

DAFTAR PUSTAKA

- Abushad, M., Arshad, M., Naseem, S., Husain, S., and Khan, W., 2020, Role of Cr Doping in Tuning the Optical and Dielectric Properties of TiO₂ Nanostructures, *Mater. Chem. Phys.*, 256, 123641.
- Adebayo, M.A., Adebomi, J.I., Abe, T.O., and Areo, F.I., 2020, Removal of Aqueous Congo Red and Malachite Green Using Ackee Apple Seed–Bentonite Composite, *Colloids Interface Sci. Commun.*, 38, 100311.
- Ahmed, M.A., Abou-Gamra, Z.M., and Salem, A.M., 2017, Photocatalytic Degradation of Methylene Blue Dye Over Novel Spherical Mesoporous Cr₂O₃/TiO₂ Nanoparticles Prepared by Sol-Gel Using Octadecylamine Template, *J. Environ. Chem. Eng.*, 5, 4251–4261.
- Alvarez, S.Y.M., Mar, J.L.G., Turnes-Palomino, G., Alejandro, F.M., Quintero, A.C., Ramírez, A.H., and Reyes, L.H., 2019, Synthesis of Cr³⁺-Doped TiO₂ Nanoparticles: Characterization and Evaluation of Their Visible Photocatalytic Performance and Stability, *Environ. Technol.*, 40, 144–153.
- Asmadi, Endro S, and W Oktiawan, 2009, Pengurangan Chrom (Cr) dalam Limbah Cair Industri Kulit pada Proses Tannery Menggunakan Senyawa Alkali Ca(OH)₂, NaOH dan NaHCO₃ (Studi Kasus PT. Trimulyo Kencana Mas Semarang), *J. Air Indones.*, 5, 41–54.
- Bahnemann, W., Muneer, M., and Haque, M.M., 2007, Titanium Dioxide-Mediated Photocatalysed Degradation of Few Selected Organic Pollutants in Aqueous Suspensions, *Catal. Today*, 124, 133–148.
- Bendjabeur, S., Zouaghi, R., Kaabeche, O.N.H., and Sehili, T., 2017, Parameters Affecting Adsorption and Photocatalytic Degradation Behavior of Gentian Violet under UV Irradiation with Several Kinds of TiO₂ as a Photocatalyst, *Int. J. Chem. React. Eng.*, 15, 20160206.
- Bessekhouad, Y., Robert, D., Weber, J. V., and Chaoui, N., 2004, Effect of Alkaline-Doped TiO₂ on Photocatalytic Efficiency, *J. Photochem. Photobiol. A Chem.*, 167, 49–57.
- Carp, O., Huisman, C.L., and Reller, A., 2004, Photoinduced Reactivity of Titanium Dioxide, *Prog. Solid State Chem.*, 32, 33–177.
- Chen, T., Foo, C., and Tsang, S.C.E., 2021, Interstitial and Substitutional Light Elements in Transition Metals for Heterogeneous Catalysis, *Chem. Sci.*, 12, 517–532.
- Choi, J., Park, H., and Hoffmann, M.R., 2010, Effects of Single Metal-Ion Doping on the Visible-Light Photoreactivity of TiO₂, *J. Phys. Chem. C*, 114, 783–792.
- Chong, M.N., Jin, B., Chow, C.W.K., and Saint, C., 2010, Recent Developments in

- Photocatalytic Water Treatment Technology: A Review, *Water Res.*, 44, 2997–3027.
- Chowdhury, M., Mostafa, M.G., Biswas, T.K., Mandal, A., and Saha, A.K., 2015, Characterization of the Effluents from Leather Processing Industries, *Environ. Process.*, 2, 173–187.
- Devi, L.G., Kumar, S.G., Murthy, B.N., and Kottam, N., 2009, Influence of Mn²⁺ and Mo⁶⁺ Dopants on the Phase Transformations of TiO₂ Lattice and Its Photo Catalytic Activity under Solar Illumination, *Catal. Commun.*, 10, 794–798.
- Di Bucchianico, A., 2008, *Coefficient of Determination (R²)*. Encyclopedia of Statistics in Quality and Reliability, John Wiley & Sons, Chichester, England.
- Dubey, R.S. and Singh, S., 2017, Results in Physics Investigation of Structural and Optical Properties of Pure and Chromium Doped TiO₂ Nanoparticles Prepared by Solvothermal Method, *Results Phys.*, 7, 1283–1288.
- Dwivedi, S., Jadhav, J., Sharma, H., and Biswas, S., 2014, Pulsed Laser Deposited Ferromagnetic Chromium Dioxide Thin Films for Applications in Spintronics, *Phys. Procedia*, 54, 62–69.
- Ekwere, I.O., Horsfall, M., and Otaigbe, J.O.E., 2019, A Study on the Photocatalytic Reduction of Some Metal Ions in Aqueous Solution Using UV- Titanium Dioxide System, *Int. Res. J. Pure Appl. Chem.*, 18, 1–7.
- Erdemoglu, S., Aksu, S.K., Sayilkan, F., Izgi, B., Asilturk, M., Sayilkan, H., Frimmel, F., and Gucer, S., 2008, Photocatalytic Degradation of Congo Red by Hydrothermal Synthesized Nanocrystalline TiO₂ and Identification of Degradation Products by LC-MS, *J. Hazard. Mater.*, 155, 469–476.
- Ghanbarian, M., Nabizadeh, R., Mahvi, A.H., Nasserli, S., and Naddafi, K., 2011, Photocatalytic Degradation of Linear Alkyl Benzene Sulfonate from Aqueous Solution by TiO₂ Nanoparticles, *Iran. J. Environ. Heal. Sci. Eng.*, 8, 309–316.
- Gharbani, P., Tabatabaie, S.M., dan Mehrizad, A., 2008, Removal of Congo Red from Textile Wastewater by Ozonation, *Int. J. Environ. Sci. Technol.*, 5, 495–500.
- Giacinta, M., Salimin, Z., and Junaidi, 2013, Pengolahan Logam Berat Krom (Cr) pada Limbah Cair Industri Penyamakan Kulit dengan Proses Koagulasi dan Presipitasi, *J. Tek. Lingkung.*, 2, 1–8.
- Gomez, R., Orts, J.M., Partor, F.J., Diez, M.I., Ortin, F.J., Arico, A., Giacoppo, G., Barbera, O., Chen, X., Wang, D., and Kovacs, A., 2020, The Physical/Chemical Model of Photoelectrochemical Hydrogen Production with Tandem Electrode Architecture, *Horizon2020 EU Framework Programme*, 760930.
- Guo, Z., Ma, R., and Li, G., 2006, Degradation of Phenol by Nanomaterial TiO₂ in

Wastewater, *Chem. Eng. J.*, 119, 55–59.

- Hidayat, I., 2006, Pemanfaatan Limbah Sludge Krom Penyamakan Kulit sebagai Bahan Pewarna Glasir, *Skripsi*, Teknik Lingkungan Teknik Sipil dan Industri Universitas Islam Indonesia, Yogyakarta.
- Hoffmann, M.R., Martin, S.T., Choi, W., and Bahnemann, D.W., 1995, Environmental Applications of Semiconductor Photocatalysis, *Chem. Rev.*, 95, 69–96.
- Horn, M., Schwerdtfeger, C.F., and Meagher, E.P., 1972, Refinement of the Structure of Anatase at Several Temperatures, *Z. Krist. - New Cryst. Struct.*, 136, 273–281.
- Iryani, A., Ilmi, M.M., and Hartanto, D., 2017, Adsorption Study of Congo Red Dye with ZSM-5 Directly Synthesized from Bangka Kaolin Without Organic Template, *Mal. J. Fund. Appl. Sci.*, 13, 832–839.
- Jagusiak, A., Goclon, J., and Panczyk, T., 2021, Adsorption of Evans Blue and Congo Red on Carbon Nanotubes and Its Influence on the Fracture Parameters of Defective and Functionalized Carbon Nanotubes Studied Using Computational Methods, *Appl. Surf. Sci.*, 539, 148236.
- Jariyanorasade, A. and Junyapoon, S., 2018, Factors Affecting the Degradation of Linear Alkylbenzene Sulfonate by TiO₂ Assisted Photocatalysis and Its Kinetics, *EnvironmentAsia*, 11, 45–60.
- Jemaa, I. Ben, Chaabouni, F., and Ranguis, A., 2020, Cr Doping Effect on the Structural, Optoelectrical and Photocatalytic Properties of RF Sputtered TiO₂ Thin Films from a Powder Target, *J. Alloys Compd.*, 825, 153988.
- Kerrami, A., Khezami, L., Bououdina, M., Mahtout, L., Modwi, A., Rabhi, S., Bensouici, F., and Belkacemi, H., 2021, Efficient Photodegradation of Azucryl Red by Copper-Doped TiO₂ Nanoparticles-Experimental and Modeling Studies, *Environ. Sci. Pollut. Res.*, 28, 57543–57556.
- Koh, P.W., Hatta, M.H.M., Ong, S.T., Yuliati, L., and Lee, S.L., 2017, Photocatalytic Degradation of Photosensitizing and Non-Photosensitizing Dyes Over Chromium Doped Titania Photocatalysts under Visible Light, *J. Photochem. Photobiol. A Chem.*, 332, 215–223.
- Koh, P.W., Yuliati, A.L., Lintang, B.H.O., and Lee, S.L.L., 2015, Increasing Rutile Phase Amount in Chromium-Doped Titania by Simple Stirring Approach for Photodegradation of Methylene Blue under Visible Light, *Aust. J. Chem.*, 68, 1129–1135.
- Koh, P.W., Yuliati, L., and Lee, S.L., 2014, Effect of Transition Metal Oxide Doping (Cr, Co, V) in the Photocatalytic Activity of TiO₂ for Congo Red Degradation under Visible Light, *J. Teknol. Sci. Eng.*, 69, 45–50.
- Kormann, C., Bahnemann, D.W., and Hoffmann, M.R., 1991, Photolysis of Chloroform and Other Organic Molecules in Aqueous TiO₂ Suspensions, *Environ. Sci. Technol.*, 25, 494–500.

- Lachheb, H., Puzenat, E., Houas, A., Ksibi, M., Elaloui, E., Guillard, C., and Herrmann, J.M., 2002, Photocatalytic Degradation of Various Types of Dyes (Alizarin S, Crocein Orange G, Methyl Red, Congo Red, Methylene Blue) in Water by UV-Irradiated Titania, *Appl. Catal. B Environ.*, 39, 75–90.
- Lafi, R., Montasser, I., and Hafiane, A., 2019, Adsorption of Congo Red Dye from Aqueous Solutions by Prepared Activated Carbon with Oxygen-Containing Functional Groups and Its Regeneration, *Adsorpt. Sci. Technol.*, 37, 160–181.
- Lauer, K., Moller, C., Bartel, T., and Kirscht, F., 2014, Low Temperature FTIR Investigation of Aluminum Doped Solar-Grade Silicon, *Energy Procedia*, 55, 545–551.
- Lestari, N.D., Wahyuni, E.T., and Aprilita, N.H., 2021, Visible Light Antibacterial Activity of TiO₂-Ag Prepared from Radiophotography Wastewater, *Iran. J. Chem. Chem. Eng.*, 40, 866–871.
- Li, H., Li, J.Z., and Chi, Z.F., 2014, Enhanced Chromium Recovery from Tannery Waste by Acid-Alkali Reaction in China, *Adv. Mater. Res.*, 878, 185–193.
- Li, X., Guo, Z., and He, T., 2013, The Doping Mechanism of Cr into TiO₂ and Its Influence on the Photocatalytic Performance, *Phys. Chem.*, 15, 20037–20045.
- Li, Z., Hanafy, H., Zhang, L., Sellaoui, L., Schadeck Netto, M., Oliveira, M.L.S., Seliem, M.K., Luiz Dotto, G., Bonilla-Petriciolet, A., and Li, Q., 2020, Adsorption of Congo Red and Methylene Blue Dyes on An Ashitaba Waste and A Walnut Shell-Based Activated Carbon from Aqueous Solutions: Experiments, Characterization and Physical Interpretations, *Chem. Eng. J.*, 388, 124263.
- Linsebigler, A.L., Lu, G., and Yates, J.T., 1995, Photocatalysis on TiO₂ Surfaces: Principles, Mechanisms, and Selected Results, *Chem. Rev.*, 95, 735–758.
- Liu, X., Li, W., Chen, N., Xing, X., Dong, C., and Wang, Y., 2015, Ag-ZnO Heterostructure Nanoparticles with Plasmon-Enhanced Catalytic Degradation for Congo Red under Visible Light, *RSC Adv.*, 5(43), 34456–34465.
- Lofrano, G., Meriç, S., Zengin, G.E., and Orhon, D., 2013, Chemical and Biological Treatment Technologies for Leather Tannery Chemicals and Wastewaters: A Review, *Sci. Total Environ.*, 461–462, 265–281.
- López, R., Gómez, R., and Oros-Ruiz, S., 2011, Photophysical and Photocatalytic Properties of TiO₂-Cr Sol-Gel Prepared Semiconductors, *Catal. Today*, 166, 159–165.
- Mahal, H.S., Singh, B.P., and Kant, R., 2021, The Effect of Co Doping on Structural, Optical and Dielectric Behaviour of TiO₂ Nanoparticles, *Def. Sci. J.*, 71, 390–394.

- Mahendran, V. and Gogate, P.R., 2021, Ultrasound-Assisted Synthesis of Fe-Doped TiO₂ Catalyst for Photocatalytic Oxidation Application, *Int. J. Environ. Res.*, 15, 1071–1084.
- Malengreaux, C., Pirard, S.L., Léonard, G., Mahy, J.G., Klobes, B., Hermann, R., Heinrichs, B., and Bartlett, J.R., 2016, Study of the Photocatalytic Activity of Fe³⁺, Cr³⁺, La³⁺ and Eu³⁺ Single-Doped and Co-doped TiO₂ Catalysts Produced by Aqueous Sol-Gel Processing, *J. Alloys Compd.*, 691, 726–738.
- Momeni, M.M. and Motalebian, M., 2021, Chromium-Doped Titanium Oxide Nanotubes Grown Via One-Step Anodization for Efficient Photocathodic Protection of Stainless Steel, *Surf. Coatings Technol.*, 420, 127304.
- Mueller-Buschbaum, H. and Bluhm, K., 1988, Weitere Magnetische Untersuchungen An Ti_(3-x)M_(x)O₅-Phasen (M= Al³⁺, Fe²⁺, Mn²⁺, Mg²⁺) Mit Einem Beitrag Ueber CrTi₂O₅, *Z. Anorg. Allg. Chem.*, 18, 1–12.
- Mutuma, B.K., Shao, G.N., Kim, W.D., and Kim, H.T., 2015, Sol-Gel Synthesis of Mesoporous Anatase-Brookite and Anatase-Brookite-Rutile TiO₂ Nanoparticles and Their Photocatalytic Properties, *J. Colloid Interface Sci.*, 442, 1–7.
- Naseem, K., Farooqi, Z.H., Begum, R., and Irfan, A., 2018, Removal of Congo Red Dye from Aqueous Medium by Its Catalytic Reduction Using Sodium Borohydride in the Presence of Various Inorganic Nano-Catalysts: A Review, *J. Clean. Prod.*, 187, 296–307.
- Nguyen, T. and Hind, A., 2001, The Measurement of Absorption Edge and Band Gap Properties of Novel Nanocomposite Materials, *Varian, UV Work*, 81, 1–5.
- Nosaka, Y. and Nosaka, A.Y., 2017, Generation and Detection of Reactive Oxygen Species in Photocatalysis, *Chem. Rev.*, 117, 11302–11336.
- Nugraha, A.W., Suparno, O., and Indrasti, N.S., 2018, Analisis Material, Energi Dan Toksisitas (MET) pada Industri Penyamakan Kulit untuk Identifikasi Strategi Produksi Bersih, *J. Teknol. Ind. Pertan.*, 28, 48–60.
- Othman, S.H., Rashid, S.A., Ghazi, T.I.M., and Abdullah, N., 2011, Fe-Doped TiO₂ Nanoparticles Produced Via MOCVD: Synthesis, Characterization, and Photocatalytic Activity, *J. Nanomater.*, 2011, 1–8.
- Peng, Y., Huang, G., and Huang, W., 2012, Visible-Light Absorption and Photocatalytic Activity of Cr-Doped TiO₂ Nanocrystal Films, *Adv. Powder Technol.*, 23, 8–12.
- Praveen, P., Viruthagiri, G., Mugundan, S., and Shanmugam, N., 2014, Sol-Gel Synthesis and Characterization of Pure and Manganese Doped TiO₂ Nanoparticles - A New NLO Active Material, *Spectrochim. Acta A Mol. Biomol. Spectrosc.*, 120, 548–557.
- Puigdollers, A.R., Schlexer, P., Tosoni, S., and Pacchioni, G., 2017, Increasing Oxide Reducibility: The Role of Metal/Oxide Interfaces in the Formation of

Oxygen Vacancies, *ACS Catal.*, 7, 6493–6513.

- Raguram, T. and Rajni, K.S., 2019, Synthesis and Analysing the Structural, Optical, Morphological, Photocatalytic and Magnetic Properties of TiO₂ and Doped (Ni and Cu) TiO₂ Nanoparticles by Sol–Gel Technique, *Appl. Phys. A Mater. Sci. Process.*, 125, 1–11.
- Rahman, K.A., Sharma, N., Atanacio, A.J., Bak, T., Wachsman, E.D., Moffitt, M., and Nowotny, J., 2019, Chromium Segregation in Cr-Doped TiO₂ (Rutile): Impact of Oxygen Activity, *Ionics*, 2, 3363–3372.
- Reza, K.M., Kurny, A.S.W., and Gulshan, F., 2017, Parameters Affecting the Photocatalytic Degradation of Dyes Using TiO₂: A Review, *Appl. Water Sci.*, 7, 1569–1578.
- Riyani, K., Setyaningtyas, T., and Dwiasi, D.W., 2015, Sintesis dan Karakterisasi Fotokatalis TiO₂-Cu, *Molekul*, 10, 104–111.
- Riyani, K., Setyaningtyas, T., and Riapanitra, A., 2021, Degradation of Phenol in Batik Industry Wastewater Using Thin Layer TiO₂ Photocatalyst, *IOP Conf. Ser.: Earth Environ. Sci.*, 746, 1–8.
- Salahuddin, N., Abdelwahab, M.A., Akelah, A., and Elnagar, M., 2021, Adsorption of Congo Red and Crystal Violet Dyes onto Cellulose Extracted from Egyptian water hyacinth, *Nat. Hazards*, 105, 1375–1394.
- Sansiviero, M.T.C., Dos Santos, D.S., Job, A.E., and Aroca, R.F., 2011, Layer by layer TiO₂ Thin Films and Photodegradation of Congo Red, *J. Photochem. Photobiol. A Chem.*, 220, 20–24.
- Sathishkumar, K., AlSalhi, M.S., Sanganyado, E., Devanesan, S., Arulprakash, A., and Rajasekar, A., 2019, Sequential Electrochemical Oxidation and Bio-Treatment of the Azo Dye Congo Red and Textile Effluent, *J. Photochem. Photobiol. B Biol.*, 200, 111655.
- Schiavon, M., Pilon-Smits, E.A.H., Wirtz, M., Hell, R., and Malagoli, M., 2008, Interactions between Chromium and Sulfur Metabolism in Brassica juncea, *J. Environ. Qual.*, 37, 1536–1545.
- Shyichuk, A. and Zych, E., 2019, Dopant-Related Electron Trap States in Lu₂O₃:Ta, *J. Lumin.*, 214, 116583.
- Simonin, J.P., 2016, On the Comparison of Pseudo-First Order and Pseudo-Second Order Rate Laws in the Modeling of Adsorption Kinetics, *Chem. Eng. J.*, 300, 254–263.
- So, C.M., Cheng, M.Y., Yu, J.C., and Wong, P.K., 2002, Degradation of Azo Dye Procion Red MX-5B by Photocatalytic Oxidation, *Chemosphere*, 46, 905–912.
- Sudarmaji, S., Mukono, J., dan Prasasti, C.I., 2006, Toksikologi Logam Berat B3 dan Dampaknya Terhadap Kesehatan, *J. Kesehat. Lingkungan*, 2, 129–142.
- Sunaryo, I. dan Sutiyasmi, S., 2010, Pengolahan Limbah Cair Laboratorium Riset

- Penyamakan Kulit di Balai Besar Kulit, Karet dan Plastik (BBKKP), *J. Ris. Ind.*, IV, 61–72.
- Tan, Y., Kang, Y., Wang, W., Lv, X., Wang, B., Zhang, Q., Cui, C., Cui, S., Jiao, S., Pang, G., and Feng, S., 2021, Chitosan Modified Inorganic Nanowires Membranes for Ultra-Fast and Efficient Removal of Congo Red, *Appl. Surf. Sci.*, 569, 150970.
- Tapalad, T., Neramittagapong, A., Neramittagapong, S., and Boonmee, M., 2008, Degradation of Congo Red Dye by Ozonation, *Chiang Mai J. Sci.*, 35, 63–68.
- Wahyuningsih, S., Hidayatika, W.N., Sari, P.L., Sari, P.P., Hidayat, R., Munawaroh, H., and Ramelan, A.H., 2018, The Influence of Cr³⁺ on TiO₂ Crystal Growth and Photoactivity Properties, *IOP Conf. Ser. Mater. Sci. Eng.*, 333, 012023.
- Wen, K., Li, Y., Zhang, S., Zhang, X., and Han, R., 2020, Adsorption of Congo Red from Solution by Iron Doped PVA-Chitosan Composite Film, *Desalin. Water Treat.*, 187, 378–389.
- White, J. and Smith, W., 2013, A Brief Note on the Temperature-Dependent Photocatalytic Degradation of Congo Red Using Zinc Oxide, *Am. J. Water Resour.*, 1, 66–69.
- Wu, X., 2015, Preparation of Enhanced Visible and Near Infrared Lights Responsive Photocatalysts for Environmental Cleanup, *Thesis*, Graduate School of Environmental Studies Tohoku University, Japan.
- Xu, D. and Ma, H., 2021, Degradation of Rhodamine B in Water by Ultrasound-Assisted TiO₂ Photocatalysis, *J. Clean. Prod.*, 313, 127758.
- Yadav, H.M., Kolekar, T. V., Barge, A.S., Thorat, N.D., Delekar, S.D., Kim, B.M., Kim, B.J., and Kim, J.S., 2016, Enhanced Visible Light Photocatalytic Activity of Cr³⁺-Doped Anatase TiO₂ Nanoparticles Synthesized by Sol-Gel Method, *J. Mater. Sci. Mater. Electron.*, 27, 526–534.
- Yaneva, Z.L. and Georgieva, N. V., 2014, Insights into Congo Red Adsorption on Agro-Industrial Materials - Spectral, Equilibrium, Kinetic, Thermodynamic, Dynamic and Desorption Studies . A Review, *Int. Rev. Chem. Eng.*, 4, 127–146.
- Yang, K., Dai, Y., and Huangl, B., 2009, Density Functional Characterization of the Electronic Structure and Visible-Light Absorption of Cr-Doped Anatase TiO₂, *ChemPhysChem*, 10, 2327–2333.
- Zhang, E., Wu, J., Wang, G., Zhang, B., and Xie, Y., 2016, Efficient Fenton Oxidation of Congo Red Dye by Magnetic MgFe₂O₄ Nanorods, *J. Nanosci. Nanotechnol.*, 16, 4727–4732.