



## DAFTAR PUSTAKA

- Adinaveen, T., Vijaya, J. J., & Kennedy, L. J. (2016). Comparative Study of Electrical Conductivity on Activated Carbons Prepared from Various Cellulose Materials. *Arabian Journal for Science and Engineering*, 41(1), 55–65. <https://doi.org/10.1007/s13369-014-1516-6>
- Ahmazadeh, S., Asadipour, A., Pournamdar, M., Behnam, B., Rahimi, H. R., & Dolatabadi, M. (2017). Removal of ciprofloxacin from hospital wastewater using electrocoagulation technique by aluminum electrode: Optimization and modelling through response surface methodology. *Process Safety and Environmental Protection*, 109, 538–547. <https://doi.org/10.1016/j.psep.2017.04.026>
- Aitken, M., & Kleinrock, M. (2015). Global Medicines Use in 2020. *IMS Institute for Healthcare Informatics*, 1–43.
- Ambroz, F., Macdonald, T. J., Martis, V., & Parkin, I. P. (2018). Evaluation of the BET Theory for the Characterization of Meso and Microporous MOFs. *Small Method*, 1–17. <https://doi.org/10.1002/smtd.201800173>
- Amrizal Fauzi, A., Prasetyo, I., & Ariyanto, T. (2018). Karbon Mesopori dari Pirolisis Polimer Sintesis dan Aplikasinya untuk Penyerapan Gas Rumah Kaca. *Jurnal Konversi Universitas Muhammadiyah Jakarta*, 7 (1)(1), 19–28. <https://doi.org/https://doi.org/10.24853/konversi.7.1.10>
- Atchabarova, A. A., Abdimomyn, S. K., Abduakhytova, D. A., Zhigalenok, Y. R., Tokpayev, R. R., Kishibayev, K. K., Khavaza, T. N., Kurbatov, A. P., Zlobina, Y. V., & Djenizian, T. J. (2022). Role of carbon material surface functional groups on their interactions with aqueous solutions. *Journal of Electroanalytical Chemistry*, 922(March), 116707. <https://doi.org/10.1016/j.jelechem.2022.116707>
- Callister, W. D., & Wiley, J. (2007). *Materials Science* (J. Hayton (ed.); Seventh Ed). John Willey & Sons, Inc.
- Cha, B. J., Woo, T. G., Han, S. W., Saqlain, S., Seo, H. O., Cho, H. K., Kim, J. Y., & Kim, Y. D. (2018). Surface modification of TiO<sub>2</sub> for obtaining high resistance against poisoning during photocatalytic decomposition of toluene. *Catalysts*, 8(11), 1–13. <https://doi.org/10.3390/catal8110500>
- Chalmers, J. M., & Griffiths, P. R. (2003). *Handbook of Vibrational Spectroscopy*. In



- Chougala, L. S., Yatnatti, M. S., Linganagoudar, R. K., Kamble, R. R., & Kadadevarmath, J. S. (2017). A simple approach on synthesis of TiO<sub>2</sub> nanoparticles and its application in dye sensitized solar cells. *Journal of Nano- and Electronic Physics*, 9(4), 1–6. [https://doi.org/10.21272/jnep.9\(4\).04005](https://doi.org/10.21272/jnep.9(4).04005)
- Czyski, A., Anusiak, K., & Tezyk, A. (2019). The degradation of levofloxacin in infusions exposed to daylight with an identification of a degradation product with HPLC-MS. *Scientific Reports*, 9(1), 1–7. <https://doi.org/10.1038/s41598-019-40201-9>
- Fick, J., Söderström, H., Lindberg, R. H., Phan, C., Tysklind, M., & Larsson, D. G. J. (2009). Pharmaceuticals and Personal Care Products in the Environment CONTAMINATION OF SURFACE, GROUND, AND DRINKING WATER FROM PHARMACEUTICAL PRODUCTION. *Environmental Toxicology and Chemistry / SETAC*, 28(12), 2522–2527. <https://doi.org/10.1897/09-073.1>
- Food and Drug Administration. (1987). *CIPRO (R), (ciprofloxacin hydrochloride) tablet, CIPRO(R), (ciprofloxacin hydrochloride) for oral consumption* (pp. 1–25).
- Girardi, C., Greve, J., Lamshöft, M., Fetzer, I., Miltner, A., Schäffer, A., & Kästner, M. (2011). Biodegradation of Ciprofloxacin in Water and Soil and its Effects on the Microbial Communities. *Journal of Hazardous Materials*, 198, 22–30. <https://doi.org/10.1016/j.jhazmat.2011.10.004>
- Githinji, L. J. M., Musey, M. K., & Ankumah, R. O. (2011). Evaluation of the fate of ciprofloxacin and amoxicillin in domestic wastewater. *Water, Air, and Soil Pollution*, 219(1–4), 191–201. <https://doi.org/10.1007/s11270-010-0697-1>
- Guerra-Rodríguez, S., Rodríguez, E., Singh, D. N., & Rodríguez-Chueca, J. (2018). Assessment of Sulfate Radical-based Advanced Oxidation Processes for Water and Wastewater Treatment: A Review. *Water (Switzerland)*, 10(12), 1–19. <https://doi.org/10.3390/w10121828>
- Hanaor, D. A. H., & Sorrell, C. C. (2011). Review of the anatase to rutile phase transformation. *Journal of Materials Science*, 46(4), 855–874. <https://doi.org/10.1007/s10853-010-5113-0>



Ijadpanah-Saravy, H., Safari, M., Khodadadi-Darban, A., & Rezaei, A. (2014). Synthesis of Titanium Dioxide Nanoparticles for Photocatalytic Degradation of Cyanide in Wastewater. *Analytical Letters*, 47(10), 1772–1782.  
<https://doi.org/10.1080/00032719.2014.880170>

Jumat, N. A., Wai, P. S., Ching, J. J., & Basirun, W. J. (2017). Synthesis of polyaniline-TiO<sub>2</sub> nanocomposites and their application in photocatalytic degradation. *Polymers and Polymer Composites*, 25(7), 507–514.  
<https://doi.org/10.1177/096739111702500701>

Kansal, S. K., Kundu, P., Sood, S., Lamba, R., Umar, A., & Mehta, S. K. (2014). Photocatalytic degradation of the antibiotic levofloxacin using highly crystalline TiO<sub>2</sub> nanoparticles. *New Journal of Chemistry*, 38(7), 3220–3226.  
<https://doi.org/10.1039/c3nj01619f>

Kelly, K. R., & Brooks, B. W. (2018). Global Aquatic Hazard Assessment of Ciprofloxacin: Exceedances of Antibiotic Resistance Development and Ecotoxicological Thresholds. In *Progress in Molecular Biology and Translational Science* (1st ed., Vol. 159). Elsevier Inc.  
<https://doi.org/10.1016/bs.pmbts.2018.07.004>

Kemenkes RI. (2020). Farmakope Indonesia edisi VI. In *Departemen Kesehatan Republik Indonesia*. Kementerian Kesehatan Republik Indonesia.

Kenyon, C. (2022). Concentrations of Ciprofloxacin in the World's Rivers Are Associated with the Prevalence of Fluoroquinolone Resistance in *Escherichia coli*: A Global Ecological Analysis. *Antibiotics*, 11(3), 4–9.  
<https://doi.org/10.3390/antibiotics11030417>

Klimaszyk, P., & Rzymski, P. (2018). Water and Aquatic Fauna on Drugs: What are the Impacts of Pharmaceutical Pollution? In *Water Management and the Environment: Case Studies. WINEC 2017*. (pp. 255–278). Springer. [https://doi.org/10.1007/978-3-319-79014-5\\_12](https://doi.org/10.1007/978-3-319-79014-5_12)

Kłosińska-Szmurło, E., Pluciński, F. A., Grudzień, M., Betlejewska-Kielak, K., Biernacka, J., & Mazurek, A. P. (2014). Experimental and theoretical studies on the molecular properties of ciprofloxacin, norfloxacin, pefloxacin, sparfloxacin, and gatifloxacin in determining bioavailability. *Journal of Biological Physics*, 40(4),



Kumar, A., Kumar, A., Mudila, H., Awasthi, K., & Kumar, V. (2020). Synthesis and thermal analysis of polyaniline (PANI). *Journal of Physics: Conference Series*, 1531(1), 1–6. <https://doi.org/10.1088/1742-6596/1531/1/012108>

Lal, M., Sharma, P., & Ram, C. (2021). Calcination temperature effect on titanium oxide (TiO<sub>2</sub>) nanoparticles synthesis. *Optik*, 241, 1–26. <https://doi.org/10.1016/j.ijleo.2021.166934>

Li, X., Wang, D., Cheng, G., Luo, Q., An, J., & Wang, Y. (2008). Preparation of polyaniline-modified TiO<sub>2</sub> nanoparticles and their photocatalytic activity under visible light illumination. *Applied Catalysis B: Environmental*, 81(3–4), 267–273. <https://doi.org/10.1016/j.apcatb.2007.12.022>

Lin, Y., Li, D., Hu, J., Xiao, G., Wang, J., Li, W., & Fu, X. (2012). Highly efficient photocatalytic degradation of organic pollutants by PANI-modified TiO<sub>2</sub> composite. *Journal of Physical Chemistry C*, 116(9), 5764–5772. <https://doi.org/10.1021/jp211222w>

Ma, X., & Wang, Z. (2022). Removal of Ciprofloxacin from Wastewater by Ultrasound/Electric Field/Sodium Persulfate (US/E/PS). *Processes*, 10(1), 1–15. <https://doi.org/10.3390/pr10010124>

Mentus, S., Ćirić-Marjanović, G., Trchov, M., & Stejskal, J. (2009). Conducting carbonized polyaniline nanotubes. *Nanotechnology*, 20(24), 1–10. <https://doi.org/10.1088/0957-4484/20/24/245601>

Mutia, A. S., Ariyanto, T., & Prasetyo, I. (2022). Ciprofloxacin Removal from Simulated Wastewater Through a Combined Process of Adsorption and Oxidation Processes Using Fe/C Adsorbent. *Water, Air, and Soil Pollution*, 233(4), 1–13. <https://doi.org/10.1007/s11270-022-05618-5>

Naeem, K., & Ouyang, F. (2009). Effect of lamp power and its position on photocatalytic degradation of phenol in aqueous suspension of TiO<sub>2</sub>. *E-Journal of Surface Science and Nanotechnology*, 7(August), 804–807. <https://doi.org/10.1380/ejssnt.2009.804>

Nasrollahzadeh, M., Atarod, M., Sajjadi, M., Sajadi, S. M., & Issaabadi, Z. (2019). Plant-Mediated Green Synthesis of Nanostructures: Mechanisms, Characterization, and



Applications. In *Interface Science and Technology* (1st ed., Vol. 28, pp. 199–322). Elsevier Ltd. <https://doi.org/10.1016/B978-0-12-813586-0.00006-7>

National Library of Medicine. (2021). *Ciprofloxacin*. <https://pubchem.ncbi.nlm.nih.gov/compound/Ciprofloxacin>

Oluwole, A. O., & Olatunji, O. S. (2022). Photocatalytic degradation of tetracycline in aqueous systems under visible light irradiation using needle-like SnO<sub>2</sub> nanoparticles anchored on exfoliated g-C<sub>3</sub>N<sub>4</sub>. *Environmental Sciences Europe*, 34(1), 1–14. <https://doi.org/10.1186/s12302-021-00588-7>

Phoon, B. L., Ong, C. C., Mohamed Saheed, M. S., Show, P. L., Chang, J. S., Ling, T. C., Lam, S. S., & Juan, J. C. (2020). Conventional and Emerging Technologies for Removal of Antibiotics from Wastewater. *Journal of Hazardous Materials*, 400, 1–99. <https://doi.org/10.1016/j.jhazmat.2020.122961>

Ponder, J. F., Gregory, S. A., Atassi, A., Menon, A. K., Lang, A. W., Savagian, L. R., Reynolds, J. R., & Yee, S. K. (2022). Significant Enhancement of the Electrical Conductivity of Conjugated Polymers by Post-Processing Side Chain Removal. *Journal of the American Chemical Society*, 144(3), 1351–1360. <https://doi.org/10.1021/jacs.1c11558>

Prasad, A. R., & Ratna, J. V. (2018). Development and Validation of a Simple UV-Spectrophotometric Method for the Determination of Ciprofloxacin HCl Present in Taste Masked Drug Resin Complex. *International Journal of Applied Pharmaceutics*, 10(3), 37–41. <https://doi.org/10.22159/ijap.2018v10i3.24199>

Radoičić, M., Ćirić-Marjanović, G., Spasojević, V., Ahrenkiel, P., Mitić, M., Novaković, T., & Šaponjić, Z. (2017). Superior Photocatalytic Properties of Carbonized PANI/TiO<sub>2</sub> Nanocomposites. *Applied Catalysis B: Environmental*, 213, 155–166. <https://doi.org/10.1016/j.apcatb.2017.05.023>

Rahman, M., Ara, M. G., Alim, M. A., Uddin, S., Najda, A., Albadrani, G. M., Sayed, A. A., & Mousa, S. A. (2021). Mesoporous Carbon : A Versatile Material for Scientific Applications. *International Journal of Molecular Science*, 22, 1–21. <https://doi.org/https://doi.org/10.3390/ijms22094498>

Raini, M. (2016). Antibiotik Golongan Fluorokuinolon : Manfaat dan Kerugian. *Media Litbangkes*, 26(3), 163–174.



Saadattalab, V., Shakeri, A., & Gholami, H. (2016). Effect of CNTs and nano ZnO on physical and mechanical properties of polyaniline composites applicable in energy devices. *Progress in Natural Science: Materials International*, 26(6), 517–522. <https://doi.org/10.1016/j.pnsc.2016.09.005>

Sapurina, I. Y., & Shishov, M. A. (2012). Oxidative Polymerization of Aniline: Molecular Synthesis of Polyaniline and the Formation of Supramolecular Structures. In *New Polymers for Special Applications* (p. 13). <https://doi.org/http://dx.doi.org/10.5772/48758>

The MathWorks Inc. (2023). *fminsearch*. <https://jp.mathworks.com/help/matlab/ref/fminsearch.html>

Thommes, M., Kaneko, K., Neimark, A. V., Olivier, J. P., Rodriguez-Reinoso, F., Rouquerol, J., & Sing, K. S. W. (2015). Physisorption of gases, with special reference to the evaluation of surface area and pore size distribution (IUPAC Technical Report). *Pure and Applied Chemistry*, 87(9–10), 1051–1069. <https://doi.org/10.1515/pac-2014-1117>

Triwardiati, D., & Ermawati, I. R. (2018). Analisis Bandgap Karbon Nanodots (C-Dots) Kulit Bawang Merah Menggunakan Teknik Microwave. *Prosiding Seminar Nasional Teknoka*, 3, 25–30. <https://doi.org/10.22236/teknoka.v3i0.2810>

Viana, M. M., Soares, V. F., & Mohallem, N. D. S. (2010). Synthesis and characterization of TiO<sub>2</sub> nanoparticles. *Ceramics International*, 36(7), 2047–2053. <https://doi.org/10.1016/j.ceramint.2010.04.006>

Wang, D., Xiao, L., Luo, Q., Li, X., An, J., & Duan, Y. (2011). Highly efficient visible light TiO<sub>2</sub> photocatalyst prepared by sol-gel method at temperatures lower than 300°C. *Journal of Hazardous Materials*, 192(1), 150–159. <https://doi.org/10.1016/j.jhazmat.2011.04.110>

Yang, Y., Ling, Y., Wang, G., Liu, T., Wang, F., Zhai, T., Tong, Y., & Li, Y. (2015). Photohole Induced Corrosion of Titanium Dioxide: Mechanism and Solutions. *Nano Letters*, 15(10), 7051–7057. <https://doi.org/10.1021/acs.nanolett.5b03114>

Zhang, W., Li, C., Ma, Z., Yang, L., & He, H. (2016). Effects of calcination temperature on properties of 0.5% Al-3% in-TiO<sub>2</sub> photocatalyst prepared using sol-gel method. *Journal of Advanced Oxidation Technologies*, 19(1), 119–124.



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Zheng, X., Xu, S., Wang, Y., Sun, X., Gao, Y., & Gao, B. (2018). Enhanced degradation of ciprofloxacin by graphitized mesoporous carbon (GMC)-TiO<sub>2</sub> nanocomposite: Strong synergy of adsorption-photocatalysis and antibiotics degradation mechanism. *Journal of Colloid and Interface Science*, 527, 202–213.  
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