

## Daftar Pustaka

- Aba, L., Yusuf, Y., Mitrayana, Siswanta, D., Junaidi, Triyana, K., 2014. Sensitivity improvement of ammonia gas sensor based on poly (3, 4-ethylenedioxythiophene): poly (strenesulfonate) by employing doping of bromocresol green. *J. Nanotechnol.* 2014, 1–5.
- Alassi, A., Benammar, M., Brett, D., 2017. Quartz Crystal Microbalance Electronic Interfacing Systems: A Review. *Sensors* 17, 2799.
- Aria, M.M., Irajizad, A., Astarai, F.R., Shariatpanahi, S.P., Sarvari, R., 2016. Etanol sensing properties of PVP electrospun membranes studied by quartz crystal microbalance. *Meas. J. Int. Meas. Confed.* 78, 283–288.
- Auld, B., 1973. *Acoustic Fields dan Waves in Solids*, 1st ed. John Wiley & Sons, Toronto.
- Ayad, M.M., El-Hefnawey, G., Torad, N.L., 2009. A sensor of alcohol vapours based on thin polyaniline base film dan quartz crystal microbalance. *J. Hazard. Mater.* 168, 85–88.
- Ayad, M.M., Salahuddin, N.A., Minisy, I.M., Amer, W.A., 2014. Chitosan/polyaniline nanofibers coating on the quartz crystal microbalance electrode for gas sensing. *Sensors Actuators, B Chem.* 202, 144–153.
- Bai, H., Shi, G., 2007. Gas Sensors Based on Conducting Polymers. *Sensors* 7, 267–307.
- Bai, X.-Y., Ji, W.-J., Li, S.-N., Jiang, Y.-C., Hu, M.-C., Zhai, Q.-G., 2017. Nonlinear Optical Rod Indium-Imidazolecarboxylate Framework as Room-Temperature Gas Sensor for Butanol Isomers. *Cryst. Growth Des.* 17, 423–427.
- Baumgarten, P.K., 1971. Electrostatic spinning of acrylic microfibers. *Journal of colloid and interface science*, 36(1), 71-79.
- Cady, W.G., 1921. New methods for maintaining constant frequency in high-frequency circuits. *Physical Review*, 18, 142-143.
- Cheng, Y.-W., Wang, C., 2016. Solvent-induced crystallization of electrospun syndiotactic polystyrene nanofibers dan its reversible desorption/sorption of volatile organic vapors. *J. Polym. Res.* 23, 234.
- Cipriani, E., Zanetti, M., Bracco, P., Brunella, V., Luda, M.P., Costa, L., 2016. Crosslinking dan carbonization processes in PAN films dan nanofibers. *Polym. Degrad. Stab.* 123, 178–188.
- Comini, E., Faglia, G., Sberveglieri, G., 2009. *Solid State Gas Sensing*. Springer, New York.

- Ding, B., Kim, J., Miyazaki, Y., Shiratori, S., 2004. Electrospun nanofibrous membranes coated quartz crystal microbalance as gas sensor for NH<sub>3</sub> detection. *Sensors Actuators, B Chem.* 101, 373–380.
- Ding, B., Wang, M., Wang, X., Yu, J., Sun, G., 2010. Electrospun nanomaterials for ultrasensitive sensors. *Mater. Today* 13, 16–27.
- Ding, B., Wang, X., Yu, J., Wang, M., 2011. Polyamide 6 composite nano-fiber/net functionalized by polyethyleneimine on quartz crystal microbalance for highly sensitive formaldehida sensors. *J. Mater. Chem.* 21, 12784.
- Ding, X., Chen, Xiangdong, Chen, Xinpeng, Zhao, X., Li, N., 2018. A QCM humidity sensor based on fullerene/graphene oxide nanocomposites with high quality factor. *Sensors Actuators B Chem.* 266, 534–542.
- Evyapan, M., Kadem, B., Basova, T. V., Yushina, I. V., Hassan, A.K., 2016. Study of the sensor response of spun metal phthalocyanine films to volatile organic vapors using surface plasmon resonance. *Sensors Actuators B Chem.* 236, 605–613.
- Gardner, J.W., Bartlett, P.N., 1993. Design of conducting polymer gas sensors: Modelling dan experiment. *Synth. Met.* 57, 3665–3670.
- Gupta, V.K., Yola, M.L., Eren, T., Atar, N., 2015. Selective QCM sensor based on atrazine imprinted polymer: Its application to wastewater sample. *Sensors Actuators, B Chem.* 218, 215–221.
- Hackner, A., Legner, W., Müller, G., Biavardi, E., Dalcanale, E., Zampolli, S., Elmi, I., Cardinali, G.C., 2013. Surface ionization detection of amine containing drugs. *Sensors Actuators, B Chem.* 185, 771–776.
- Hansen, C.M., 2007. *Hansen solubility parameters: a user's handbook*. CRC Press Taylor and Francis Group: Boca Raton, FL, USA.
- He, K., Wang, X., Meng, X., Zheng, H., Suye, S.I., 2014. Amperometric determination of hydroquinone dan catechol on gold electrode modified by direct electrodeposition of poly(3,4-ethylenedioxythiophene). *Sensors Actuators, B Chem.* 193, 212–219.
- Honeychurch, K., 2016. Review: The Application of Liquid Chromatography Electrochemical Detection for the Determination of Drugs of Abuse. *Separations* 3, 28.
- Hu, Y., Yu, H., Yan, Z., Ke, Q., 2018. The surface chemical composition effect of a polyacrylic acid/polyvinyl alcohol nanofiber/quartz crystal microbalance sensor on ammonia sensing behavior. *RSC Adv.* 8, 8747–8754.
- Huang, L., Manickam, S.S., McCutcheon, J.R., 2013. Increasing strength of electrospun nanofiber membranes for water filtration using solvent vapor. *J.*

*Memb. Sci.* 436, 213–220.

Huang, T.-M. in, Pang, F., Hsieh, I.F., Cakmak, M., 2016. Control of radial structural gradient in PAN/silver nanofibers using solvent vapor treatment. *Synth. Met.* 221, 309–318.

Huang, W., Wang, Xueqin, Jia, Y., Li, X., Zhu, Z., Li, Y., Si, Y., Ding, B., Wang, Xueli, Yu, J., 2013. Highly sensitive formaldehida sensors based on polyvinylamine modified polyacrylonitrile nanofibers. *RSC Adv.* 3, 22994.

Janata, J., 2009. *Principles of Chemical Sensors*, Principles of Chemical Sensors. Springer US, Boston, MA.

Jia, Y., Chen, L., Yu, H., Zhang, Y., Dong, F., 2015. Graphene oxide/polystyrene composite nanofibers on quartz crystal microbalance electrode for the ammonia detection. *RSC Adv.* 5, 40620–40627.

Jia, Y., Yan, C., Yu, H., Chen, L., Dong, F., 2014. One-step fabrication of ammonia sensor by electrospinning PS-b-PMA nanofibers on quartz crystal microbalance. *Sensors Actuators B Chem.* 203, 459–464.

Jia, Y., Yu, H., Cai, J., Li, Z., Dong, F., 2017. Explore on the quantitative analysis of specific surface area on sensitivity of polyacrylic acid-based QCM ammonia sensor. *Sensors Actuators B Chem.* 243, 1042–1045.

Jia, Y., Yu, H., Zhang, Y., Dong, F., Li, Z., 2016. Cellulose acetate nanofibers coated layer-by-layer with polyethylenimine dan graphene oxide on a quartz crystal microbalance for use as a highly sensitive ammonia sensor. *Colloids Surfaces B Biointerfaces* 148, 263–269.

Kakida, H., Tashiro, K., 1997. Mechanism dan Kinetics of Stabilization Reaction of Polyacrylonitrile dan Related Copolymers II. Relationships between Isothermal DSC Thermograms dan FT-IR Spectral Changes of Polyacrylonitrile in Comparison with the Case of Acrylonitrile/Methacrylic Acid. *Polym. J.* 29, 353–357.

Kim, S.S., Lee, J., 2014. Antibacterial activity of polyacrylonitrile-chitosan electrospun nanofibers. *Carbohydr. Polym.* 102, 231–237.

Li, J., Su, S., Zhou, L., Kundrát, V., Abbot, A.M., Mushtaq, F., Ouyang, D., James, D., Roberts, D., Ye, H., 2013. Carbon nanowalls grown by microwave plasma enhanced chemical vapor deposition during the carbonization of polyacrylonitrile fibers. *J. Appl. Phys.* 113, 0–6.

Lippmann, G., 1881. Principe de la conservation de l'électricité, ou second principe de la théorie des phénomènes électriques. *Journal de Physique Théorique et Appliquée*, 10(1), 381-394.

Liu, C., Li, X., Liu, T., Liu, Z., Li, N., Zhang, Y., Xiao, C., Feng, X., 2016.

- Microporous CA/PVDF membranes based on electrospun nanofibers with controlled crosslinking induced by solvent vapor. *J. Memb. Sci.* 512, 1–12.
- Long, G.L., Winefordner, J.D., 1983. Limit of detection. A closer look at the IUPAC definition. *Anal. Chem.* 55, 712A-724A.
- Lu, H.L., Lu, C.J., Tian, W.C., Sheen, H.J., 2015. A vapor response mechanism study of surface-modified single-walled carbon nanotubes coated chemiresistors dan quartz crystal microbalance sensor arrays. *Talanta* 131, 467–474.
- Lyashkov, A.Y., Tonkoshkur, A.S., 2013. Gas sensitivity of ZnO-based ceramics to vapors of saturated monohydric alcohols. *Mater. Chem. Phys.* 140, 31–36.
- Morris, A.S., 2001. *Measurement dan Instrumentation Principles*, 3rd ed. Butterworth-Heinemann, Oxford.
- National Center for Biotechnology Information. PubChem Database. Safrole, CID=5144, <https://pubchem.ncbi.nlm.nih.gov/compound/Safrole> (di akses pada 11 Agustus 2019)
- Nugroho, D.B., 2018. Pengembangan Sensor Safrol Berbasis Quartz Crystal Microbalance dilapisi dengan Polyvinyl Acetate, *Tesis*, FMIPA UGM, Yogyakarta.
- Pinalli, R., Barboza, T., Bianchi, F., Massera, C., Ugozzoli, F., Dalcanale, E., 2013. Detection of amphetamine precursors with quinoxaline-bridged cavitanads. *Supramol. Chem.* 25, 682–687.
- Portaccio, M., Menale, C., Diano, N., Serri, C., Mita, D.G., Lepore, M., 2015. Monitoring production process of cisplatin-loaded PLGA nanoparticles by FT-IR microspectroscopy dan univariate data analysis. *J. Appl. Polym. Sci.* 132, 1–9.
- Ramakrishna, S., Fujihara, K., Teo, W.-E. & Lim, T.-C., 2005. *An Introduction to Electrospinning and Nanofibers*. Singapore: World Scientific Publisher.
- Rianjanu, A., Kusumaatmaja, A., Suyono, E.A., Triyana, K., 2018a. Solvent vapor treatment improves mechanical strength of electrospun polyvinyl alcohol nanofibers. *Heliyon* 4, e00592.
- Rianjanu, A., Roto, R., Julian, T., Hidayat, S., Kusumaatmaja, A., Suyono, E., Triyana, K., 2018b. Polyacrylonitrile Nanofiber-Based Quartz Crystal Microbalance for Sensitive Detection of Safrol. *Sensors* 18, 1150.
- Rianjanu, A., Triyana, K., Nurbaiti, N., Hasanah, S.A., Kusumaatmaja, A., Roto, R., 2019a. An enhanced safrole sensing performance of a polyacrylonitrile nanofiber-based-QCM sensor by overlaying with chitosan. *Sains Malaysiana* accepted manuscript.
- Rianjanu, A., Nugroho, D.B., Kusumaatmaja, A., Roto, R., Triyana, K., 2019b. A

study of quartz crystal microbalance modified with polyvinyl acetate nanofiber to differentiate short-chain alcohol isomers. *Sens. Bio-Sensing Res.* 25, 100294.

- Rianjanu, A., Hasanah, S.A., Nugroho, D.B., Kusumaatmaja, A., Roto, R., Triyana, K., 2019c. Polyvinyl Acetate Film-Based Quartz Crystal Microbalance for the Detection of Benzene, Toluene, and Xylene Vapors in Air. *Chemosensors* 7, 20.
- Riowirawan, 2017, Pengembangan Sensor Uap Amoniak dengan Quartz Crystal Microbalances (QCM) Berlapis Chitosan, Tesis, FMIPA UGM, Yogyakarta.
- Roto, R., 2005, Electron and Ion Transport in Redox Active Transition Metals Layered Double Hydroxides, *Disertasi*, The University of New Brunswick, Canada.
- Sauerbrey, G., 1959. Verwendung von Schwingquarzen zur Wägung dünner Schichten und zur Mikrowägung. *Zeitschrift für Phys.* 155, 206–222.
- Seekaew, Y., Lokavee, S., Phokharatkul, D., Wisitsoraat, A., Kerdcharoen, T., Wongchoosuk, C., 2014. Low-cost dan flexible printed graphene-PEDOT:PSS gas sensor for ammonia detection. *Org. Electron. physics, Mater. Appl.* 15, 2971–2981.
- Segal, E., Tchoudakov, R., Narkis, M., Siegmann, A., Wei, Y., 2005. Polystyrene/polyaniline nanoblends for sensing of aliphatic alcohols. *Sensors Actuators, B Chem.* 104, 140–150.
- Sun, Y.F., Liu, S.B., Meng, F.L., Liu, J.Y., Jin, Z., Kong, L.T., Liu, J.H., 2012. Metal Oxide Nanostructures dan Their Gas Sensing Properties: A Review. *Sensors* 12, 2610–2631.
- Taylor, G.I., 1964. Disintegration of water drops in an electric field. Proceedings of the Royal Society of London. Series A. *Mathematical and Physical Sciences*, 280(1382), 383-397.
- Triyana, K., Sembiring, A., Rianjanu, A., Hidayat, S., Riowirawan, R., Julian, T., Kusumaatmaja, A., Santoso, I., Roto, R., 2018. Chitosan-Based Quartz Crystal Microbalance for Alcohol Sensing. *Electronics* 7, 181.
- Triyana, K., Rianjanu, A., Nugroho, D.B., As'ari, A.H., Kusumaatmaja, A., Roto, R., Suryana, R., Wasisto, H.S., 2019. A highly sensitive safrole sensor based on QCM-coated polyvinyl acetate (PVAc) nanofiber. *Sci. Rep.*
- United Nations Office on Drugs dan Crime, 2017. *Market Analysis of Synthetic Drugs. Amphetamine-type stimulants, new psychoactive substances.* Vienna.
- Vercelli, B., Zecchin, S., Comisso, N., Zotti, G., Berlin, A., Dalcanale, E., Groenendaal, L., 2002. Solvoconductivity of polyconjugated polymers: The roles of polymer oxidation degree dan solvent electrical permittivity. *Chem. Mater.* 14, 4768–4774.

- Virji, S., Kaner, R.B., Weiller, B.H., 2006. Hydrogen sensors based on conductivity changes in polyaniline nanofibers. *J. Phys. Chem. B* 110, 22266–22270.
- Wang, H., Liu, X., Xie, J., Duan, M., Tang, J., 2016. Effect of humidity on the CO gas sensing of ZnSn(OH)<sub>6</sub> film via quartz crystal microbalance technique. *J. Alloys Compd.* 657, 691–696.
- Wang, J., He, E., Liu, X., Yu, L., Wang, H., Zhang, R., Zhang, H., 2017. High performance hydrazine vapor sensor based on redox mechanism of twisted perylene diimide derivative with lower reduction potential. *Sensors Actuators B Chem.* 239, 898–905.
- Wang, N., Wang, X., Jia, Y., Li, X., Yu, J., Ding, B., 2014. Electrospun nanofibrous chitosan membranes modified with polyethyleneimine for formaldehida detection. *Carbohydr. Polym.* 108, 192–199.
- Wang, S.Y., Ma, J.Y., Li, Z.J., Su, H.Q., Alkurd, N.R., Zhou, W.L., Wang, L., Du, B., Tang, Y.L., Ao, D.Y., Zhang, S.C., Yu, Q.K., Zu, X.T., 2015. Surface acoustic wave ammonia sensor based on ZnO/SiO<sub>2</sub> composite film. *J. Hazard. Mater.* 285, 368–374.
- Wang, Y., Ding, P., Hu, R., Zhang, J., Ma, X., Luo, Z., Li, G., 2013. A dibutyl phthalate sensor based on a nanofiber polyaniline coated quartz crystal monitor. *Sensors (Basel)*. 13, 3765–3775.
- Xue, Y., Liu, J., Lian, F., Liang, J., 2013. Effect of the oxygen-induced modification of polyacrylonitrile fibers during thermal-oxidative stabilization on the radial microcrystalline structure of the resulting carbon fibers. *Polym. Degrad. Stab.* 98, 2259–2267.
- Yao, Y., Chen, X., Guo, H., Wu, Z., 2011. Graphene oxide thin film coated quartz crystal microbalance for humidity detection. *Appl. Surf. Sci.* 257, 7778–7782.
- Ying, Z., Jiang, Y., Du, X., Xie, G., Yu, J., Wang, H., 2007. PVDF coated quartz crystal microbalance sensor for DMMP vapor detection. *Sensors Actuators, B Chem.* 125, 167–172.
- Zhang, C., Wang, X., Lin, J., Ding, B., Yu, J., Pan, N., 2011. Nanoporous polystyrene fibers functionalized by polyethyleneimine for enhanced formaldehida sensing. *Sensors Actuators, B Chem.* 152, 316–323.
- Zhang, D., Wang, D., Li, P., Zhou, X., Zong, X., Dong, G., 2018. Facile fabrication of high-performance QCM humidity sensor based on layer-by-layer self-assembled polyaniline/graphene oxide nanocomposite film. *Sensors Actuators B Chem.* 255, 1869–1877.
- Zhang, H. Di, Yan, X., Zhang, Z.H., Yu, G.F., Han, W.P., Zhang, J.C., Long, Y.Z., 2016. Electrospun PEDOT:PSS/PVP Nanofibers for CO Gas Sensing with Quartz Crystal Microbalance Technique. *Int. J. Polym. Sci.* 2016, 1–6.



UNIVERSITAS  
GADJAH MADA

**Quartz Crystal Microbalance Termodifikasi Lapisan Nanofiber Polimer sebagai Sensor Senyawa Organik**

ADITYA RIANJANU, Dr. Kuwat Triyana, M.Si.; Dr. Ahmad Kusumaatmaja, M.Si.; Drs. Roto, M.Eng, Ph.D.

Universitas Gadjah Mada, 2019 | Diunduh dari <http://etd.repository.ugm.ac.id/>

Zhang, K., Fan, G., Hu, R., Li, G., 2015. Enhanced dibutyl phthalate sensing performance of a quartz crystal microbalance coated with Au-decorated ZnO porous microspheres. *Sensors (Switzerland)* 15, 21153–21168.