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**Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada
Magnetoresistance Sensors**
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DAFTAR PUSTAKA

Abuzeid, H. M., Julien, C. M., Zhu, L., & Hashem, A. M. (2023). Green Synthesis of Nanoparticles and Their Energy Storage, Environmental, and Biomedical Applications. *Crystals*, *13*(11). https://doi.org/10.3390/cryst13111576

Acharya, D., Rani, A., Agarwal, S., & Singh, V. (2016). Application of adaptive Savitzky–Golay filter for EEG signal processing. *Perspectives in Science*, *8*, 677–679. https://doi.org/10.1016/j.pisc.2016.06.056

Adeyemi, J. O., Oriola, A. O., Onwudiwe, D. C., & Oyedeji, A. O. (2022). Plant Extracts Mediated Metal-Based Nanoparticles: Synthesis and Biological Applications. *Biomolecules*, *12*(5). https://doi.org/10.3390/biom12050627

Ajiz, H. A., Mawarani, L. J., Widiyastuti, W., & Setyawan, H. (2020). Peningkatan Stabilitas Busa dengan Nanofluida Silika Untuk Meningkatkan Produksi Gas Alam. *Berkala Sainstek*, *8*(1), 6. https://doi.org/10.19184/bst.v8i1.15401

Alemi-Tameh, F., Safaei-Ghomi, J., Mahmoudi-Hashemi, M., & Teymuri, R. (2016). A comparative study on the catalytic activity of Fe_3O_4@SiO_2–SO_3H and Fe_3O_4@SiO_2–NH_2 nanoparticles for the synthesis of spiro [chromeno [2, 3-c] pyrazole-4, 3′-indoline]-diones under mild conditions. *Research on Chemical Intermediates*, *42*(7), 6391–6406. https://doi.org/10.1007/s11164-016-2470-6

Alterary, S. S., & Alkhamees, A. (2021). Synthesis, surface modification, and characterization of Fe_3O_4@SiO_2core@shell nanostructure. *Green Processing and Synthesis*, *10*(1), 384–391. https://doi.org/10.1515/gps-2021-0031

Anand, G., Thyagarajan, T., Kokila, D., & Kamal, C. (2022). Design optimization of giant magneto resistance–based magnetic nanoparticle detection in liquid samples for biomedical applications. *Journal of Nanoparticle Research*, *24*(8). https://doi.org/10.1007/s11051-022-05484-6

Antarnusa, G., Esmawan, A., Dwi Jayanti, P., Rizki Fitriani, S., Suherman, A., Kinarya Palupi, E., Umam, R., & Ardimas. (2022). Synthesis of Fe_3O_4 at different reaction temperatures and investigation of its magnetic properties on giant magnetoresistance (GMR) sensors for bio-detection applications. *Journal of Magnetism and Magnetic Materials*, *563*(August), 169903. https://doi.org/10.1016/j.jmmm.2022.169903

Ardiyanti, H., Mabarroh, N., Wibowo, N. A., Istiqomah, N. I., Tumbelaka, R. M., Darmawan, M. Y., Zurnansyah, Z., Prabowo, Y. D., Absor, M. A. U., & Suharyadi, E. (2025). Facile and Fast Assay of Biomolecule Using ICs-Based Giant Magnetoresistance Chip Sensor with Green-Synthesized Magnetite Nanotag. *Sensing and Imaging*, *26*(1). https://doi.org/10.1007/s11220-025-00597-3

UNIVERSITAS GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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Arista, D., Rachmawati, A., Ramadhani, N., Saputro, R. E., Taufiq, A., & Sunaryono. (2019). Antibacterial Performance of Fe_3O_4/PEG-4000 Prepared by Co-precipitation Route. *IOP Conference Series: Materials Science and Engineering*, *515*(1). https://doi.org/10.1088/1757-899X/515/1/012085

Arregi, J. A. (2019). Vibrating Sample Magnetometry M106. *Materials Science and Engineering Vibrating*, 2–16.

Aslani, E., Abri, A., & Pazhang, M. (2018a). Immobilization of trypsin onto Fe_3O_4@SiO_2 –NH_2 and study of its activity and stability. *Colloids and Surfaces B: Biointerfaces*, *170*, 553–562. https://doi.org/10.1016/j.colsurfb.2018.06.022

Aslani, E., Abri, A., & Pazhang, M. (2018b). Immobilization of trypsin onto Fe_3O_4@SiO_2 –NH_2 and study of its activity and stability. *Colloids and Surfaces B: Biointerfaces*, *170*(May), 553–562. https://doi.org/10.1016/j.colsurfb.2018.06.022

Asriza, R. O., Indriawati, A., Julianti, E., & Fabiani, V. A. (2020). Synthesis and characterization of Fe_3O_4/SiO_2Nanocomposite from Kaolin Bangka Island. *IOP Conference Series: Earth and Environmental Science*, *599*(1). https://doi.org/10.1088/1755-1315/599/1/012063

Aswathi, V. P., Meera, S., Maria, C. G. A., & Nidhin, M. (2023). Green synthesis of nanoparticles from biodegradable waste extracts and their applications: a critical review. *Nanotechnology for Environmental Engineering*, *8*(2), 377–397. https://doi.org/10.1007/s41204-022-00276-8

B.R.Kirupakar, B. A. V., Sree, M. P., & Deenadayalan. (2016). Vibrating Sample Magnetometer and It's Application in Characterisation of Magnetic Property of The Anti Cancer Drug Magnetic Microspheres. *International Journal of Pharmaceutics & Drug Analysis*, *4*(5), 227–233.

Baibich, M. N., Broto, J. M., Fert, A., Van Dau, F. N., Petroff, F., Eitenne, P., Creuzet, G., Friederich, A., & Chazelas, J. (1988). Giant magnetoresistance of (001)Fe/(001)Cr magnetic superlattices. *Physical Review Letters*, *61*(21), 2472–2475. https://doi.org/10.1103/PhysRevLett.61.2472

Bárcena, C., Sra, A. K., & Gao, J. (2009). Applications of magnetic nanoparticles in biomedicine. *Nanoscale Magnetic Materials and Applications*, *167*, 591–626. https://doi.org/10.1007/978-0-387-85600-1_20

Borehalli Mayegowda, S., Roy, A., Manjula, N. G., Pandit, S., Alghamdi, S., Almehmadi, M., Allahyani, M., Awwad, N. S., & Sharma, R. (2023). Eco-friendly synthesized nanoparticles as antimicrobial agents: an updated review. *Frontiers in Cellular and Infection Microbiology*, *13*(August), 1–13. https://doi.org/10.3389/fcimb.2023.1224778

Bruno, P. (1999). Theory of interlayer exchange interactions in magnetic multilayers. *Journal of Physics Condensed Matter*, *11*(48), 9403–9419.

UNIVERSITAS
GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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https://doi.org/10.1088/0953-8984/11/48/305

Cai, W., Guo, M., Weng, X., Zhang, W., Owens, G., & Chen, Z. (2020). Modified green synthesis of Fe_3O_4@SiO_2 nanoparticles for pH responsive drug release. *Materials Science and Engineering C*, *112*(March). https://doi.org/10.1016/j.msec.2020.110900

Callister, & Rethwisch, D. G. (2007). Fundamentals of Materials Science and Engineering. In *Sustainability (Switzerland)* (Vol. 11, Issue 1).

Chae, H. S., Kim, S. D., Piao, S. H., & Choi, H. J. (2016). Core-shell structured Fe_3O_4@SiO_2 nanoparticles fabricated by sol–gel method and their magnetorheology. *Colloid and Polymer Science*, *294*(4), 647–655. https://doi.org/10.1007/s00396-015-3818-y

Charles Kittel. (2005). Introduction to Solid State Physics. In *Introduction to Solid State Physics* (8th Editio). John Wiley & Sons, Inc. https://doi.org/10.1142/11041

Chen, Y. T., Kolhatkar, A. G., Zenasni, O., Xu, S., & Lee, T. R. (2017). Biosensing using magnetic particle detection techniques. In *Sensors (Switzerland)* (Vol. 17, Issue 10). https://doi.org/10.3390/s17102300

Chen, Z., Yao, J., Ma, B., Liu, B., Kim, J., Li, H., Zhu, X., Zhao, C., & Amde, M. (2022). A robust biocatalyst based on laccase immobilized superparamagnetic Fe_3O_4@SiO_2–NH_2 nanoparticles and its application for degradation of chlorophenols. *Chemosphere*, *291*(October 2021). https://doi.org/10.1016/j.chemosphere.2021.132727

Corbett, G. G. (1994). Book Review: Materials Science and Engineering, an Introduction. In *International Journal of Mechanical Engineering Education* (Vol. 22, Issue 1). https://doi.org/10.1177/030641909402200102

Cregg, P. J., Murphy, K., & Mardinoglu, A. (2012). Inclusion of interactions in mathematical modelling of implant assisted magnetic drug targeting. *Applied Mathematical Modelling*, *36*(1), 1–34. https://doi.org/10.1016/j.apm.2011.05.036

Cuana, R., Panre, A. M., Istiqomah, N. I., Tumbelaka, R. M., Sunaryono, Wicaksono, S. T., & Suharyadi, E. (2022). Green Synthesis of Fe_3O_4 /Chitosan Nanoparticles Utilizing Moringa Oleifera Extracts and Their Surface Plasmon Resonance Properties . *ECS Journal of Solid State Science and Technology*, *11*(8), 083015. https://doi.org/10.1149/2162-8777/ac8b36

Cuana, R., Panre, A. M., Istiqomah, N. I., Tumbelaka, R. M., Wicaksono, S. T., & Suharyadi, E. (2022). Green synthesis of Fe_3O_4/chitosan nanoparticles utilizing moringa oleifera extracts and their surface plasmon resonance properties. *ECS Journal of Solid State Science and Technology*, *11*(8), 83015. https://doi.org/10.1149/2162-8777/ac8b36

Cullity & Graham. (2009). *Introduction to Magnetic Materials*. America. IEEE

UNIVERSITAS GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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Press

De Melo, C. F., Araújo, R. L., Ardjomand, L. M., Quoirin, N. S. R., Ikeda, M., & Costa, A. A. (2006). Calibration of magnetic field meters at 60 hz using a helmholtz Coil: Constructive aspects and calculation of associated uncertainties. *18th IMEKO World Congress 2006: Metrology for a Sustainable Development*, *3*, 1942–1945.

Dejong, M. D., & Livesey, K. L. (2015). Analytic theory for the switch from Bloch to Néel domain wall in nanowires with perpendicular anisotropy. *Physical Review B - Condensed Matter and Materials Physics*, *92*(21), 1–12. https://doi.org/10.1103/PhysRevB.92.214420

Dey, P., & Roy, J. N. (2021). Giant Magnetoresistance (GMR). In *Spintronics: Fundamentals and Applications* (pp. 75–101). Springer Singapore. https://doi.org/10.1007/978-981-16-0069-2_3

Elmobarak, W. F., & Almomani, F. (2021). Functionalization of silica-coated magnetic nanoparticles as powerful demulsifier to recover oil from oil-in-water emulsion. *Chemosphere*, *279*, 130360. https://doi.org/10.1016/j.chemosphere.2021.130360

Fan, Q., Guan, Y., Zhang, Z., Xu, G., Yang, Y., & Guo, C. (2019). A new method of synthesis well-dispersion and dense Fe_3O_4@SiO_2 magnetic nanoparticles for DNA extraction. *Chemical Physics Letters*, *715*(November 2018), 7–13. https://doi.org/10.1016/j.cplett.2018.11.001

Ganapathe, L. S., Mohamed, M. A., Mohamad Yunus, R., & Berhanuddin, D. D. (2020). Magnetite (Fe_3O_4) Nanoparticles in Biomedical Application: From Synthesis to Surface Functionalisation. In *Magnetochemistry* (Vol. 6, Issue 4). https://doi.org/10.3390/magnetochemistry6040068

Ganzoury, M. A., Allam, N. K., Nicolet, T., & All, C. (2015). Introduction to Fourier Transform Infrared Spectrometry. *Renewable and Sustainable Energy Reviews*, *50*, 1–8. https://doi.org/10.1016/j.rser.2015.05.073

Garcia, S., Mabarroh, N., Darmawan, M. Y., Wibowo, N. A., Ardiyanti, H., Tumbelaka, R. M., Istiqomah, N. I., & Suharyadi, E. (2023). Two spin-valve GMR thin films on half wheatstone bridge circuit for detecting green-synthesized Fe_3O_4@Ag nanoparticles-labeled biomolecule. *Materialia*, *32*(August), 101930. https://doi.org/10.1016/j.mtla.2023.101930

Gatard, V. (2016). *Electrolyse de l ' eau en milieu alcalin assistée par champ magnétique alternatif radio fréquence Alkaline water electrolysis enhanced by radio frequency alternating magnetic field*.

Ger, T. R., Wu, P. S., Wang, W. J., Chen, C. A., Abu, P. A. R., & Chen, S. L. (2023). Development of a Microfluidic Chip System with Giant Magnetoresistance Sensor for High-Sensitivity Detection of Magnetic Nanoparticles in Biomedical Applications. *Biosensors*, *13*(8).

UNIVERSITAS
GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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https://doi.org/10.3390/bios13080807

Ghemes, C., Tibu, M., Lostun, M., Chiriac, H., & Lupu, N. (2023). *Tunnel Magnetoresistance-Based Sensor for Biomedical Application: Proof-of-Concept*.

Ghorbani, F., & Kamari, S. (2019). Core–shell magnetic nanocomposite of Fe_3O_4@SiO_2 @NH_2 as an efficient and highly recyclable adsorbent of methyl red dye from aqueous environments. *Environmental Technology and Innovation*, *14*, 100333. https://doi.org/10.1016/j.eti.2019.100333

Griffiths, D. J., & Schroeter, D. F. (2018). *Introduction to Quantum Mechanics, 3rf edition (2018)*. Cambridge University Press.

Gupta, A. K., & Gupta, M. (2005). Synthesis and surface engineering of iron oxide nanoparticles for biomedical applications. *Biomaterials*, *26*(18), 3995–4021. https://doi.org/10.1016/j.biomaterials.2004.10.012

Han, S. J., & Wang, S. (2010). Magnetic Nanotechnology for Biodetection. *JALA - Journal of the Association for Laboratory Automation*, *15*(2), 93–98. https://doi.org/10.1016/j.jala.2009.10.008

Hassan, M. A., Xu, T., Tian, Y., Zhong, Y., Ali, F. A. Z., Yang, X., & Lu, B. (2021). Health benefits and phenolic compounds of Moringa oleifera leaves: A comprehensive review. *Phytomedicine*, *93*(June), 153771. https://doi.org/10.1016/j.phymed.2021.153771

Hassanzadeh-Tabrizi, S. A. (2023). Precise calculation of crystallite size of nanomaterials: A review. *Journal of Alloys and Compounds*, *968*(August), 171914. https://doi.org/10.1016/j.jallcom.2023.171914

Hirota, E., Sakakima, H., & Inomata, K. (2002). *Giant MagnetoResistance Devices* (Vol. 40). https://doi.org/10.1007/978-3-662-04777-4

Hossain, M., Qin, B., Li, B., & Duan, X. (2022). Synthesis, characterization, properties and applications of two-dimensional magnetic materials. *Nano Today*, *42*. https://doi.org/10.1016/j.nantod.2021.101338

Huang, H., Garu, P., Li, C., Chang, W., Chen, B., Sung, S.-Y., Lee, C.-M., Chen, J., Hsieh, T.-F., Sheu, W., Ouyang, H., Wang, W., Chang, C., Wang, C., Hsu, M., & Wei, Z.-H. (2019). Magnetoresistive Biosensors for Direct Detection of Magnetic Nanoparticle Conjugated Biomarkers on a Chip. *SPIN*, *09*. https://doi.org/10.1142/S2010324719400022

Ilavenil, K. K., Senthilkumar, V., & Kasthuri, A. (2025). Green synthesis of metal nanoparticles from three medicinal plants: a review of environmental and health applications. *Discover Catalysis*, *2*(1). https://doi.org/10.1007/s44344-025-00007-6

Inkson, B. J. (2016). Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) for Materials Characterization. In *Materials*

UNIVERSITAS GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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Characterization Using Nondestructive Evaluation (NDE) Methods. Elsevier Ltd. https://doi.org/10.1016/B978-0-08-100040-3.00002-X

Iskandar, D., Suprapto, Y. K., & Purnama, I. K. E. (2017). Determination of priority parameter for classification of poverty using chi-square method and crammer's V correlation. *Proceedings - 2016 International Seminar on Application of Technology for Information and Communication, ISEMANTIC 2016*, 247–252. https://doi.org/10.1109/ISEMANTIC.2016.7873846

Iskandar, D., Suprapto, Y. K., & Purnama, I. K. E. (2017). Determination of priority parameter for classification of poverty using chi-square method and crammer's V correlation. *Proceedings - 2016 International Seminar on Application of Technology for Information and Communication, ISEMANTIC 2016*, 247–252. https://doi.org/10.1109/ISEMANTIC.2016.7873846

Jannah, W. N., Taufiq, A., Zulaikah, S., Hidayat, A., Suharyadi, E., Wicaksono, S. T., & Sunaryono, S. (2023). Fe_3O_4–graphene/polyethylene glycol–SiO_2 as a phase change material for thermal energy storage. *Materials Chemistry and Physics*, *310*(5). https://doi.org/10.1016/j.matchemphys.2023.128457

Jiles, D. (2015). Introduction to magnetism and magnetic materials, third edition. In *Introduction to Magnetism and Magnetic Materials, Third Edition*.

Jin, Z., Koo, T. M., Kim, M. S., Al-Mahdawi, M., Oogane, M., Ando, Y., & Kim, Y. K. (2021). Highly-sensitive magnetic sensor for detecting magnetic nanoparticles based on magnetic tunnel junctions at a low static field. *AIP Advances*, *11*(1). https://doi.org/10.1063/9.0000189

Jogschies, L., Klaas, D., Kruppe, R., Rittinger, J., Taptimthong, P., Wienecke, A., Rissing, L., & Wurz, M. C. (2015). Recent developments of magnetoresistive sensors for industrial applications. *Sensors (Switzerland)*, *15*(11), 28665–28689. https://doi.org/10.3390/s151128665

Julliere, M. (1975). Tunneling between ferromagnetic films. *Physics Letters A*, *54*(3), 225–226. https://doi.org/10.1016/0375-9601(75)90174-7

Karpinsky, D. V., Silibin, M. V., Trukhanov, A. V., Zhaludkevich, A. L., Maniecki, T., Maniukiewicz, W., Sikolenko, V., Paixão, J. A., & Khomchenko, V. A. (2019). A correlation between crystal structure and magnetic properties in co-doped $BiFeO_3$ ceramics. *Journal of Physics and Chemistry of Solids*, *126*(November 2018), 164–169. https://doi.org/10.1016/j.jpcs.2018.11.006

Kiwumulo, H. F., Muwonge, H., Ibingira, C., Lubwama, M., Kirabira, J. B., & Ssekitoleko, R. T. (2022). Green synthesis and characterization of iron-oxide nanoparticles using Moringa oleifera: a potential protocol for use in low and middle income countries. *BMC Research Notes*, *15*(1), 1–8. https://doi.org/10.1186/s13104-022-06039-7

Kodarta, W., Sinaga, J. F., Pane, R. H. U., Pasaribu, M. U., Ichsan, A. F., & Bemis, R. (2024). Green Synthesis of Fe_3O_4 Nanoparticles Using Pineapple Peel

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Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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Extract For Adsorption of Rhodamine B. *Akta Kimia Indonesia*, *9*(2), 114. https://doi.org/10.12962/j25493736.v9i2.21671

Kumar, L., Kumar, P., & Kar, M. (2013). Cation distribution by Rietveld technique and magnetocrystalline anisotropy of Zn substituted nanocrystalline cobalt ferrite. *Journal of Alloys and Compounds*, *551*, 72–81. https://doi.org/10.1016/j.jallcom.2012.10.009

Kurnaz Yetim, N., & Hasanoğlu Özkan, E. (2021). Synthesis of Au-doped magnetic nanocomposites: structural, magnetic, and catalytic properties. *Journal of Materials Science: Materials in Electronics*, *32*(20), 24766–24774. https://doi.org/10.1007/s10854-021-06922-2

Laurent, S., Forge, D., Port, M., Roch, A., Robic, C., Vander Elst, L., & Muller, R. N. (2010). Erratum: Magnetic iron oxide nanoparticles: Synthesis, stabilization, vectorization, physicochemical characterizations, and biological applications (Chemical Reviews (2008) 108 (2064)). *Chemical Reviews*, *110*(4), 2574. https://doi.org/10.1021/cr900197g

Lestari, K. R. (2021). Sintesis, Klasifikasi, dan Sifat Bahan Nano. In *LP_UNAS.Jakarta Selatan*.

Li, B., Fan, H., Zhao, Q., & Wang, C. (2016). Synthesis, characterization and cytotoxicity of novel multifunctional Fe_3O_4@SiO_2@$GdVO_4$: Dy^{3+} core-shell nanocomposite as a drug carrier. *Materials*, *9*(3), 3–9. https://doi.org/10.3390/ma9030149

Li, G., Sun, S., Wilson, R. J., White, R. L., Pourmand, N., & Wang, S. X. (2006). Spin valve sensors for ultrasensitive detection of superparamagnetic nanoparticles for biological applications. *Sensors and Actuators, A: Physical*, *126*(1), 98–106. https://doi.org/10.1016/j.sna.2005.10.001

Liang, S., Sutham, P., Wu, K., Mallikarjunan, K., & Wang, J. P. (2022). Giant Magnetoresistance Biosensors for Food Safety Applications. *Sensors*, *22*(15). https://doi.org/10.3390/s22155663

Liu, L., Li, Y., AL-Huqail, A. A., Ali, E., Alkhalifah, T., Alturise, F., & Ali, H. E. (2023). Green synthesis of Fe_3O_4 nanoparticles using Alliaceae waste (Allium sativum) for a sustainable landscape enhancement using support vector regression. *Chemosphere*, *334*(April), 138638. https://doi.org/10.1016/j.chemosphere.2023.138638

Lu, Y., Yin, Y., Mayers, B. T., & Xia, Y. (2002). Modifying the Surface Properties of Superparamagnetic Iron Oxide Nanoparticles through a Sol-Gel Approach. *Nano Letters*, *2*(3), 183–186. https://doi.org/10.1021/nl015681q

Maleki, B., & Esmaeili, H. (2023). Application of Fe_3O_4/SiO_2@ZnO magnetic composites as a recyclable heterogeneous nanocatalyst for biodiesel production from waste cooking oil: Response surface methodology. *Ceramics International*, *49*(7), 11452–11463.

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Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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https://doi.org/10.1016/j.ceramint.2022.11.344

Miller, J. N., & Miller, J. C. (2009). Statistics and Chemometrics for Analyical Chemistry. In *Catalysis in Industry* (6th ed., Vol. 5, Issue 3). Pearson education limited. https://doi.org/10.1134/S2070050413030021

Mohammadpour, A., Karami, N., Zabihi, R., Fazeliyan, E., Abbasi, A., Karimi, S., Barbosa de Farias, M., Adeodato Vieira, M. G., Shahsavani, E., & Mousavi Khaneghah, A. (2023). Green synthesis, characterization, and application of Fe_3O_4 nanoparticles for methylene blue removal: RSM optimization, kinetic, isothermal studies, and molecular simulation. *Environmental Research*, *225*(February), 115507. https://doi.org/10.1016/j.envres.2023.115507

Mostafaei, M., Hosseini, S. N., Khatami, M., Javidanbardan, A., Sepahy, A. A., & Asadi, E. (2018). Isolation of recombinant Hepatitis B surface antigen with antibody-conjugated superparamagnetic Fe_3O_4/SiO_2 core-shell nanoparticles. *Protein Expression and Purification*, *145*(November 2017), 1–6. https://doi.org/10.1016/j.pep.2017.12.004

Mu, X. H., Liu, H. F., Tong, Z. Y., Du, B., Liu, S., Liu, B., Liu, Z. W., Gao, C., Wang, J., & Dong, H. (2019). A new rapid detection method for ricin based on tunneling magnetoresistance biosensor. *Sensors and Actuators, B: Chemical*, *284*(December 2018), 638–649. https://doi.org/10.1016/j.snb.2018.12.127

Munasir, Dewanto, A. S., Kusumawati, D. H., Putri, N. P., Yulianingsih, A., Sa'Adah, I. K. F., Taufiq, A., Hidayat, N., Sunaryono, S., & Supardi, Z. A. I. (2018). Structure Analysis of Fe_3O_4@SiO_2 Core Shells Prepared from Amorphous and Crystalline SiO_2 Particles. *IOP Conference Series: Materials Science and Engineering*, *367*(1). https://doi.org/10.1088/1757-899X/367/1/012010

Munasir, & Terraningtyas, A. (2019). Synthesis and characterization of Fe_3O_4/SiO_2 composite with in-situ method: TEOS as SiO_2 NPs precursor. *Journal of Physics: Conference Series*, *1171*(1), 0–5. https://doi.org/10.1088/1742-6596/1171/1/012050

Mustapha, T., Misni, N., Ithnin, N. R., Daskum, A. M., & Unyah, N. Z. (2022). A Review on Plants and Microorganisms Mediated Synthesis of Silver Nanoparticles, Role of Plants Metabolites and Applications. *International Journal of Environmental Research and Public Health*, *19*(2). https://doi.org/10.3390/ijerph19020674

Nakano, T., Fujiwara, K., & Oogane, M. (2025). Tunnel-magnetoresistance sensors with sub-pT detectivity for detecting bio-magnetic fields. *Applied Physics Letters*, *126*(16). https://doi.org/10.1063/5.0263879

Noma, S. A. A., Ulu, A., Koytepe, S., & Ateş, B. (2020). Preparation and characterization of amino and carboxyl functionalized core-shell Fe_3O_4/SiO_2 for L-asparaginase immobilization: A comparison study. *Biocatalysis and*

UNIVERSITAS GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
Muhammad Rizki, Prof. Dr. Eng. Edi Suharyadi, M.Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Biotransformation, *38*(5), 392–404. https://doi.org/10.1080/10242422.2020.1767605

Nuryadin, B. W. (2020). *Pengantar Fisika Nanomaterial: Teori dan Aplikasi*. 1–181.

Parvaneh, S., Khademi, F., Abdi, G., Alizadeh, A., & Mostafaie, A. (2021). Efficient conjugation of anti-HBsAg antibody to modified core-shell magnetic nanoparticles (Fe_3O_4@SiO_2/NH_2). *BioImpacts*, *11*(4), 237–244. https://doi.org/10.34172/bi.2021.34

Phong, P. T., Linh, P. H., Huong, T. T., Nhung, N. H., Nam, P. H., Anh, N. Q., & Trang, V. T. (2025). Effect of magnetic dipole interaction on the heating efficiency of Fe_3O_4@SiO_2 nanocomposites. *Physica B: Condensed Matter*, *701*(January), 416960. https://doi.org/10.1016/j.physb.2025.416960

Polte, J. (2015). Fundamental growth principles of colloidal metal nanoparticles - a new perspective. *CrystEngComm*, *17*(36), 6809–6830. https://doi.org/10.1039/c5ce01014d

Purwiandono, G., Fatimah, I., Sahroni, I., Citradewi, P. W., Kamari, A., & Sagadevan, S. (2022). *Fe_3O_4@SiO_2 nano flakes synthesized using biogenic silica from Salacca zalacca leaf ash and the mechanistic insight into adsorption and photocatalytic wet peroxidation of dye*. 345–360.

Ramesh, A. V., Rama Devi, D., Mohan Botsa, S., & Basavaiah, K. (2018). Facile green synthesis of Fe_3O_4 nanoparticles using aqueous leaf extract of Zanthoxylum armatum DC. for efficient adsorption of methylene blue. *Journal of Asian Ceramic Societies*, *6*(2), 145–155. https://doi.org/10.1080/21870764.2018.1459335

Rana, A., Yadav, K., & Jagadevan, S. (2020). A comprehensive review on green synthesis of nature-inspired metal nanoparticles: Mechanism, application and toxicity. *Journal of Cleaner Production*, *272*, 122880. https://doi.org/10.1016/j.jclepro.2020.122880

Rawat, R. S., & Wang, Y. (2020). Plasma Nanotechnology for Nanophase Magnetic Material Synthesis. In *Advances in Magnetic Materials* (Issue 10994). https://doi.org/10.4324/9781315371573-4

Safaiee, M., Zolfigol, M. A., Afsharnadery, F., & Baghery, S. (2015). Synthesis of a novel dendrimer core of oxo-vanadium phthalocyanine magnetic nano particles: As an efficient catalyst for the synthesis of 3,4-dihydropyrano[c]chromenes derivatives under green condition. *RSC Advances*, *5*(124), 102340–102349. https://doi.org/10.1039/c5ra18723k

Saif, S., Tahir, A., & Chen, Y. (2016). Green synthesis of iron nanoparticles and their environmental applications and implications. *Nanomaterials*, *6*(11), 1–26. https://doi.org/10.3390/nano6110209

Sajid, M., Shuja, S., Rong, H., & Zhang, J. (2023). Size-controlled synthesis of

UNIVERSITAS GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Fe_3O_4 and Fe_3O_4@SiO_2 nanoparticles and their superparamagnetic properties tailoring. *Progress in Natural Science: Materials International*, *33*(1), 116–119. https://doi.org/10.1016/j.pnsc.2022.08.003

Sakurai, J. J., Fu Tuan, S., & Newton, R. G. (1986). Modern Quantum Mechanics . In *Physics Today* (Vol. 39, Issue 7). https://doi.org/10.1063/1.2815083

Saputra, M. E., Istiqomah, N. I., Nikhmah, L. A., Rumiyanti, L., Tumbelaka, R. M., Larasati, D. A., Darmawan, M. Y., Asri, N. S., Angel, J., Andriyanti, W., Aliah, H., & Suharyadi, E. (2025). Microstructures, optical, magnetic properties, and specific absorption rate of novel magnetite/mesoporous silica nanoparticles synthesized using green route for magnetic hyperthermia application. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, *704*(October 2024), 135483. https://doi.org/10.1016/j.colsurfa.2024.135483

Sembiring, T., & Perangin-angin, E. S. (2023). Fabrication and characterization of cadmium sulfide nanoparticles using chemical precipitation method. *Journal of Technomaterial Physics*, *05*(1), 1–7. https://doi.org/10.1063/5.0161450

Shao, G. N., Elineema, G., Quang, D. V., Kim, Y. N., Shim, Y. H., Hilonga, A., Kim, J. K., & Kim, H. T. (2012). Two step synthesis of a mesoporous titania-silica composite from titanium oxychloride and sodium silicate. *Powder Technology*, *217*, 489–496. https://doi.org/10.1016/j.powtec.2011.11.008

Shen, H. M., Hu, L., & Fu, X. (2018). Integrated giant magnetoresistance technology for approachable weak biomagnetic signal detections. *Sensors (Switzerland)*, *18*(1), 1–20. https://doi.org/10.3390/s18010148

Srivastava, N., Srivastava, M., Alhazmi, A., Mohammad, A., Khan, S., Pal, D. B., Haque, S., Singh, R., Mishra, P. K., & Gupta, V. K. (2021). Sustainable green approach to synthesize Fe_3O_4/α-Fe_2O_3 nanocomposite using waste pulp of Syzygium cumini and its application in functional stability of microbial cellulases. *Scientific Reports*, *11*(1), 1–12. https://doi.org/10.1038/s41598-021-03776-w

Stiles, M. D. (2005). Interlayer exchange coupling. *Ultrathin Magnetic Structures III: Fundamentals of Nanomagnetism*, *200*(March), 99–142. https://doi.org/10.1007/3-540-27163-5_4

Su, D., Wu, K., Saha, R., Peng, C., & Wang, J. P. (2020). Advances in magnetoresistive biosensors. *Micromachines*, *11*(1). https://doi.org/10.3390/mi11010034

Sumardiyasa, M., & Manuaba, I. B. S. (2018). Penentuan Ukuran Kristal Menggunakan Formula Scherer. *Hull Plot*, 28–35.

Susanto, S., & Prasdiantika, R. (2019). Pengaruh Rute Sintesis Terhadap Keefektifan Pengikatan Gugus Pdeta Pada Sintesis Fe_3O_4@SiO_2@PDETA. *Jurnal Teknosains*, *8*(1), 39. https://doi.org/10.22146/teknosains.36264

UNIVERSITAS GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
Muhammad Rizki, Prof. Dr. Eng. Edi Suharyadi, M.Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Susilawati, Lubis, H., Sembiring, T., Yanti, J., Sabar, S., Pardede, S. N., Napitupulu, A. F., & Hasanah, M. (2024). Fe_3O_4/SiO_2 composite derived from rice husk ash to enhance methylene blue removal efficiency in wastewater treatment. *Case Studies in Chemical and Environmental Engineering*, *9*(April), 100762. https://doi.org/10.1016/j.cscee.2024.100762

Swastika, P. E., Ardiyanti, H., Zurnansyah, Darmawan, M. Y., Mahardika, L. J., Istiqomah, N. I., Wibowo, N. A., & Suharyadi, E. (2025). Enhanced detection of bovine serum albumin using single- and double-chip configuration of tunneling magnetoresistance–based biosensor with green-synthesized magnetite/Ag nanotag. *Microchimica Acta*, *192*(3). https://doi.org/10.1007/s00604-025-07005-3

Swastika, P. E., Ardiyanti, H., Zurnansyah, Puspitarum, D. L., Istiqomah, N. I., Wibowo, N. A., & Suharyadi, E. (2024). Commercial chip-based tunneling magnetoresistance sensor for green-synthesized magnetic nanoparticles assay. *Sensors International*, *5*(March), 100288. https://doi.org/10.1016/j.sintl.2024.100288

Taib, S., & Suharyadi, E. (2015). Sintesis Nanopartikel Magnetite (Fe_3O_4) dengan Template silika (SiO_2) dan Karakterisasi Sifat Kemagnetannya. *Indonesian Journal of Applied Physics*, *5*(01), 23. https://doi.org/10.13057/ijap.v5i01.256

Tan, X., Huang, D., Zhao, M., Liu, W., Cheng, Q., Ren, Y., Yi, M., Ding, Q., Song, Y., Xie, M., Yun, C., Liang, Z., & Li, H. (2024). GMR detection of magnetic beads with different sizes. *Journal of Magnetism and Magnetic Materials*, *597*(March), 171992. https://doi.org/10.1016/j.jmmm.2024.171992

Trouillas, P., Marsal, P., Siri, D., Lazzaroni, R., & Duroux, J. L. (2006). A DFT study of the reactivity of OH groups in quercetin and taxifolin antioxidants: The specificity of the 3-OH site. *Food Chemistry*, *97*(4), 679–688. https://doi.org/10.1016/j.foodchem.2005.05.042

Trung, T. B., Hung, V. P., Hoang, H. T., Tung, L. M., & Lee, J. (2015). Detection of liver cancer cells by using ELISA and coupling of anti-glypican 3 antibody and magnetite nanoparticles. *Geosystem Engineering*, *18*(4), 219–225. https://doi.org/10.1080/12269328.2015.1070698

Tsukakoshi, Y. (2017). What's the Difference Between TMR and GMR Sensors. *ElectronicDesign*, *66*, 1–3. https://www.electronicdesign.com/industrial-automation/what-s-difference-between-tmr-and-gmr-sensors

Tsymbal, E. Y., & David G. Pettifor. (2001). *DigitalCommons @ University of Nebraska - Lincoln Perspectives of Giant Magnetoresistance*.

Tsymbal, E. Y., Mryasov, O. N., & LeClair, P. R. (2003). Spin-dependent tunnelling in magnetic tunnel junctions. *Journal of Physics Condensed Matter*, *15*(4). https://doi.org/10.1088/0953-8984/15/4/201

Tumbelaka, R. M., Istiqomah, N. I., Kato, T., Oshima, D., & Suharyadi, E. (2022).

UNIVERSITAS GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
Muhammad Rizki, Prof. Dr. Eng. Edi Suharyadi, M.Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

High reusability of green-synthesized Fe_3O_4/TiO_2 photocatalyst nanoparticles for efficient degradation of methylene blue dye. *Materials Today Communications*, *33*(September), 104450. https://doi.org/10.1016/j.mtcomm.2022.104450

Upadhyay, K., Tamrakar, R. K., Thomas, S., & Kumar, M. (2023). Surface functionalized nanoparticles: A boon to biomedical science. *Chemico-Biological Interactions*, *380*(May), 110537. https://doi.org/10.1016/j.cbi.2023.110537

Venkateswara Rao, A., & Bhagat, S. D. (2004). Synthesis and physical properties of TEOS-based silica aerogels prepared by two step (acid-base) sol-gel process. *Solid State Sciences*, *6*(9), 945–952. https://doi.org/10.1016/j.solidstatesciences.2004.04.010

Wahajuddin, & Arora, S. (2012). Superparamagnetic iron oxide nanoparticles: Magnetic nanoplatforms as drug carriers. *International Journal of Nanomedicine*, *7*, 3445–3471. https://doi.org/10.2147/IJN.S30320

Wang, W., Zheng, L., Lu, F., Hong, R., Chen, M. Z. Q., & Zhuang, L. (2017). Facile synthesis and characterization of magnetochromatic Fe_3O_4 nanoparticles. *AIP Advances*, *7*(5). https://doi.org/10.1063/1.4977016

Weitensfelder, H., Brueckl, H., Satz, A., Pruegl, K., Zimmer, J., Luber, S., Raberg, W., Abert, C., Bruckner, F., Bachleitner-Hofmann, A., Windl, R., & Suess, D. (2018). Comparison of Sensitivity and Low-Frequency Noise Contributions in Giant-Magnetoresistive and Tunneling-Magnetoresistive Spin-Valve Sensors with a Vortex-State Free Layer. *Physical Review Applied*, *10*(5), 1. https://doi.org/10.1103/PhysRevApplied.10.054056

Wibowo, N. A., Juharni, J., Alfansuri, T., Handriani, L. S., Sabarman, H., & Suharyadi, E. (2020). Core-shell Fe_3O_4@Ag magnetic nanoparticles detection using spin-valve GMR sensing element in the wheatstone bridge circuit. *Materials Research Express*, *7*(12). https://doi.org/10.1088/2053-1591/abce87

Wibowo, N. A., Juharni, J., Sabarman, H., & Suharyadi, E. (2021). A Spin-Valve GMR Based Sensor with Magnetite@silver Core-Shell Nanoparticles as a Tag for Bovine Serum Albumin Detection. *ECS Journal of Solid State Science and Technology*, *10*(10), 107002. https://doi.org/10.1149/2162-8777/ac2d4e

Wibowo, N. A., Sabarman, H., & Suharyadi, E. (2022). A New Platform of Iron Oxide-Based Nanoparticles Assay Using GMR Chip-Based Sensor With Microcontroller. *IEEE Sensors Journal*, *22*(21), 20093–20101. https://doi.org/10.1109/JSEN.2022.3207213

Wu, K., Su, D., Liu, J., Saha, R., & Wang, J. P. (2019). Magnetic nanoparticles in nanomedicine: A review of recent advances. *Nanotechnology*, *30*(50). https://doi.org/10.1088/1361-6528/ab4241

UNIVERSITAS
GADJAH MADA
Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada Magnetoresistance Sensors
Muhammad Rizki, Prof. Dr. Eng. Edi Suharyadi, M.Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Wu, K., Tonini, D., Liang, S., Saha, R., Chugh, V. K., & Wang, J. P. (2022). Giant Magnetoresistance Biosensors in Biomedical Applications. *ACS Applied Materials and Interfaces*, *14*(8), 9945–9969. https://doi.org/10.1021/acsami.1c20141

Wu, W., He, Q., & Jiang, C. (2008). Magnetic iron oxide nanoparticles: Synthesis and surface functionalization strategies. *Nanoscale Research Letters*, *3*(11), 397–415. https://doi.org/10.1007/s11671-008-9174-9

Wyatt, O. H., & Dew-Hughes, D. (1974). *Metal, Ceramic and Polymers: An Introduction to the Structure and Properties of Engineering Materials*. 640. https://books.google.co.in/books?id=FGtuQwAACAAJ

Xu, J., Li, Q., Gao, X. Y., Leng, F. F., Lu, M., Guo, P. Z., Zhao, G. X., & Li, S. D. (2016). Detection of the Concentration of $MnFe_2O_4$ Magnetic Microparticles Using Giant Magnetoresistance Sensors. *IEEE Transactions on Magnetics*, *52*(4), 4–7. https://doi.org/10.1109/TMAG.2015.2497249

Yew, Y. P., Shameli, K., Miyake, M., Ahmad Khairudin, N. B. B., Mohamad, S. E. B., Naiki, T., & Lee, K. X. (2020). Green biosynthesis of superparamagnetic magnetite Fe_3O_4 nanoparticles and biomedical applications in targeted anticancer drug delivery system: A review. *Arabian Journal of Chemistry*, *13*(1), 2287–2308. https://doi.org/10.1016/j.arabjc.2018.04.013

Yi, Z., Dumée, L. F., Garvey, C. J., Feng, C., She, F., Rookes, J. E., Mudie, S., Cahill, D. M., & Kong, L. (2015). A New Insight into Growth Mechanism and Kinetics of Mesoporous Silica Nanoparticles by in Situ Small Angle X-ray Scattering. *Langmuir*, *31*(30), 8478–8487. https://doi.org/10.1021/acs.langmuir.5b01637

Ying, S., Guan, Z., Ofoegbu, P. C., Clubb, P., Rico, C., He, F., & Hong, J. (2022). Green synthesis of nanoparticles: Current developments and limitations. *Environmental Technology and Innovation*, *26*, 102336. https://doi.org/10.1016/j.eti.2022.102336

Yulianti, Z. W., & Munasir. (2020). *Nanopartikel Fe_3O_4/SiO_2 Berbasis Bahan Alam Sebagai Material Pengadsorbsi Pewarna Dalam Air*. *10*(8), 4–7.

Yusefi, M., Shameli, K., Yee, O. S., Teow, S. Y., Hedayatnasab, Z., Jahangirian, H., Webster, T. J., & Kuča, K. (2021). Green synthesis of Fe_3O_4 nanoparticles stabilized by a garcinia mangostana fruit peel extract for hyperthermia and anticancer activities. *International Journal of Nanomedicine*, *16*, 2515–2532. https://doi.org/10.2147/IJN.S284134

Zettli, N. (2009). Quantum mechanics: Theory, analysis, and applications. In *Quantum Mechanics: Theory, Analysis, and Applications* (2nd ed.). Willey.

Zhang, S., Zhang, Y., Liu, J., Xu, Q., Xiao, H., Wang, X., Xu, H., & Zhou, J. (2013). Thiol modified Fe_3O_4@SiO_2 as a robust, high effective, and recycling magnetic sorbent for mercury removal. *Chemical Engineering Journal*, *226*,

UNIVERSITAS
GADJAH MADA
**Green Synthesis Nanokomposit Fe3O4/SiO2, Karakterisasi dan Aplikasinya Sebagai Label Magnetik Pada
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Muhammad Rizki, Prof. Dr. Eng. Edi Suharyadi, M.Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

30–38. https://doi.org/10.1016/j.cej.2013.04.060

Zhang, Y., Xu, J., Cao, D., Li, Q., Zhao, G., Sun, N. X., & Li, S. (2018). The influence of bias magnetization of nanoparticles on GMR sensor signal and sensitivity for the ultra-low concentration detection. *Journal of Magnetism and Magnetic Materials*, *453*, 132–136. https://doi.org/10.1016/j.jmmm.2018.01.010

Zhu, J. G. (Jimmy), & Park, C. (2006). Magnetic tunnel junctions. *Materials Today*, *9*(11), 36–45. https://doi.org/10.1016/S1369-7021(06)71693-5

Zhu, N., Ji, H., Yu, P., Niu, J., Farooq, M. U., Akram, M. W., Udego, I. O., Li, H., & Niu, X. (2018). Surface modification of magnetic iron oxide nanoparticles. *Nanomaterials*, *8*(10), 1–27. https://doi.org/10.3390/nano8100810

Zsurzsa, S., El-Tahawy, M., Péter, L., Kiss, L. F., Gubicza, J., Molnár, G., & Bakonyi, I. (2022). Spacer Layer Thickness Dependence of the Giant Magnetoresistance in Electrodeposited Ni-Co/Cu Multilayers. *Nanomaterials*, *12*(23). https://doi.org/10.3390/nano12234276

Zurnansyah, Jayanti, P. D., Mahardhika, L. J., Kusumah, H. P., Ardiyanti, H., Wibowo, N. A., Istiqomah, N. I., Asri, N. S., Angel, J., & Suharyadi, E. (2024). Real-time biomolecule detection using GMR chip-based sensor with green-synthesized Fe_3O_4/rGO nanocomposites as magnetic labels. *Sensors and Actuators A: Physical*, *375*(January), 115493. https://doi.org/10.1016/j.sna.2024.115493