHM (deg)**	**FWHM (rad)**	**cos theta**	**D**	**D Rata-rata**
ZnO	31,916	0,5570	0,2785	0,9	0,154	0,297	0,0052	0,9615	27,810	28,581
	36,404	0,6354	0,3177	0,9	0,154	0,285	0,0050	0,9500	29,352	
ZnO/1%Ce	31,652	0,5524	0,2762	0,9	0,154	0,205	0,0036	0,9621	40,205	40,436
	36,136	0,6307	0,3153	0,9	0,154	0,205	0,0036	0,9507	40,667	
ZnO/3%Ce	32,055	0,5595	0,2797	0,9	0,154	0,357	0,0062	0,9611	23,131	24,145
	36,542	0,6378	0,3189	0,9	0,154	0,332	0,0058	0,9496	25,159	
ZnO/5%Ce	32,052	0,5594	0,2797	0,9	0,154	0,669	0,0117	0,9611	12,348	14,973
	36,547	0,6379	0,3189	0,9	0,154	0,664	0,0116	0,9496	12,597	
	56,914	0,9933	0,4967	0,9	0,154	0,540	0,0094	0,8792	16,727	
	63,175	1,1026	0,5513	0,9	0,154	0,512	0,0089	0,8518	18,222	

Lampiran3.2 Perhitungan %Degradasi

$$\%Degradasi = \frac{C_0 - C_t}{C_0} \cdot 100\%$$

Material	*Wavelenght*	Abs CR	Abs 10 min	Abs 20 min	Abs 30 min	deg 10 min	deg 20 min	deg 30 min
ZnO a	494	1,317	0,292	0,252	0,282	77,83	80,87	78,59
ZnO-1%Ce a	494	1,317	0,241	0,184	0,271	81,70	86,03	79,42
ZnO-3%Ce a	494	1,317	0,136	0,234	0,155	89,67	82,23	88,23
ZnO-5%Ce a	494	1,317	0,411	0,277	0,348	68,79	78,97	73,58
ZnOb	480	1,306	0,131	0,067	0,151	89,97	94,87	88,44
ZnO-1%Ce b	480	1,306	0,145	0,136	0,249	88,90	89,59	80,93
ZnO-3%Ce b	480	1,306	0,109	0,225	0,107	91,65	82,77	91,81
ZnO-5%Ce b	480	1,306	0,062	0,121	0,106	95,25	90,74	91,88
ZnO c	490	1,319	0,064	0,028	0,132	95,15	97,88	89,99
ZnO-1%Ce c	490	1,319	0,015	0,037	0,033	98,86	97,19	97,50
ZnO-3%Ce c	490	1,319	0,037	0,069	0,088	97,19	94,77	93,33
ZnO-5%Ce c	490	1,319	0,035	0,231	0,116	97,35	82,49	91,21

Lampiran 2.3 Perhitungan Aktivitas Fotokatalis

$$\text{Aktivitas fotokatalis} = C_t/C_0$$

Dimana, C_0 adalah nilai absorbansi *Congo Red* (25 mg/1000 ml, 30 mg/1000 ml dan 35 mg/1000 ml) dan C_t adalah nilai absorbansi larutan yang sudah di uji fotokatalis.

Material	Wavelenght	Abs CR	Abs 10 min	Abs 20 min	Abs 30 min	c_t/c_0 10 min	c_t/c_0 20 min	c_t/c_0 30 min
ZnO a	494	1,317	0,292	0,252	0,282	0,22	0,19	0,21
ZnO-1%Ce a	494	1,317	0,241	0,184	0,271	0,18	0,14	0,21
ZnO-3%Ce a	494	1,317	0,136	0,234	0,155	0,10	0,18	0,12
ZnO-5%Ce a	494	1,317	0,411	0,277	0,348	0,31	0,21	0,26
ZnOb	480	1,306	0,131	0,067	0,151	0,10	0,05	0,12
ZnO-1%Ce b	480	1,306	0,145	0,136	0,249	0,11	0,10	0,19
ZnO-3%Ce b	480	1,306	0,109	0,225	0,107	0,08	0,17	0,08
ZnO-5%Ce b	480	1,306	0,062	0,121	0,106	0,05	0,09	0,08
ZnO c	490	1,319	0,064	0,028	0,132	0,05	0,02	0,10
ZnO-1%Ce c	490	1,319	0,015	0,037	0,033	0,01	0,03	0,03
ZnO-3%Ce c	490	1,319	0,037	0,069	0,088	0,03	0,05	0,07
ZnO-5%Ce c	490	1,319	0,035	0,231	0,116	0,03	0,18	0,09

Lampiran 2.4 Perhitungan Laju Kinetik Fotodegradasi

$$\ln\frac{C_0}{C_t}=k_r.t$$

Dimana, C_0 adalah nilai absorbansi *Congo Red* (25 mg/1000 ml, 30 mg/1000 ml dan 35 mg/1000 ml), C_t adalah nilai absorbansi larutan yang sudah di uji fotokatalis, k_r adalah laju fotodegradasi, dan t adalah waktu proses penyinaran

Material	*Wavelenght*	Abs CR	Abs 10 min	Abs 20 min	Abs 30 min	ln c_0/c_t 10 min	ln c_0/c_t 20 min	ln c_0/c_t 30 min
ZnO a	494	1,317	0,292	0,252	0,282	1,51	1,65	1,54
ZnO-1%Ce a	494	1,317	0,241	0,184	0,271	1,70	1,97	1,58
ZnO-3%Ce a	494	1,317	0,136	0,234	0,155	2,27	1,73	2,14
ZnO-5%Ce a	494	1,317	0,411	0,277	0,348	1,16	1,56	1,33
ZnOb	480	1,306	0,131	0,067	0,151	2,30	2,97	2,16
ZnO-1%Ce b	480	1,306	0,145	0,136	0,249	2,20	2,26	1,66
ZnO-3%Ce b	480	1,306	0,109	0,225	0,107	2,48	1,76	2,50
ZnO-5%Ce b	480	1,306	0,062	0,121	0,106	3,05	2,38	2,51
ZnO c	490	1,319	0,064	0,028	0,132	3,03	3,85	2,30
ZnO-1%Ce c	490	1,319	0,015	0,037	0,033	4,48	3,57	3,69
ZnO-3%Ce c	490	1,319	0,037	0,069	0,088	3,57	2,95	2,71
ZnO-5%Ce c	490	1,319	0,035	0,231	0,116	3,63	1,74	2,43