# *REFERENCES*

**References**

[1] Y. Xu, W. Lu, G. Xu, T.W. Chou, Structural supercapacitor composites: A review, Compos. Sci. Technol. 204 (2021) 108636. https://doi.org/10.1016/j.compscitech.2020.108636.

[2] J. Liu, G. Cao, Z. Yang, D. Wang, D. Dubois, X. Zhou, G.L. Graff, L.R. Pederson, J.-G. Zhang, Cover Picture: Oriented Nanostructures for Energy Conversion and Storage (ChemSusChem 8-9-9/2008), ChemSusChem. 1 (2008) 661–661. https://doi.org/10.1002/cssc.200890024.

[3] X. Chen, R. Paul, L. Dai, Carbon-based supercapacitors for efficient energy storage, Natl. Sci. Rev. 4 (2017) 453–489. https://doi.org/10.1093/nsr/nwx009.

[4] L. Liu, H. Zhao, Y. Lei, Review on Nanoarchitectured Current Collectors for Pseudocapacitors, Small Methods. 3 (2019) 1800341. https://doi.org/10.1002/smtd.201800341.

[5] Q. Lu, J.G. Chen, J.Q. Xiao, Nanostructured electrodes for high-performance pseudocapacitors, Angew. Chemie - Int. Ed. 52 (2013) 1882–1889. https://doi.org/10.1002/anie.201203201.

[6] A. Afif, S.M. Rahman, A. Tasfiah Azad, J. Zaini, M.A. Islan, A.K. Azad, Advanced materials and technologies for hybrid supercapacitors for energy storage – A review, J. Energy Storage. 25 (2019) 100852. https://doi.org/10.1016/j.est.2019.100852.

[7] Poonam, K. Sharma, A. Arora, S.K. Tripathi, Review of supercapacitors: Materials and devices, J. Energy Storage. 21 (2019) 801–825.

https://doi.org/10.1016/j.est.2019.01.010.

[8] A. Eftekhari, The mechanism of ultrafast supercapacitors, J. Mater. Chem. A. 6 (2018) 2866–2876. https://doi.org/10.1039/C7TA10013B.

[9] P. Kurzweil, J. Schottenbauer, C. Schell, Past, Present and Future of Electrochemical Capacitors: Pseudocapacitance, Aging Mechanisms and Service Life Estimation, J. Energy Storage. (2021) 102311. https://doi.org/10.1016/j.est.2021.102311.

[10] H.J. Choi, S.M. Jung, J.M. Seo, D.W. Chang, L. Dai, J.B. Baek, Graphene for energy conversion and storage in fuel cells and supercapacitors, Nano Energy. 1 (2012) 534–551. https://doi.org/10.1016/j.nanoen.2012.05.001.

[11] G. Wang, Q. Tang, H. Bao, X. Li, G. Wang, Synthesis of hierarchical sulfonated graphene/MnO2/polyaniline ternary composite and its improved electrochemical performance, J. Power Sources. 241 (2013) 231–238. https://doi.org/10.1016/j.jpowsour.2013.04.122.

[12] J. Balamurugan, T.T. Nguyen, V. Aravindan, N.H. Kim, S.H. Lee, J.H. Lee, All ternary metal selenide nanostructures for high energy flexible charge storage devices, Nano Energy. 65 (2019) 103999. https://doi.org/10.1016/j.nanoen.2019.103999.

[13] G.Z. Chen, Supercapacitor and supercapattery as emerging electrochemical energy stores, Int. Mater. Rev. 62 (2017) 173–202. https://doi.org/10.1080/09506608.2016.1240914.

[14] C. An, Y. Zhang, H. Guo, Y. Wang, Metal oxide-based supercapacitors: progress and prospectives, Nanoscale Adv. 1 (2019) 4644–4658. https://doi.org/10.1039/c9na00543a.

[15] M.F. Dupont, S.W. Donne, Charge storage mechanisms in electrochemical capacitors: Effects of electrode properties on performance, J. Power Sources. 326 (2016) 613–623. https://doi.org/10.1016/j.jpowsour.2016.03.073.

[16] Y. Wang, Y. Song, Y. Xia, Electrochemical capacitors: mechanism, materials, systems, characterization and applications, Chem. Soc. Rev. 45 (2016) 5925–5950. https://doi.org/10.1039/C5CS00580A.

[17] A. Berrueta, A. Ursua, I.S. Martin, A. Eftekhari, P. Sanchis, Supercapacitors: Electrical Characteristics, Modeling, Applications, and Future Trends, IEEE Access. 7 (2019) 50869–50896. https://doi.org/10.1109/ACCESS.2019.2908558.

[18] G.N. Gerasimov, V.F. Gromov, O.J. Ilegbusi, L.I. Trakhtenberg, The mechanisms of sensory phenomena in binary metal-oxide nanocomposites, Sensors Actuators B Chem. 240 (2017) 613–624. https://doi.org/10.1016/j.snb.2016.09.007.

[19] S. Ghosh, G.R. Rao, T. Thomas, Analysis of Charge Storage Behavior in Redox-electrolyte Based Battery-like-systems: A Case Study on Zr-doped Ceria, ChemistrySelect. 5 (2020) 1628–1639. https://doi.org/10.1002/slct.201904761.

[20] Y. Liu, B. Soucaze-Guillous, P.-L. Taberna, P. Simon, Understanding of carbon-based supercapacitors ageing mechanisms by electrochemical and analytical methods, J. Power Sources. 366 (2017) 123–130. https://doi.org/10.1016/j.jpowsour.2017.08.104.

[21] S. Kumar, G. Saeed, L. Zhu, K.N. Hui, N.H. Kim, J.H. Lee, 0D to 3D carbon-based networks combined with pseudocapacitive electrode material for high energy density supercapacitor: A review, Chem. Eng. J. 403 (2021) 126352. https://doi.org/10.1016/j.cej.2020.126352.

[22] A. Eftekhari, Surface Diffusion and Adsorption in Supercapacitors, ACS Sustain. Chem. Eng. 7 (2019) 3692–3701. https://doi.org/10.1021/acssuschemeng.8b01075.

[23] P.J. Mahon, G.L. Paul, S.M. Keshishian, A.M. Vassallo, Measurement and modelling of the high-power performance of carbon-based supercapacitors, J. Power Sources. 91 (2000) 68–76. https://doi.org/10.1016/S0378-7753(00)00488-2.

[24] G. Wang, L. Zhang, J. Zhang, A review of electrode materials for electrochemical supercapacitors, Chem. Soc. Rev. 41 (2012) 797–828. https://doi.org/10.1039/c1cs15060j.

[25] A. Muzaffar, M.B. Ahamed, K. Deshmukh, J. Thirumalai, A review on recent advances in hybrid supercapacitors: Design, fabrication and applications, Renew. Sustain. Energy Rev. 101 (2019) 123–145. https://doi.org/10.1016/j.rser.2018.10.026.

[26] J. Xing, M. Liao, C. Zhang, M. Yin, D. Li, Y. Song, The effect of anions on the electrochemical properties of polyaniline for supercapacitors, Phys. Chem. Chem. Phys. 19 (2017) 14030–14041. https://doi.org/10.1039/C7CP02016C.

[27] A. Ehsani, A.A. Heidari, H.M. Shiri, Electrochemical Pseudocapacitors Based on Ternary Nanocomposite of Conductive Polymer/Graphene/Metal Oxide: An Introduction and Review to it in Recent Studies, Chem. Rec. 19 (2019) 908–926.

https://doi.org/10.1002/tcr.201800112.

[28] H. Kumar, R. Sharma, A. Yadav, R. Kumari, Recent advancement made in the field of reduced graphene oxide-based nanocomposites used in the energy storage devices: A review, J. Energy Storage. 33 (2021) 102032. https://doi.org/10.1016/j.est.2020.102032.

[29] B.P. Prasanna, D.N. Avadhani, K. Chaitra, N. Nagaraju, N. Kathyayini, Synthesis of polyaniline/MWCNTs by interfacial polymerization for superior hybrid supercapacitance performance, J. Polym. Res. 25 (2018). https://doi.org/10.1007/s10965-018-1526-2.

[30] M.S. Javed, A.J. Khan, S. Asim, S.S.A. Shah, T. Najam, S.H. Siyalg, M.F. Tahir, Z. Zhao, W. Mai, Insights to pseudocapacitive charge storage of binary metal-oxide nanobelts decorated activated carbon cloth for highly-flexible hybrid-supercapacitors, J. Energy Storage. 31 (2020) 101602. https://doi.org/10.1016/j.est.2020.101602.

[31] J.M. Baptista, J.S. Sagu, U.W. KG, K. Lobato, State-of-the-art materials for high power and high energy supercapacitors: Performance metrics and obstacles for the transition from lab to industrial scale – A critical approach, Chem. Eng. J. 374 (2019) 1153–1179. https://doi.org/10.1016/j.cej.2019.05.207.

[32] J. Song, L. Du, J. Wang, H. Zhang, Y. Zhang, B. Li, Z. Zhang, T. Li, J. Luo, NiS nanosheets synthesized by one-step microwave for high-performance supercapacitor, Funct. Mater. Lett. 14 (2021). https://doi.org/10.1142/S1793604721500351.

[33] S. Satpathy, M. Dhar, B.K. Bhattacharyya, Why supercapacitor follows complex time-dependent power law (t∝) and does not obey normal exponential <math altimg="si1.svg"> <mrow> <mo>(</mo> <msup> <mi>e</mi> <mfrac> <mrow> <mo>−</mo> <mi>t</mi> </mrow> <mrow> <mo>(</mo> <mrow> <mi>R</mi> <mi>C</mi> <, J. Energy Storage. 31 (2020) 101606. https://doi.org/10.1016/j.est.2020.101606.

[34] M.-H. Tran, H.K. Jeong, Ternary carbon composite films for supercapacitor applications, Chem. Phys. Lett. 684 (2017) 1–7. https://doi.org/10.1016/j.cplett.2017.06.025.

[35] H. Yang, S. Kannappan, A.S. Pandian, J.H. Jang, Y.S. Lee, W. Lu, Graphene supercapacitor with both high power and energy density, Nanotechnology. 28 (2017). https://doi.org/10.1088/1361-6528/aa8948.

[36] S.K. Tiwari, J. Mishra, G. Hatui, G.C. Nayak, Conductive Polymer Composites Based on Carbon Nanomaterials, in: 2017: pp. 117–142. https://doi.org/10.1007/978-3-319-46458-9_4.

[37] C. Lian, K. Liu, H. Liu, J. Wu, Impurity Effects on Charging Mechanism and Energy Storage of Nanoporous Supercapacitors, J. Phys. Chem. C. 121 (2017) 14066–14072. https://doi.org/10.1021/acs.jpcc.7b04869.

[38] N. Priyadharsini, P. Rupa Kasturi, A. Shanmugavani, S. Surendran, S. Shanmugapriya, R. Kalai Selvan, Effect of chelating agent on the sol-gel thermolysis synthesis of LiNiPO 4 and its electrochemical properties for hybrid capacitors, J. Phys. Chem. Solids. 119 (2018) 183–192.

https://doi.org/10.1016/j.jpcs.2018.03.004.

[39] C.V. V. Muralee Gopi, A.E. Reddy, H.-J. Kim, Wearable superhigh energy density supercapacitors using a hierarchical ternary metal selenide composite of CoNiSe 2 microspheres decorated with CoFe 2 Se 4 nanorods, J. Mater. Chem. A. 6 (2018) 7439–7448. https://doi.org/10.1039/C8TA01141A.

[40] K.V.G. Raghavendra, R. Vinoth, K. Zeb, C.V.V. Muralee Gopi, S. Sambasivam, M.R. Kummara, I.M. Obaidat, H.J. Kim, An intuitive review of supercapacitors with recent progress and novel device applications, J. Energy Storage. 31 (2020) 101652. https://doi.org/10.1016/j.est.2020.101652.

[41] I. Shown, A. Ganguly, L. Chen, K. Chen, Conducting polymer-based flexible supercapacitor, Energy Sci. Eng. 3 (2015) 2–26. https://doi.org/10.1002/ese3.50.

[42] S. Kumagai, K. Mukaiyachi, D. Tashima, Rate and cycle performances of supercapacitors with different electrode thickness using non-aqueous electrolyte, J. Energy Storage. 3 (2015) 10–17. https://doi.org/10.1016/j.est.2015.08.002.

[43] S. Roldán, D. Barreda, M. Granda, R. Menéndez, R. Santamaría, C. Blanco, An approach to classification and capacitance expressions in electrochemical capacitors technology, Phys. Chem. Chem. Phys. 17 (2015) 1084–1092. https://doi.org/10.1039/C4CP05124F.

[44] A. Kausar, Overview on conducting polymer in energy storage and energy conversion system, J. Macromol. Sci. Part A. 54 (2017) 640–653. https://doi.org/10.1080/10601325.2017.1317210.

[45] M. Salanne, B. Rotenberg, K. Naoi, K. Kaneko, P.-L. Taberna, C.P. Grey, B. Dunn, P. Simon, Efficient storage mechanisms for building better supercapacitors, Nat. Energy. 1 (2016) 16070. https://doi.org/10.1038/nenergy.2016.70.

[46] S. Liu, L. Wei, H. Wang, Review on reliability of supercapacitors in energy storage applications, Appl. Energy. 278 (2020) 115436. https://doi.org/10.1016/j.apenergy.2020.115436.

[47] M. Vangari, T. Pryor, L. Jiang, Supercapacitors: Review of Materials and Fabrication Methods, J. Energy Eng. 139 (2013) 72–79. https://doi.org/10.1061/(asce)ey.1943-7897.0000102.

[48] V. Singh, D. Joung, L. Zhai, S. Das, S.I. Khondaker, S. Seal, Graphene based materials: Past, present and future, Prog. Mater. Sci. 56 (2011) 1178–1271. https://doi.org/10.1016/j.pmatsci.2011.03.003.

[49] P. Blake, P.D. Brimicombe, R.R. Nair, T.J. Booth, D. Jiang, F. Schedin, L.A. Ponomarenko, S. V Morozov, H.F. Gleeson, E.W. Hill, A.K. Geim, K.S. Novoselov, Graphene-Based Liquid Crystal Device 2008, (2008).

[50] W. Du, X. Jiang, L. Zhu, From graphite to graphene: Direct liquid-phase exfoliation of graphite to produce single- and few-layered pristine graphene, J. Mater. Chem. A. 1 (2013) 10592–10606. https://doi.org/10.1039/c3ta12212c.

[51] X. Xu, C. Liu, Z. Sun, T. Cao, Z. Zhang, E. Wang, Z. Liu, K. Liu, Interfacial engineering in graphene bandgap, Chem. Soc. Rev. 47 (2018) 3059–3099. https://doi.org/10.1039/c7cs00836h.

[52] Y. Jiang, J. Liu, Definitions of Pseudocapacitive Materials: A Brief Review, Energy Environ. Mater. 2 (2019) 30–37. https://doi.org/10.1002/eem2.12028.

[53] G. Yang, L. Li, W.B. Lee, M.C. Ng, Structure of graphene and its disorders : a review, Sci. Technol. Adv. Mater. 19 (2018) 613–648. https://doi.org/10.1080/14686996.2018.1494493.

[54] M.K. Kavitha, M. Jaiswal., Asian Journal of Physics Graphene : A review of optical properties and photonic applications, Asian J. Phys. 25 (2016) 809–831.

[55] N.M.S. Hidayah, W. Liu, C. Lai, N.Z. Noriman, Comparison on Graphite , Graphene Oxide and Reduced Graphene Oxide : Synthesis and Characterization, 150002 (2017). https://doi.org/10.1063/1.5005764.

[56] A. V. Talyzin, G. Mercier, A. Klechikov, M. Hedenström, D. Johnels, D. Wei, D. Cotton, A. Opitz, E. Moons, Brodie vs Hummers graphite oxides for preparation of multi-layered materials, Carbon N. Y. 115 (2017) 430–440. https://doi.org/10.1016/j.carbon.2016.12.097.

[57] R. Dubey, V. Guruviah, Review of carbon-based electrode materials for supercapacitor energy storage, Ionics (Kiel). 25 (2019) 1419–1445. https://doi.org/10.1007/s11581-019-02874-0.

[58] M.F. El-Kady, M. Ihns, M. Li, J.Y. Hwang, M.F. Mousavi, L. Chaney, A.T. Lech, R.B. Kaner, Engineering three-dimensional hybrid supercapacitors and microsupercapacitors for high-performance integrated energy storage, Proc. Natl. Acad. Sci. U. S. A. 112 (2015) 4233–4238. https://doi.org/10.1073/pnas.1420398112.

[59] M. Iliut, A.M. Gabudean, C. Leordean, T. Simon, C.M. Teodorescu, S. Astilean, Riboflavin enhanced fluorescence of highly reduced graphene oxide, Chem. Phys. Lett. 586 (2013) 127–131. https://doi.org/10.1016/j.cplett.2013.09.032.

[60] F. Tavakoli, M. Salavati-niasari, F. Mohandes, Green synthesis and characterization of graphene nanosheets, Mater. Res. Bull. 63 (2015) 51–57. https://doi.org/10.1016/j.materresbull.2014.11.045.

[61] Y.U. Shang, D. Zhang, Y. Liu, C. Guo, Preliminary comparison of different reduction methods of graphene oxide, Bull. Mater. Sci. 38 (2015) 7–12. https://doi.org/10.1007/s12034-014-0794-7.

[62] Y. Saito, M. Ashizawa, H. Matsumoto, Mesoporous Hydrated Graphene Nanoribbon Electrodes for Efficient Supercapacitors: Effect of Nanoribbon Dispersion on Pore Structure, Bull. Chem. Soc. Jpn. 93 (2020) 1268–1274. https://doi.org/10.1246/BCSJ.20200161.

[63] C. Zhou, M. Hong, Y. Yang, C. Yang, N. Hu, L. Zhang, Z. Yang, Y. Zhang, Laser-induced bi-metal sulfide/graphene nanoribbon hybrid frameworks for high-performance all-in-one fiber supercapacitors, J. Power Sources. 438 (2019) 227044. https://doi.org/10.1016/j.jpowsour.2019.227044.

[64] S.K. Ujjain, P. Ahuja, R.K. Sharma, Graphene nanoribbon wrapped cobalt manganite nanocubes for high performance all-solid-state flexible supercapacitors, J. Mater. Chem. A. 3 (2015) 9925–9931. https://doi.org/10.1039/c5ta00653h.

[65] Y. Ping, Y. Zhang, Y. Gong, B. Cao, Q. Fu, C. Pan, Edge-riched graphene nanoribbon for high capacity electrode materials, Electrochim. Acta. 250 (2017) 84–

90. https://doi.org/10.1016/j.electacta.2017.08.051.

[66] Y. Li, M. Van Zijll, S. Chiang, N. Pan, KOH modified graphene nanosheets for supercapacitor electrodes, J. Power Sources. 196 (2011) 6003–6006. https://doi.org/10.1016/j.jpowsour.2011.02.092.

[67] V. Thirumal, A. Pandurangan, R. Jayavel, R. Ilangovan, Synthesis and characterization of boron doped graphene nanosheets for supercapacitor applications, Synth. Met. 220 (2016) 524–532. https://doi.org/10.1016/j.synthmet.2016.07.011.

[68] Z. Fan, Q. Zhao, T. Li, J. Yan, Y. Ren, J. Feng, T. Wei, Easy synthesis of porous graphene nanosheets and their use in supercapacitors, Carbon N. Y. 50 (2012) 1699–1703. https://doi.org/10.1016/j.carbon.2011.12.016.

[69] N. Chakrabarty, A. Dey, S. Krishnamurthy, A.K. Chakraborty, CeO2/Ce2O3 quantum dot decorated reduced graphene oxide nanohybrid as electrode for supercapacitor, Appl. Surf. Sci. 536 (2021) 147960. https://doi.org/10.1016/j.apsusc.2020.147960.

[70] W. Tang, L. Peng, C. Yuan, J. Wang, S. Mo, C. Zhao, Y. Yu, Y. Min, A.J. Epstein, Facile synthesis of 3D reduced graphene oxide and its polyaniline composite for super capacitor application, Synth. Met. 202 (2015) 140–146. https://doi.org/10.1016/j.synthmet.2015.01.031.

[71] X. Bai, X. Hu, S. Zhou, J. Yan, C. Sun, P. Chen, L. Li, In situ polymerization and characterization of grafted poly (3,4-ethylenedioxythiophene)/multiwalled carbon nanotubes composite with high electrochemical performances, Electrochim. Acta.

87 (2013) 394–400. https://doi.org/10.1016/j.electacta.2012.09.079.

[72] Z. Lei, N. Christov, X.S. Zhao, Intercalation of mesoporous carbon spheres between reduced graphene oxide sheets for preparing high-rate supercapacitor electrodes, Energy Environ. Sci. 4 (2011) 1866. https://doi.org/10.1039/c1ee01094h.

[73] W. Chen, Z. Fan, G. Zeng, Z. Lai, Layer-dependent supercapacitance of graphene films grown by chemical vapor deposition on nickel foam, J. Power Sources. 225 (2013) 251–256. https://doi.org/10.1016/j.jpowsour.2012.09.110.

[74] C. Wang, Y. Zhou, L. Sun, Q. Zhao, X. Zhang, P. Wan, J. Qiu, N/P-Codoped Thermally Reduced Graphene for High-Performance Supercapacitor Applications, J. Phys. Chem. C. 117 (2013) 14912–14919. https://doi.org/10.1021/jp4015959.

[75] G. Wang, H. Wang, X. Lu, Y. Ling, M. Yu, T. Zhai, Y. Tong, Y. Li, Solid-State Supercapacitor Based on Activated Carbon Cloths Exhibits Excellent Rate Capability, Adv. Mater. 26 (2014) 2676–2682. https://doi.org/10.1002/adma.201304756.

[76] O. Okhay, A. Tkach, P. Staiti, F. Lufrano, Long term durability of solid-state supercapacitor based on reduced graphene oxide aerogel and carbon nanotubes composite electrodes, Electrochim. Acta. 353 (2020) 136540. https://doi.org/10.1016/j.electacta.2020.136540.

[77] M. Boota, K.B. Hatzell, M. Alhabeb, E.C. Kumbur, Y. Gogotsi, Graphene-containing flowable electrodes for capacitive energy storage, Carbon N. Y. 92 (2015) 142–149. https://doi.org/10.1016/j.carbon.2015.04.020.

[78] J. Zhu, J. Zu, J. Liu, Y. Wang, M. Pei, Y. Xu, Self-assembled reduced graphene oxide films with different thicknesses as high performance supercapacitor electrodes, J. Energy Storage. 32 (2020) 101795. https://doi.org/10.1016/j.est.2020.101795.

[79] Y. Xu, Z. Lin, X. Huang, Y. Liu, Y. Huang, X. Duan, Flexible Solid-State Supercapacitors Based on Three-Dimensional Graphene Hydrogel Films, ACS Nano. 7 (2013) 4042–4049. https://doi.org/10.1021/nn4000836.

[80] P. Du, X. Hu, C. Yi, H.C. Liu, P. Liu, H.-L. Zhang, X. Gong, Self-Powered Electronics by Integration of Flexible Solid-State Graphene-Based Supercapacitors with High Performance Perovskite Hybrid Solar Cells, Adv. Funct. Mater. 25 (2015) 2420–2427. https://doi.org/10.1002/adfm.201500335.

[81] S. Chen, W. Ma, Y. Cheng, Z. Weng, B. Sun, L. Wang, W. Chen, F. Li, M. Zhu, H.-M. Cheng, Scalable non-liquid-crystal spinning of locally aligned graphene fibers for high-performance wearable supercapacitors, Nano Energy. 15 (2015) 642–653. https://doi.org/10.1016/j.nanoen.2015.05.004.

[82] Y. Huang, H. Li, Z. Wang, M. Zhu, Z. Pei, Q. Xue, Y. Huang, C. Zhi, Nanostructured Polypyrrole as a flexible electrode material of supercapacitor, Nano Energy. 22 (2016) 422–438. https://doi.org/10.1016/j.nanoen.2016.02.047.

[83] Poonam, K. Sharma, A. Arora, S.K. Tripathi, Review of supercapacitors: Materials and devices, J. Energy Storage. 21 (2019) 801–825. https://doi.org/10.1016/j.est.2019.01.010.

[84] C.B. Aquino, D.A. Nagaoka, M.M. Machado, E.G. Cândido, A.G.M. da Silva,

P.H.C. Camargo, S.H. Domingues, Chemical versus electrochemical: What is the best synthesis method to ternary GO/WO3NW/PAni nanocomposites to improve performance as supercapacitor?, Electrochim. Acta. 356 (2020) 136786. https://doi.org/10.1016/j.electacta.2020.136786.

[85] H.-B. Zhao, L. Yuan, Z.-B. Fu, C.-Y. Wang, X. Yang, J.-Y. Zhu, J. Qu, H.-B. Chen, D.A. Schiraldi, Biomass-Based Mechanically Strong and Electrically Conductive Polymer Aerogels and Their Application for Supercapacitors, ACS Appl. Mater. Interfaces. 8 (2016) 9917–9924. https://doi.org/10.1021/acsami.6b00510.

[86] C.O. Baker, X. Huang, W. Nelson, R.B. Kaner, Polyaniline nanofibers: broadening applications for conducting polymers, Chem. Soc. Rev. 46 (2017) 1510–1525. https://doi.org/10.1039/C6CS00555A.

[87] S.B. Yoon, E.H. Yoon, K.B. Kim, Electrochemical properties of leucoemeraldine, emeraldine, and pernigraniline forms of polyaniline/multi-wall carbon nanotube nanocomposites for supercapacitor applications, J. Power Sources. 196 (2011) 10791–10797. https://doi.org/10.1016/j.jpowsour.2011.08.107.

[88] M. Ates, A review on conducting polymer coatings for corrosion protection, J. Adhes. Sci. Technol. 30 (2016) 1510–1536. https://doi.org/10.1080/01694243.2016.1150662.

[89] Q. Meng, K. Cai, Y. Chen, L. Chen, Research progress on conducting polymer based supercapacitor electrode materials, Nano Energy. 36 (2017) 268–285. https://doi.org/10.1016/j.nanoen.2017.04.040.

[90] A. Mostafaei, A. Zolriasatein, Synthesis and characterization of conducting

polyaniline nanocomposites containing ZnO nanorods, Prog. Nat. Sci. Mater. Int. 22 (2012) 273–280. https://doi.org/10.1016/j.pnsc.2012.07.002.

[91] Y. Li, Q. Yan, Y. Wang, Y. Li, M. Zhu, K. Cheng, K. Ye, K. Zhu, J. Yan, D. Cao, X. Zhang, G. Wang, Polyaniline coated 3D crosslinked carbon nanosheets for high-energy-density supercapacitors, Appl. Surf. Sci. 493 (2019) 506–513. https://doi.org/10.1016/j.apsusc.2019.07.038.

[92] C.-C. Hu, J.-Y. Lin, Effects of the loading and polymerization temperature on the capacitive performance of polyaniline in NaNO3, Electrochim. Acta. 47 (2002) 4055–4067. https://doi.org/10.1016/S0013-4686(02)00411-5.

[93] R. Zeng, Z. Li, L. Li, Y. Li, J. Huang, Y. Xiao, K. Yuan, Y. Chen, Covalent Connection of Polyaniline with MoS 2 Nanosheets toward Ultrahigh Rate Capability Supercapacitors, ACS Sustain. Chem. Eng. 7 (2019) 11540–11549. https://doi.org/10.1021/acssuschemeng.9b01442.

[94] F.S. Omar, A. Numan, N. Duraisamy, S. Bashir, K. Ramesh, S. Ramesh, A promising binary nanocomposite of zinc cobaltite intercalated with polyaniline for supercapacitor and hydrazine sensor, J. Alloys Compd. 716 (2017) 96–105. https://doi.org/10.1016/j.jallcom.2017.05.039.

[95] J. Yang, Y. Yang, J. Lan, Y. Yu, X. Yang, Polyaniline-manganese dioxide-carbon nanofiber ternary composites with enhanced electrochemical performance for supercapacitors, J. Electroanal. Chem. 843 (2019) 22–30. https://doi.org/10.1016/j.jelechem.2019.04.073.

[96] M. Mandal, D. Ghosh, S. Giri, I. Shakir, C.K. Das, Polyaniline-wrapped 1D CoMoO

4 ·0.75H 2 O nanorods as electrode materials for supercapacitor energy storage applications, RSC Adv. 4 (2014) 30832–30839. https://doi.org/10.1039/C4RA03399J.

[97] J. Li, D. Xiao, Y. Ren, H. Liu, Z. Chen, J. Xiao, Bridging of adjacent graphene/polyaniline layers with polyaniline nanofibers for supercapacitor electrode materials, Electrochim. Acta. 300 (2019) 193–201. https://doi.org/10.1016/j.electacta.2019.01.089.

[98] M.R. Waikar, A.S. Rasal, N.S. Shinde, S.D. Dhas, A. V. Moholkar, M.D. Shirsat, S.K. Chakarvarti, R.G. Sonkawade, Electrochemical performance of Polyaniline based symmetrical energy storage device, Mater. Sci. Semicond. Process. 120 (2020) 105291. https://doi.org/10.1016/j.mssp.2020.105291.

[99] M. Ates, M.A. Serin, I. Ekmen, Y.N. Ertas, Supercapacitor behaviors of polyaniline/CuO, polypyrrole/CuO and PEDOT/CuO nanocomposites, Polym. Bull. 72 (2015) 2573–2589. https://doi.org/10.1007/s00289-015-1422-4.

[100] Y. Wang, A. Liu, T. Li, Y. Han, Y. Ma, Q. Zhang, J. Zhang, Effect of Aniline Concentration on the Morphology and Electrochemical Properties of DBSA-Doped Polyaniline for Flexible Supercapacitor Electrode Materials, J. Electron. Mater. 49 (2020) 3751–3760. https://doi.org/10.1007/s11664-020-08085-y.

[101] X. Zhao, O. Grätz, J. Pionteck, Effect of dopant and oxidant on the electrochemical properties of polyaniline/graphite nanoplate composites, Polym. Int. 67 (2018) 1429–1437. https://doi.org/10.1002/pi.5663.

[102] Y. Zhao, S. Xu, L. Chang, W. He, W. Wu, K. Wang, M. Wang, D. Li, Facile

synthesis of polyaniline nanobelts for supercapacitor applications, Mater. Lett. 286 (2021) 129207. https://doi.org/10.1016/j.matlet.2020.129207.

[103] P. Das, S. Mondal, S. Malik, Fully organic polyaniline nanotubes as electrode material for durable supercapacitor, J. Energy Storage. 39 (2021) 102662. https://doi.org/10.1016/j.est.2021.102662.

[104] K. Kakaei, S. Khodadoost, M. Gholipour, N. Shouraei, Core-shell polyaniline functionalized carbon quantum dots for supercapacitor, J. Phys. Chem. Solids. 148 (2021) 109753. https://doi.org/10.1016/j.jpcs.2020.109753.

[105] X. Fu, T. Li, F. Qi, S. Zhang, J. Wen, W. Shu, P. Luo, R. Zhang, S. Hu, Q. Liu, Designing high electrochemical surface area between polyaniline and hydrogel polymer electrolyte for flexible supercapacitors, Appl. Surf. Sci. 507 (2020) 145135. https://doi.org/10.1016/j.apsusc.2019.145135.

[106] S.F. Shaikh, F.F.M. Shaikh, A. V. Shaikh, M. Ubaidullah, A.M. Al-Enizi, H.M. Pathan, Electrodeposited more-hydrophilic nano-nest polyaniline electrodes for supercapacitor application, J. Phys. Chem. Solids. 149 (2021) 109774. https://doi.org/10.1016/j.jpcs.2020.109774.

[107] R. Wang, Q.-R. Wang, M.-J. Yao, K.-N. Chen, X.-Y. Wang, L.-L. Liu, Z.-Q. Niu, J. Chen, Flexible ultrathin all-solid-state supercapacitors, Rare Met. 37 (2018) 536–542. https://doi.org/10.1007/s12598-018-1034-x.

[108] M. Yanilmaz, M. Dirican, A.M. Asiri, X. Zhang, Flexible polyaniline-carbon nanofiber supercapacitor electrodes, J. Energy Storage. 24 (2019) 100766. https://doi.org/10.1016/j.est.2019.100766.

[109] X. Lu, J. Zhu, W. Wu, B. Zhang, Hierarchical architecture of PANI@TiO2/Ti3C2Tx ternary composite electrode for enhanced electrochemical performance, Electrochim. Acta. 228 (2017) 282–289. https://doi.org/10.1016/j.electacta.2017.01.025.

[110] Y. Ma, C. Hou, H. Zhang, M. Qiao, Y. Chen, H. Zhang, Q. Zhang, Z. Guo, Morphology-dependent electrochemical supercapacitors in multi-dimensional polyaniline nanostructures, J. Mater. Chem. A. 5 (2017) 14041–14052. https://doi.org/10.1039/C7TA03279J.

[111] X. Wang, J. Deng, X. Duan, D. Liu, J. Guo, P. Liu, Crosslinked polyaniline nanorods with improved electrochemical performance as electrode material for supercapacitors, J. Mater. Chem. A. 2 (2014) 12323–12329. https://doi.org/10.1039/C4TA02231A.

[112] M.S. Kumar, P. Das, K.Y. Yasoda, N.K. Kothurkar, S. Malik, S.K. Batabyal, Fabrication of organic nanocomposite of polyaniline for enhanced electrochemical performance, J. Energy Storage. 31 (2020) 101700. https://doi.org/10.1016/j.est.2020.101700.

[113] X. Chen, P. Liu, C. Liu, G. Liu, J. Wei, J. Xu, Q. Jiang, X. Liu, F. Jiang, Microstructure control for high-capacitance polyaniline, Electrochim. Acta. 391 (2021) 138977. https://doi.org/10.1016/j.electacta.2021.138977.

[114] V.A. Mooss, V. Vijayakumar, S. Kurungot, A.A. Athawale, Interconnected polyaniline nanostructures: Enhanced interface for better supercapacitance retention, Polymer (Guildf). 212 (2021) 123169.

https://doi.org/10.1016/j.polymer.2020.123169.

[115] H. Khammar, A. Abdelwahab, H.S. Abdel-Samad, H.H. Hassan, Synergistic performance of simply fabricated polyaniline/carbon xerogel composite as supercapacitor electrode, J. Electroanal. Chem. 880 (2021) 114848. https://doi.org/10.1016/j.jelechem.2020.114848.

[116] J. Jiang, Y. Li, J. Liu, X. Huang, C. Yuan, X.W. Lou, Recent advances in metal oxide-based electrode architecture design for electrochemical energy storage, Adv. Mater. 24 (2012) 5166–5180. https://doi.org/10.1002/adma.201202146.

[117] C.D. Lokhande, D.P. Dubal, O.-S. Joo, Metal oxide thin film based supercapacitors, Curr. Appl. Phys. 11 (2011) 255–270. https://doi.org/10.1016/j.cap.2010.12.001.

[118] M.L. Aparna, A.N. Grace, P. Sathyanarayanan, N.K. Sahu, A comparative study on the supercapacitive behaviour of solvothermally prepared metal ferrite (MFe2O4, M = Fe, Co, Ni, Mn, Cu, Zn) nanoassemblies, J. Alloys Compd. 745 (2018) 385–395. https://doi.org/10.1016/j.jallcom.2018.02.127.

[119] V.C. Lokhande, A.C. Lokhande, C.D. Lokhande, J.H. Kim, T. Ji, Supercapacitive composite metal oxide electrodes formed with carbon, metal oxides and conducting polymers, J. Alloys Compd. 682 (2016) 381–403. https://doi.org/10.1016/j.jallcom.2016.04.242.

[120] S. Liu, D. Ni, H.-F. Li, K.N. Hui, C.-Y. Ouyang, S.C. Jun, Effect of cation substitution on the pseudocapacitive performance of spinel cobaltite MCo 2 O 4 (M = Mn, Ni, Cu, and Co), J. Mater. Chem. A. 6 (2018) 10674–10685. https://doi.org/10.1039/C8TA00540K.

[121] H. Chen, J. Jiang, L. Zhang, T. Qi, D. Xia, H. Wan, Facilely synthesized porous NiCo2O4 flowerlike nanostructure for high-rate supercapacitors, J. Power Sources. 248 (2014) 28–36. https://doi.org/10.1016/j.jpowsour.2013.09.053.

[122] C. Jin, Y. Cui, G. Zhang, W. Luo, Y. Liu, Y. Sun, Z. Tian, W. Zheng, Synthesis of copper-cobalt hybrid oxide microflowers as electrode material for supercapacitors, Chem. Eng. J. 343 (2018) 331–339. https://doi.org/10.1016/j.cej.2018.02.117.

[123] L. Merabet, K. Rida, N. Boukmouche, Sol-gel synthesis, characterization, and supercapacitor applications of MCo2O4 (M = Ni, Mn, Cu, Zn) cobaltite spinels, Ceram. Int. 44 (2018) 11265–11273. https://doi.org/10.1016/j.ceramint.2018.03.171.

[124] Y. Dong, Y. Wang, Y. Xu, C. Chen, Y. Wang, L. Jiao, H. Yuan, Facile synthesis of hierarchical nanocage MnCo 2 O 4 for high performance supercapacitor, Electrochim. Acta. 225 (2017) 39–46. https://doi.org/10.1016/j.electacta.2016.12.109.

[125] J. Li, D. Xiong, L. Wang, M.K.S. Hirbod, X. Li, High-performance self-assembly MnCo2O4 nanosheets for asymmetric supercapacitors, J. Energy Chem. 37 (2019) 66–72. https://doi.org/10.1016/j.jechem.2018.11.015.

[126] T. Huang, Facilely Synthesized NiCo2O4 Nanoparticles as Electrode Material for Supercapacitors, Int. J. Electrochem. Sci. (2018) 6144–6154. https://doi.org/10.20964/2018.06.60.

[127] M.S. Yadav, Synthesis and characterization of Mn2O3−Mn3O4 nanoparticles and activated charcoal based nanocomposite for supercapacitor electrode application, J. Energy Storage. 27 (2020) 101079. https://doi.org/10.1016/j.est.2019.101079.

[128] X. Xu, J. Gao, W. Hong, Ni-based chromite spinel for high-performance supercapacitors, RSC Adv. 6 (2016) 29646–29653. https://doi.org/10.1039/C5RA27931C.

[129] V.C. BOSE, V. BIJU, Mixed valence nanostructured Mn3O4 for supercapacitor applications, Bull. Mater. Sci. 38 (2015) 865–873. https://doi.org/10.1007/s12034-015-0906-z.

[130] I. Kotutha, T. Duangchuen, E. Swatsitang, W. Meewasana, J. Khajonrit, S. Maensiri, Electrochemical properties of rGO/CoFe2O4 nanocomposites for energy storage application, Ionics (Kiel). 25 (2019) 5401–5409. https://doi.org/10.1007/s11581-019-03114-1.

[131] S. Wang, J. Pu, Y. Tong, Y. Cheng, Y. Gao, Z. Wang, ZnCo 2 O 4 nanowire arrays grown on nickel foam for high-performance pseudocapacitors, J. Mater. Chem. A. 2 (2014) 5434–5440. https://doi.org/10.1039/C3TA14941B.

[132] K. Vijaya Sankar, S. Surendran, K. Pandi, A.M. Allin, V.D. Nithya, Y.S. Lee, R. Kalai Selvan, Studies on the electrochemical intercalation/de-intercalation mechanism of NiMn 2 O 4 for high stable pseudocapacitor electrodes, RSC Adv. 5 (2015) 27649–27656. https://doi.org/10.1039/C5RA00407A.

[133] A. Pendashteh, M.S. Rahmanifar, R.B. Kaner, M.F. Mousavi, Facile synthesis of nanostructured CuCo2O4 as a novel electrode material for high-rate supercapacitors, Chem. Commun. 50 (2014) 1972. https://doi.org/10.1039/c3cc48773c.

[134] G. Singh, S. Chandra, Electrochemical performance of MnFe 2 O 4 nano-ferrites synthesized using thermal decomposition method, Int. J. Hydrogen Energy. 43

(2018) 4058–4066. https://doi.org/10.1016/j.ijhydene.2017.08.181.

[135] B.J. Reddy, P. Vickraman, A.S. Justin, A facile synthesis of novel $$\upalpha $$ α - $$\hbox {ZnMoO}_{{4}}$$ ZnMoO 4 microspheres as electrode material for supercapacitor applications, Bull. Mater. Sci. 42 (2019) 52. https://doi.org/10.1007/s12034-019-1749-9.

[136] S.M. Nikam, A. Sharma, M. Rahaman, A.M. Teli, S.H. Mujawar, D.R.T. Zahn, P.S. Patil, S.C. Sahoo, G. Salvan, P.B. Patil, Pulsed laser deposited CoFe 2 O 4 thin films as supercapacitor electrodes, RSC Adv. 10 (2020) 19353–19359. https://doi.org/10.1039/D0RA02564J.

[137] Y. Zou, Z. Zhang, W. Zhong, W. Yang, Hydrothermal direct synthesis of polyaniline, graphene/polyaniline and N-doped graphene/polyaniline hydrogels for high performance flexible supercapacitors, J. Mater. Chem. A. 6 (2018) 9245–9256. https://doi.org/10.1039/c8ta01366g.

[138] Z. Hou, S. Zou, J. Li, Morphology and structure control of amine- functionalized graphene/polyaniline composite for high-performance supercapacitors, J. Alloys Compd. 827 (2020). https://doi.org/10.1016/j.jallcom.2020.154390.

[139] S. Jadhav, R.S. Kalubarme, C. Terashima, B.B. Kale, V. Godbole, A. Fujishima, S.W. Gosavi, Manganese dioxide/ reduced graphene oxide composite an electrode material for high-performance solid state supercapacitor, Electrochim. Acta. 299 (2019) 34–44. https://doi.org/10.1016/j.electacta.2018.12.182.

[140] M. Fu, Q. Zhuang, Z. Zhu, Z. Zhang, W. Chen, Q. Liu, H. Yu, Facile synthesis of V2O5/graphene composites as advanced electrode materials in supercapacitors, J.

Alloys Compd. 862 (2021) 158006. https://doi.org/10.1016/j.jallcom.2020.158006.

[141] L. Liu, Y. Wang, Q. Meng, B. Cao, A novel hierarchical graphene/polyaniline hollow microsphere as electrode material for supercapacitor applications, J. Mater. Sci. 52 (2017) 7969–7983. https://doi.org/10.1007/s10853-017-1000-2.

[142] S.R. Charandabinezhad, H. Asgharzadeh, N. Arsalani, Synthesis and characterization of reduced graphene oxide/magnetite/polyaniline composites as electrode materials for supercapacitors, J. Mater. Sci. Mater. Electron. 32 (2021) 1864–1876. https://doi.org/10.1007/s10854-020-04955-7.

[143] A. Gupta, S. Sardana, J. Dalal, S. Lather, A.S. Maan, R. Tripathi, R. Punia, K. Singh, A. Ohlan, Nanostructured Polyaniline/Graphene/Fe2O3Composites Hydrogel as a High-Performance Flexible Supercapacitor Electrode Material, ACS Appl. Energy Mater. 3 (2020) 6434–6446. https://doi.org/10.1021/acsaem.0c00684.

[144] Z. Çıplak, A. Yıldız, N. Yıldız, Green preparation of ternary reduced graphene oxide-au@polyaniline nanocomposite for supercapacitor application, J. Energy Storage. 32 (2020) 101846. https://doi.org/10.1016/j.est.2020.101846.

[145] Z. Xu, Z. Zhang, H. Yin, S. Hou, H. Lin, J. Zhou, S. Zhuo, Investigation on the role of different conductive polymers in supercapacitors based on a zinc sulfide/reduced graphene oxide/conductive polymer ternary composite electrode, RSC Adv. 10 (2020) 3122–3129. https://doi.org/10.1039/c9ra07842h.

[146] R. Ghanbari, M. Entezar Shabestari, E. Naderi Kalali, Y. Hu, S.R. Ghorbani, Electrochemical performance and complex impedance properties of reduced-graphene oxide/polypyrrole nanofiber nanocomposite, Ionics (Kiel). 27 (2021)

1279–1290. https://doi.org/10.1007/s11581-021-03907-3.

[147] H. Zhou, T. Ni, X. Qing, X. Yue, G. Li, Y. Lu, One-step construction of graphene-polypyrrole hydrogels and their superior electrochemical performance, RSC Adv. 4 (2014) 4134–4139. https://doi.org/10.1039/c3ra44647f.

[148] S.Z. Golkhatmi, A. Sedghi, H.N. Miankushki, M. Khalaj, Structural properties and supercapacitive performance evaluation of the nickel oxide/graphene/polypyrrole hybrid ternary nanocomposite in aqueous and organic electrolytes, Energy. 214 (2021) 118950. https://doi.org/10.1016/j.energy.2020.118950.

[149] C. Liang, C. Yang, L. Zang, Q. Liu, J. Qiu, Y. Li, W. Zuo, X. Liu, UV-Assisted One-Step Synthesis of Ternary Graphene/Polypyrrole/Silver Nanocomposites for Supercapacitors, Energy Technol. 9 (2021) 1–9. https://doi.org/10.1002/ente.202000966.

[150] J. Jose, S.P. Jose, T. Prasankumar, S. Shaji, S. Pillai, S.P. B, Emerging ternary nanocomposite of rGO draped palladium oxide/polypyrrole for high performance supercapacitors, J. Alloys Compd. 855 (2021) 157481. https://doi.org/10.1016/j.jallcom.2020.157481.

[151] Q. Xin, Z. Guo, Y. Zang, J. Lin, Graphene aerogel-coated MoO3 nanoparticle/polypyrrole ternary composites for high-performance supercapacitor, J. Mater. Sci. Mater. Electron. 31 (2020) 17110–17119. https://doi.org/10.1007/s10854-020-04271-0.

[152] S. Abraham, T. Prasankumar, K. Vinoth Kumar, S. Zh Karazhanov, S. Jose, Novel lead dioxide intercalated polypyrrole/graphene oxide ternary composite for high

throughput supercapacitors, Mater. Lett. 273 (2020) 127943. https://doi.org/10.1016/j.matlet.2020.127943.

[153] Y. Hou, Y. Cheng, T. Hobson, J. Liu, Design and Synthesis of Hierarchical MnO 2 Nanospheres/Carbon Nanotubes/Conducting Polymer Ternary Composite for High Performance Electrochemical Electrodes, Nano Lett. 10 (2010) 2727–2733. https://doi.org/10.1021/nl101723g.

[154] X. Lu, H. Dou, S. Yang, L. Hao, L. Zhang, L. Shen, F. Zhang, X. Zhang, Fabrication and electrochemical capacitance of hierarchical graphene/polyaniline/carbon nanotube ternary composite film, Electrochim. Acta. 56 (2011) 9224–9232. https://doi.org/10.1016/j.electacta.2011.07.142.

[155] Y. Yan, Q. Cheng, V. Pavlinek, P. Saha, C. Li, Fabrication of polyaniline/mesoporous carbon/MnO2 ternary nanocomposites and their enhanced electrochemical performance for supercapacitors, Electrochim. Acta. 71 (2012) 27–32. https://doi.org/10.1016/j.electacta.2012.03.101.

[156] X. Xia, Q. Hao, W. Lei, W. Wang, H. Wang, X. Wang, Reduced-graphene oxide/molybdenum oxide/polyaniline ternary composite for high energy density supercapacitors: Synthesis and properties, J. Mater. Chem. 22 (2012) 8314. https://doi.org/10.1039/c2jm16216d.

[157] K. Lu, R. Jiang, X. Gao, H. Ma, Fe3O4/carbon nanotubes/polyaniline ternary composites with synergistic effects for high performance supercapacitors, RSC Adv. 4 (2014) 52393–52401. https://doi.org/10.1039/c4ra11088a.

[158] K.V. Sankar, R.K. Selvan, The preparation of MnFe2O4 decorated flexible

graphene wrapped with PANI and its electrochemical performances for hybrid supercapacitors, RSC Adv. 4 (2014) 17555. https://doi.org/10.1039/c3ra47681b.

[159] D. Ghosh, S. Giri, M. Mandal, C.K. Das, High performance supercapacitor electrode material based on vertically aligned PANI grown on reduced graphene oxide/Ni(OH) 2 hybrid composite, RSC Adv. 4 (2014) 26094–26101. https://doi.org/10.1039/C4RA02653E.

[160] K.V. Sankar, R.K. Selvan, The ternary MnFe2O4/graphene/polyaniline hybrid composite as negative electrode for supercapacitors, J. Power Sources. 275 (2015) 399–407. https://doi.org/10.1016/j.jpowsour.2014.10.183.

[161] H.R. Naderi, P. Norouzi, M.R. Ganjali, Supercapacitive evaluation of carbon black/exfoliated graphite/MnO2 ternary nanocomposite electrode by continuous cyclic voltammetry, Mater. Chem. Phys. 163 (2015) 38–44. https://doi.org/10.1016/j.matchemphys.2015.07.011.

[162] H. Li, Y. He, V. Pavlinek, Q. Cheng, P. Saha, C. Li, MnO 2 nanoflake/polyaniline nanorod hybrid nanostructures on graphene paper for high-performance flexible supercapacitor electrodes, J. Mater. Chem. A. 3 (2015) 17165–17171. https://doi.org/10.1039/C5TA04008F.

[163] A.K. Thakur, A.B. Deshmukh, R.B. Choudhary, I. Karbhal, M. Majumder, M. V. Shelke, Facile synthesis and electrochemical evaluation of PANI/CNT/MoS2 ternary composite as an electrode material for high performance supercapacitor, Mater. Sci. Eng. B. 223 (2017) 24–34. https://doi.org/10.1016/j.mseb.2017.05.001.

[164] Y. Ma, D. Zhao, Y. Chen, J. Huang, Z. Zhang, X. Zhang, B. Zhang, A novel core-

shell polyaniline/graphene oxide/copper nanocomposite for high performance and low-cost supercapacitors, Chem. Pap. 73 (2019) 119–129. https://doi.org/10.1007/s11696-018-0556-x.

[165] O. Yoruk, Y. Bayrak, M. Ates, Design and assembly of supercapacitor based on reduced graphene oxide/TiO2/polyaniline ternary nanocomposite and its application in electrical circuit, Polym. Bull. 79 (2022) 2969–2993. https://doi.org/10.1007/s00289-021-03649-2.

[166] A. Raghavan, S. Sarkar, S. Ghosh, Development of PANI based ternary nanocomposite with enhanced capacity retention for high performance supercapacitor application, Electrochim. Acta. 388 (2021) 138564. https://doi.org/10.1016/j.electacta.2021.138564.

[167] S. Palsaniya, H.B. Nemade, A.K. Dasmahapatra, Hierarchical PANI-RGO-ZnO ternary nanocomposites for symmetric tandem supercapacitor, J. Phys. Chem. Solids. 154 (2021) 110081. https://doi.org/10.1016/j.jpcs.2021.110081.

[168] N. Parveen, M.O. Ansari, T.H. Han, M.H. Cho, Simple and rapid synthesis of ternary polyaniline/titanium oxide/graphene by simultaneous TiO2 generation and aniline oxidation as hybrid materials for supercapacitor applications, J. Solid State Electrochem. 21 (2017) 57–68. https://doi.org/10.1007/s10008-016-3310-8.

[169] C. Pan, H. Gu, L. Dong, Synthesis and electrochemical performance of polyaniline @MnO2/graphene ternary composites for electrochemical supercapacitors, J. Power Sources. 303 (2016) 175–181. https://doi.org/10.1016/j.jpowsour.2015.11.002.

[170] S. Palsaniya, H.B. Nemade, A.K. Dasmahapatra, Synthesis of

polyaniline/graphene/MoS2 nanocomposite for high performance supercapacitor electrode, Polymer (Guildf). 150 (2018) 150–158. https://doi.org/10.1016/j.polymer.2018.07.018.

[171] F. Movassagh-Alanagh, A. Bordbar-Khiabani, A. Ahangari-Asl, Fabrication of a ternary PANI@Fe3O4@CFs nanocomposite as a high performance electrode for solid-state supercapacitors, Int. J. Hydrogen Energy. 44 (2019) 26794–26806. https://doi.org/10.1016/j.ijhydene.2019.08.184.

[172] S. Muthusamy, J. Charles, M.S. Michael, K. Shree Kesavan, Enhanced specific capacitance of a novel ternary polypyrrole incorporated with prussian blue and mesoporous carbon black for high performance supercapacitor applications, Mater. Res. Bull. 120 (2019) 110587. https://doi.org/10.1016/j.materresbull.2019.110587.

[173] H. Yu, R. Lv, H. Wu, C. Qian, S. Wang, M. Chen, Fabrication of Ternary Hierarchical Nanosheets RGO/PANI/Fe 2 O 3 as Electrode Material with High Capacitance Performance, J. Electrochem. Soc. 167 (2020) 040501. https://doi.org/10.1149/1945-7111/ab6dd4.

[174] P. Haldar, Use of redox additive to enhance the electrochemical performance of Co3O4/polyaniline/graphene composite-based supercapacitors, J. Mater. Sci. Mater. Electron. 31 (2020) 7905–7915. https://doi.org/10.1007/s10854-020-03329-3.

[175] J. Huang, X. Song, C. He, Z. Zhang, L. Qu, D. Zhao, Preparation and performance of multiwall carbon nanotubes/FeNi3/polyaniline composite electrode material for supercapacitors, Ionics (Kiel). 26 (2020) 2525–2536. https://doi.org/10.1007/s11581-019-03357-y.

[176] W. Wang, Q. Hao, W. Lei, X. Xia, X. Wang, Ternary nitrogen-doped graphene/nickel ferrite/polyaniline nanocomposites for high-performance supercapacitors, J. Power Sources. 269 (2014) 250–259. https://doi.org/10.1016/j.jpowsour.2014.07.010.

[177] A.R. Akbar, W. Tian, M.B. Qadir, Z. Khaliq, Z. Liu, M. Tahir, Y. Hu, C. Xiong, Q. Yang, A novel ternary composite aerogel for high-performance supercapacitor, Colloids Surfaces A Physicochem. Eng. Asp. 610 (2021) 125644. https://doi.org/10.1016/j.colsurfa.2020.125644.

[178] K.Y. Yasoda, S. Kumar, M.S. Kumar, K. Ghosh, S.K. Batabyal, Fabrication of MnS/GO/PANI nanocomposites on a highly conducting graphite electrode for supercapacitor application, Mater. Today Chem. 19 (2021) 100394. https://doi.org/10.1016/j.mtchem.2020.100394.

[179] S. Giri, D. Ghosh, A.P. Kharitonov, C.K. Das, Study of copper ferrite nanowire formation in presence of carbon nanotubes and influence of fluorination on high performance supercapacitor energy storage application, Funct. Mater. Lett. 5 (2012). https://doi.org/10.1142/S1793604712500464.

[180] B. Mazinani, M. Kazazi, G. Mobarhan, M. Shokouhimehr, The Combustion Synthesis of Ag-Doped MnCo2O4 Nanoparticles for Supercapacitor Applications, JOM. 71 (2019) 1499–1506. https://doi.org/10.1007/s11837-019-03387-x.

[181] Y. Tian, Z. Yu, L. Cao, X.L. Zhang, C. Sun, D.W. Wang, Graphene oxide: An emerging electromaterial for energy storage and conversion, J. Energy Chem. 55 (2021) 323–344. https://doi.org/10.1016/j.jechem.2020.07.006.

[182] Y. Ping, Y. Zhang, Y. Gong, B. Cao, Q. Fu, C. Pan, Edge-riched graphene nanoribbon for high capacity electrode materials, Electrochim. Acta. 250 (2017) 84–90. https://doi.org/10.1016/j.electacta.2017.08.051.

[183] X. Huang, Z. Zeng, Z. Fan, J. Liu, H. Zhang, Graphene-based electrodes, Adv. Mater. 24 (2012) 5979–6004. https://doi.org/10.1002/adma.201201587.

[184] Y.-F. Lin, C.-H. Chen, W.-J. Xie, S.-H. Yang, C.-S. Hsu, M.-T. Lin, W.-B. Jian, Nano Approach Investigation of the Conduction Mechanism in Polyaniline Nanofibers, ACS Nano. 5 (2011) 1541–1548. https://doi.org/10.1021/nn103525b.

[185] X. Hu, Y. Yu, Y. Wang, J. Zhou, L. Song, Separating nano graphene oxide from the residual strong-acid filtrate of the modified Hummers method with alkaline solution, Appl. Surf. Sci. 329 (2015) 83–86. https://doi.org/10.1016/j.apsusc.2014.12.110.

[186] L.M. da Silva, D.A. de Lima Almeida, S.S. Oishi, A.B. Couto, N.G. Ferreira, Constituent material influence on the electrochemical performance and supercapacitance of PAni/diamond/CF composite, Mater. Sci. Eng. B. 228 (2018) 249–260. https://doi.org/10.1016/j.mseb.2017.12.004.

[187] M. Jaymand, Recent progress in chemical modification of polyaniline, Prog. Polym. Sci. 38 (2013) 1287–1306. https://doi.org/10.1016/j.progpolymsci.2013.05.015.

[188] A. Khan, A.A.P. Khan, M.M. Rahman, A.M. Asiri, Inamuddin, K.A. Alamry, S.A. Hameed, Preparation and characterization of PANI@G/CWO nanocomposite for enhanced 2-nitrophenol sensing, Elsevier B.V., 2018. https://doi.org/10.1016/j.apsusc.2017.09.219.

[189] M.Y. HO, P.S. KHIEW, D. ISA, T.K. TAN, W.S. CHIU, C.H. CHIA, A REVIEW OF METAL OXIDE COMPOSITE ELECTRODE MATERIALS FOR ELECTROCHEMICAL CAPACITORS, Nano. 09 (2014) 1430002. https://doi.org/10.1142/S1793292014300023.

[190] L. Wang, D.C. Bock, J. Li, E.A. Stach, A.C. Marschilok, K.J. Takeuchi, E.S. Takeuchi, Synthesis and Characterization of CuFe 2 O 4 Nano/Submicron Wire–Carbon Nanotube Composites as Binder-free Anodes for Li-Ion Batteries, ACS Appl. Mater. Interfaces. 10 (2018) 8770–8785. https://doi.org/10.1021/acsami.8b00244.

[191] K. Song, X. Wang, J. Wang, B. Zhang, R. Yang, Hierarchical structure of CoFe2O4 core-shell microsphere coating on carbon fiber cloth for high-performance asymmetric flexible supercapacitor applications, Ionics (Kiel). 25 (2019) 4905–4914. https://doi.org/10.1007/s11581-019-03030-4.

[192] S. Paul, K.S. Choi, D.J. Lee, P. Sudhagar, Y.S. Kang, Factors affecting the performance of supercapacitors assembled with polypyrrole/multi-walled carbon nanotube composite electrodes, Electrochim. Acta. 78 (2012) 649–655. https://doi.org/10.1016/j.electacta.2012.06.088.

[193] L. Dashairya, D. Das, P. Saha, Binder-free electrophoretic deposition of Sb/rGO on Cu foil for superior electrochemical performance in Li-ion and Na-ion batteries, Electrochim. Acta. 358 (2020) 136948. https://doi.org/10.1016/j.electacta.2020.136948.

[194] S. Park, S. Kim, Effect of carbon blacks filler addition on electrochemical behaviors

of Co3O4/graphene nanosheets as a supercapacitor electrodes, Electrochim. Acta. 89 (2013) 516–522. https://doi.org/10.1016/j.electacta.2012.11.075.

[195] A.G. Pandolfo, G.J. Wilson, T.D. Huynh, A.F. Hollenkamp, The Influence of Conductive Additives and Inter-Particle Voids in Carbon EDLC Electrodes, Fuel Cells. 10 (2010) 856–864. https://doi.org/10.1002/fuce.201000027.

[196] D. Majumdar, S. Ghosh, Recent advancements of copper oxide based nanomaterials for supercapacitor applications, J. Energy Storage. 34 (2021) 101995. https://doi.org/10.1016/j.est.2020.101995.

[197] Y. Shao, M.F. El-Kady, J. Sun, Y. Li, Q. Zhang, M. Zhu, H. Wang, B. Dunn, R.B. Kaner, Design and Mechanisms of Asymmetric Supercapacitors, Chem. Rev. 118 (2018) 9233–9280. https://doi.org/10.1021/acs.chemrev.8b00252.

[198] A. Chonat, S. Palatty, Enhanced Electrochemical Performance of a Hybrid Supercapacitive Material Based on Ternary Doped Polyaniline/Activated Carbon Composite, Energy & Fuels. 34 (2020) 10148–10159. https://doi.org/10.1021/acs.energyfuels.0c01555.

[199] G. Xu, W. Wang, X. Qu, Y. Yin, L. Chu, B. He, H. Wu, J. Fang, Y. Bao, L. Liang, Electrochemical properties of polyaniline in p-toluene sulfonic acid solution, Eur. Polym. J. 45 (2009) 2701–2707. https://doi.org/10.1016/j.eurpolymj.2009.05.016.

[200] W. Wang, S. Wu, A new ternary composite based on carbon nanotubes/polyindole/graphene with preeminent electrocapacitive performance for supercapacitors, Appl. Surf. Sci. 396 (2017) 1360–1367. https://doi.org/10.1016/j.apsusc.2016.11.167.

[201] H.-L. Girard, H. Wang, A. D'Entremont, L. Pilon, Physical Interpretation of Cyclic Voltammetry for Hybrid Pseudocapacitors, J. Phys. Chem. C. 119 (2015) 11349–11361. https://doi.org/10.1021/acs.jpcc.5b00641.

[202] M. Habib, A. Khalil, Z. Muhammad, R. Khan, C. Wang, Z. ur Rehman, H.T. Masood, W. Xu, H. Liu, W. Gan, C. Wu, H. Chen, L. Song, WX2(X=S, Se) Single Crystals: A Highly Stable Material for Supercapacitor Applications, Electrochim. Acta. 258 (2017) 71–79. https://doi.org/10.1016/j.electacta.2017.10.083.

[203] S.T. Senthilkumar, R.K. Selvan, Y.S. Lee, J.S. Melo, Electric double layer capacitor and its improved specific capacitance using redox additive electrolyte, J. Mater. Chem. A. 1 (2013) 1086–1095. https://doi.org/10.1039/C2TA00210H.

[204] P. Tamilarasan, S. Ramaprabhu, Ionic liquid-functionalized partially exfoliated multiwalled carbon nanotubes for high-performance supercapacitors, J. Mater. Chem. A. 2 (2014) 14054–14063. https://doi.org/10.1039/c4ta02718c.

[205] D. Malevich, E. Halliop, B.A. Peppley, J.G. Pharoah, K. Karan, Investigation of Charge-Transfer and Mass-Transport Resistances in PEMFCs with Microporous Layer Using Electrochemical Impedance Spectroscopy, J. Electrochem. Soc. 156 (2009) B216. https://doi.org/10.1149/1.3033408.

[206] L. Mai, F. Dong, X. Xu, Y. Luo, Q. An, Y. Zhao, J. Pan, J. Yang, Liqiang Mai, * Fei Dong, Xu Xu, Yanzhu Luo, Qinyou An, Yunlong Zhao, Jie Pan, and Jingnan Yang, (2013).

[207] T. Das, B. Verma, Polyaniline-Acetylene black-Copper cobaltite based ternary hybrid material with enhanced electrochemical properties and its use in

supercapacitor electrodes, Int. J. Energy Res. 44 (2020) 934–949. https://doi.org/10.1002/er.4951.

[208] A. Romero, M.P. Lavin-Lopez, L. Sanchez-Silva, J.L. Valverde, A. Paton-Carrero, Comparative study of different scalable routes to synthesize graphene oxide and reduced graphene oxide, Mater. Chem. Phys. 203 (2018) 284–292. https://doi.org/10.1016/j.matchemphys.2017.10.013.

[209] G. Surekha, K.V. Krishnaiah, N. Ravi, R. Padma Suvarna, FTIR, Raman and XRD analysis of graphene oxide films prepared by modified Hummers method, in: J. Phys. Conf. Ser., Institute of Physics Publishing, 2020. https://doi.org/10.1088/1742-6596/1495/1/012012.

[210] X. Du, Y. Xu, L. Xiong, Y. Bai, J. Zhu, S. Mao, Polyaniline with high crystallinity degree: Synthesis, structure, and electrochemical properties, J. Appl. Polym. Sci. 131 (2014). https://doi.org/10.1002/app.40827.

[211] Y. Wang, C. Shen, L. Niu, R. Li, H. Guo, Y. Shi, C. Li, X. Liu, Y. Gong, Hydrothermal synthesis of CuCo2O4/CuO nanowire arrays and RGO/Fe2O3 composites for high-performance aqueous asymmetric supercapacitors, J. Mater. Chem. A. 4 (2016) 9977–9985. https://doi.org/10.1039/c6ta02950g.

[212] A. Pendashteh, S.E. Moosavifard, M.S. Rahmanifar, Y. Wang, M.F. El-Kady, R.B. Kaner, M.F. Mousavi, Highly Ordered Mesoporous CuCo2O4 Nanowires, a Promising Solution for High-Performance Supercapacitors, Chem. Mater. 27 (2015) 3919–3926. https://doi.org/10.1021/acs.chemmater.5b00706.

[213] K.R. Reddy, B.C. Sin, K.S. Ryu, J. Noh, Y. Lee, In situ self-organization of carbon

black-polyaniline composites from nanospheres to nanorods: Synthesis, morphology, structure and electrical conductivity, Synth. Met. 159 (2009) 1934–1939. https://doi.org/10.1016/j.synthmet.2009.06.018.

[214] F.S. Omar, A. Numan, N. Duraisamy, M.M. Ramly, R. Ramesh, R. Ramesh, Binary composite of polyaniline/copper cobaltite for high performance asymmetric supercapacitor application, Electrochim. Acta. 227 (2017) 41–48. https://doi.org/10.1016/j.electacta.2017.01.006.

[215] A. Nawaz, P. Kumar, Pyrolysis of mustard straw: Evaluation of optimum process parameters, kinetic and thermodynamic study, Bioresour. Technol. 340 (2021) 125722. https://doi.org/10.1016/j.biortech.2021.125722.

[216] S. Sultana, Rafiuddin, M. Zain Khan, K. Umar, Synthesisand characterization of copper ferrite nanoparticles doped polyaniline, J. Alloys Compd. 535 (2012) 44–49. https://doi.org/10.1016/j.jallcom.2012.04.081.

[217] M. Ghaani, J. Saffari, Synthesis of CuFe2 O4 Nanoparticles by a new co-precipitation method and using them as Efficient Catalyst for One-pot Synthesis of Naphthoxazinones, J. NANOSTRUCTURES. 6 (2016) 172–178. https://doi.org/10.7508/jns.2016.02.010.

[218] K.V. Sankar, R.K. Selvan, D. Meyrick, Electrochemical performances of CoFe2O4 nanoparticles and a rGO based asymmetric supercapacitor, RSC Adv. 5 (2015) 99959–99967. https://doi.org/10.1039/c5ra14938j.

[219] K. Vijaya Sankar, R. Kalai Selvan, Fabrication of flexible fiber supercapacitor using covalently grafted CoFe2O4/reduced graphene oxide/polyaniline and its

electrochemical performances, Electrochim. Acta. 213 (2016) 469–481. https://doi.org/10.1016/j.electacta.2016.07.056.

[220] M. Canales, J. Torras, G. Fabregat, A. Meneguzzi, C. Alemán, Polyaniline emeraldine salt in the amorphous solid state: Polaron versus bipolaron, J. Phys. Chem. B. 118 (2014) 11552–11562. https://doi.org/10.1021/jp5067583.

[221] T. Das, B. Verma, High performance ternary polyaniline-acetylene black-cobalt ferrite hybrid system for supercapacitor electrodes, Synth. Met. 251 (2019) 65–74. https://doi.org/10.1016/j.synthmet.2019.03.025.

[222] S. Verma, V.K. Pandey, B. Verma, Facile synthesis of graphene oxide-polyaniline-copper cobaltite (GO/PANI/CuCo2O4) hybrid nanocomposite for supercapacitor applications, Synth. Met. 286 (2022). https://doi.org/10.1016/j.synthmet.2022.117036.

[223] D. Ham, J. Chang, S.H. Pathan, W.Y. Kim, R.S. Mane, B.N. Pawar, O.S. Joo, H. Chung, M.Y. Yoon, S.H. Han, Electrochemical capacitive properties of spray-pyrolyzed copper-ferrite thin films, Curr. Appl. Phys. 9 (2009). https://doi.org/10.1016/j.cap.2008.08.042.

[224] J. Zhao, Y. Cheng, X. Yan, D. Sun, F. Zhu, Q. Xue, Magnetic and electrochemical properties of CuFe 2O 4 hollow fibers fabricated by simple electrospinning and direct annealing, CrystEngComm. 14 (2012) 5879–5885. https://doi.org/10.1039/c2ce25684c.

[225] V.S. Kumbhar, A.D. Jagadale, N.M. Shinde, C.D. Lokhande, Chemical synthesis of spinel cobalt ferrite (CoFe 2 O 4 ) nano-flakes for supercapacitor application, Appl.

Surf. Sci. 259 (2012) 39–43. https://doi.org/10.1016/j.apsusc.2012.06.034.

[226] P. Xiong, H. Huang, X. Wang, Design and synthesis of ternary cobalt ferrite/graphene/polyaniline hierarchical nanocomposites for high-performance supercapacitors This work is dedicated to Professor MIN Enze on the occasion of his 90th birthday., J. Power Sources. 245 (2014) 937–946. https://doi.org/10.1016/j.jpowsour.2013.07.064.

[227] B. Rani, N.K. Sahu, Electrochemical properties of CoFe2O4 nanoparticles and its rGO composite for supercapacitor, Diam. Relat. Mater. 108 (2020) 107978. https://doi.org/10.1016/j.diamond.2020.107978.

[228] M. Zhu, D. Meng, C. Wang, G. Diao, Facile fabrication of hierarchically porous CuFe2O4 nanospheres with enhanced capacitance property, ACS Appl. Mater. Interfaces. 5 (2013) 6030–6037. https://doi.org/10.1021/am4007353.

[229] T. Das, B. Verma, Synthesis of polymer composite based on polyaniline-acetylene black-copper ferrite for supercapacitor electrodes, Polymer (Guildf). 168 (2019) 61–69. https://doi.org/10.1016/j.polymer.2019.01.058.

# *APPENDIX*

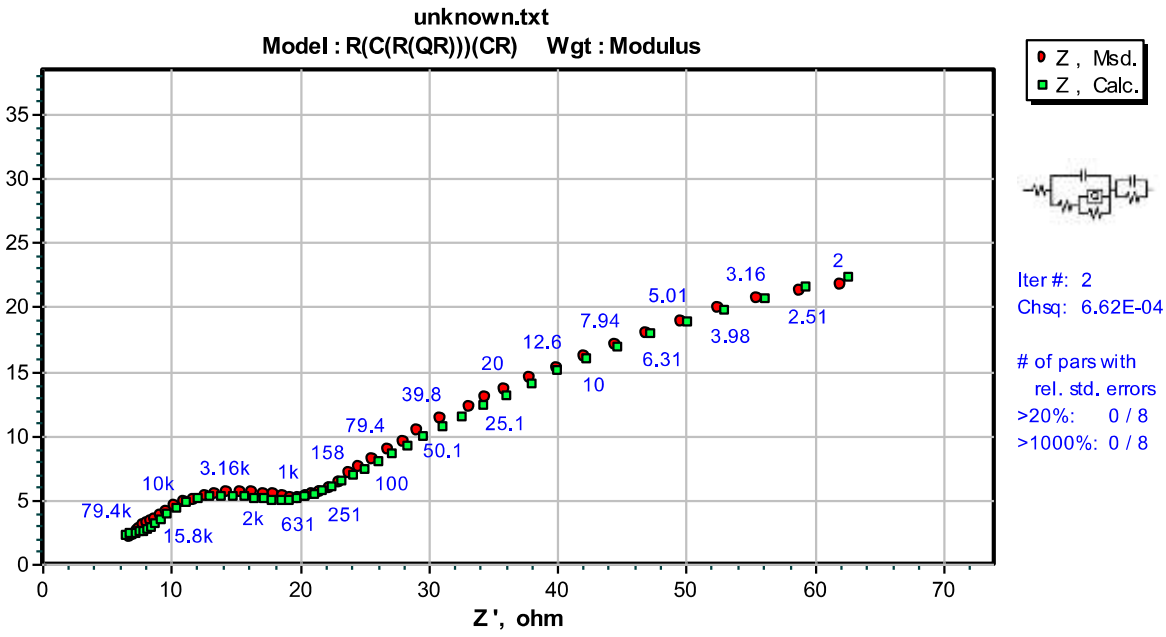


**Figure A1:** Equivalent circuit diagram of GO

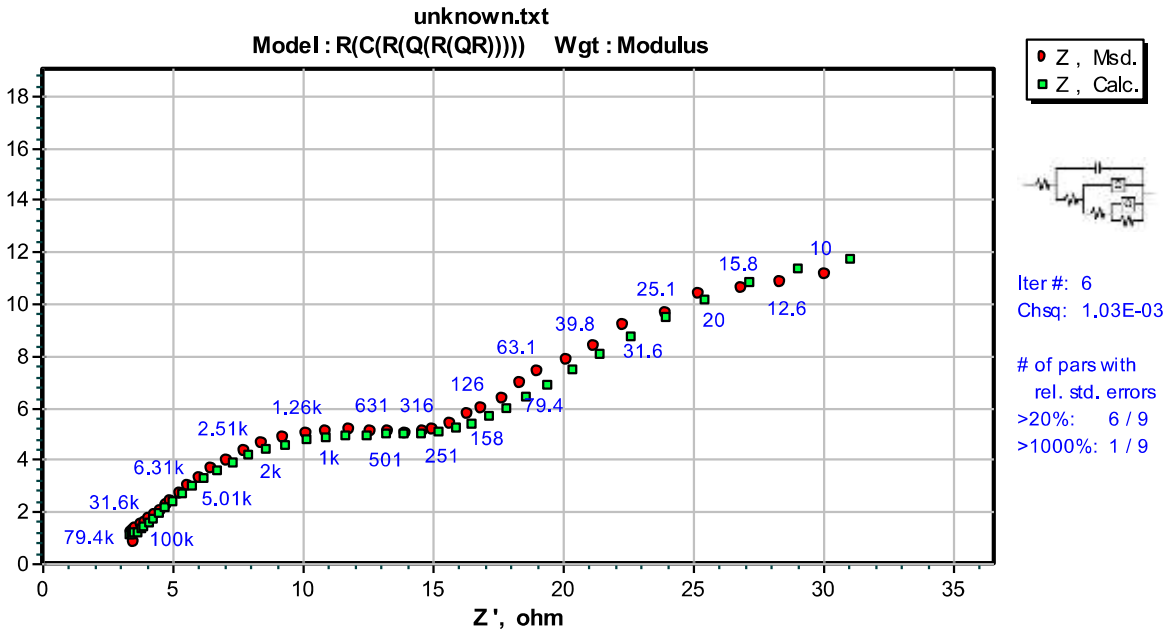


**Figure A2:** Fitted circuit curve of GO/PANI

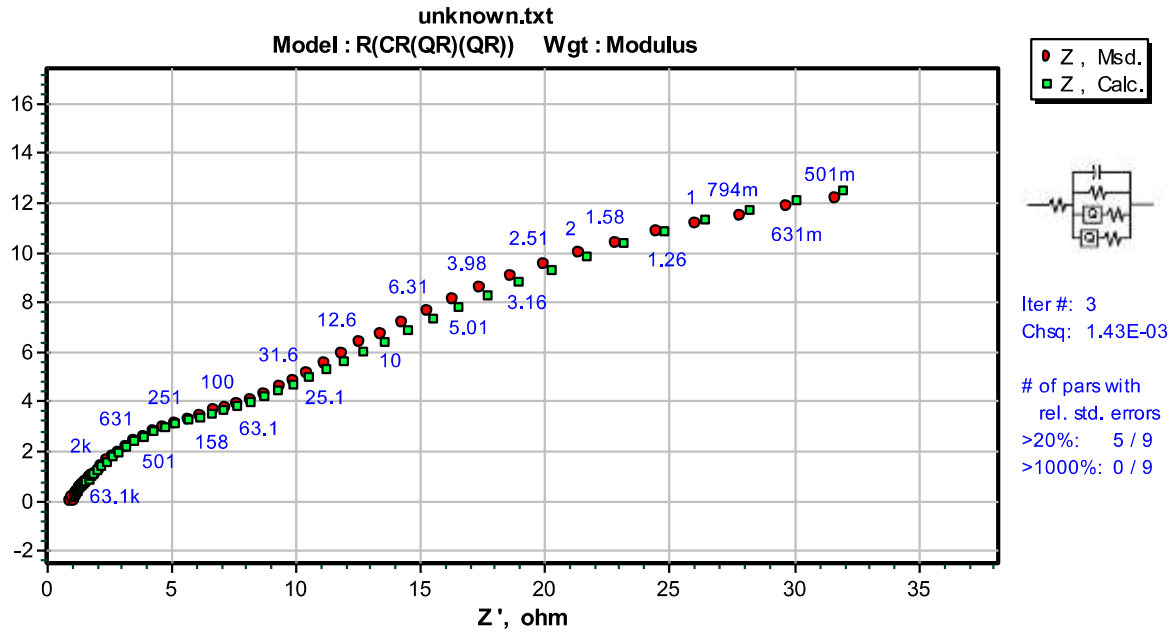


**Figure A3:** Equivalent circuit diagram of PANI/$CuCo_2O_4$

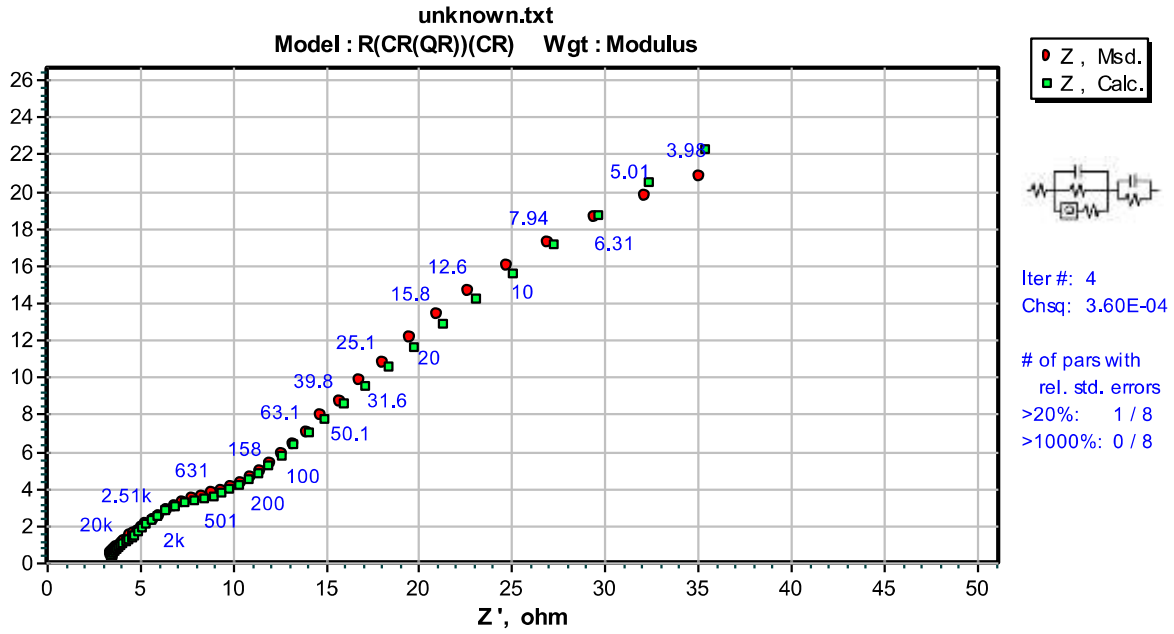


**Figure A4:** Equivalent circuit diagram of GO/PANI/$CuCo_2O_4$

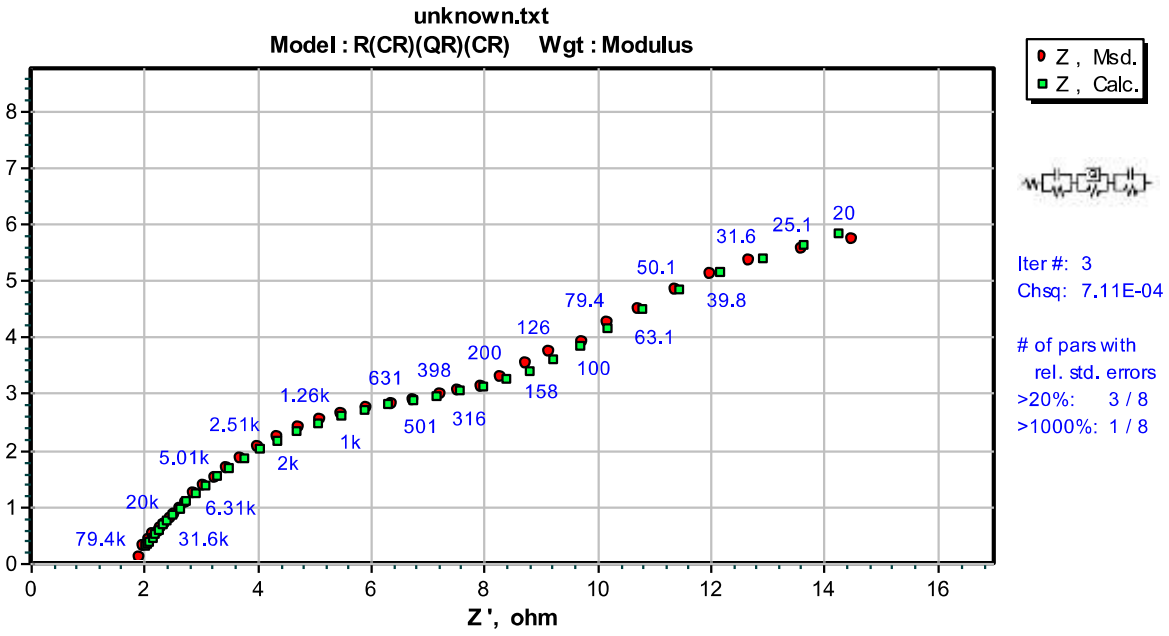


**Figure A5:** Fitted circuit curve of PANI/$CuFe_2O_4$

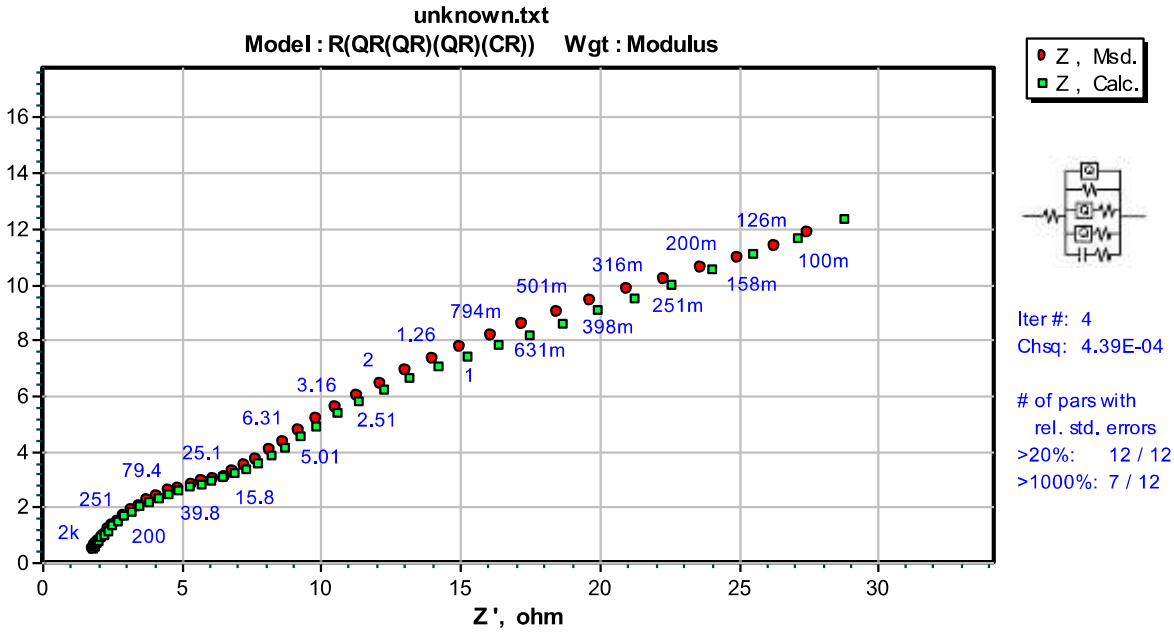


**Figure A6:** Fitted circuit curve of GO/PANI/$CuFe_2O_4$

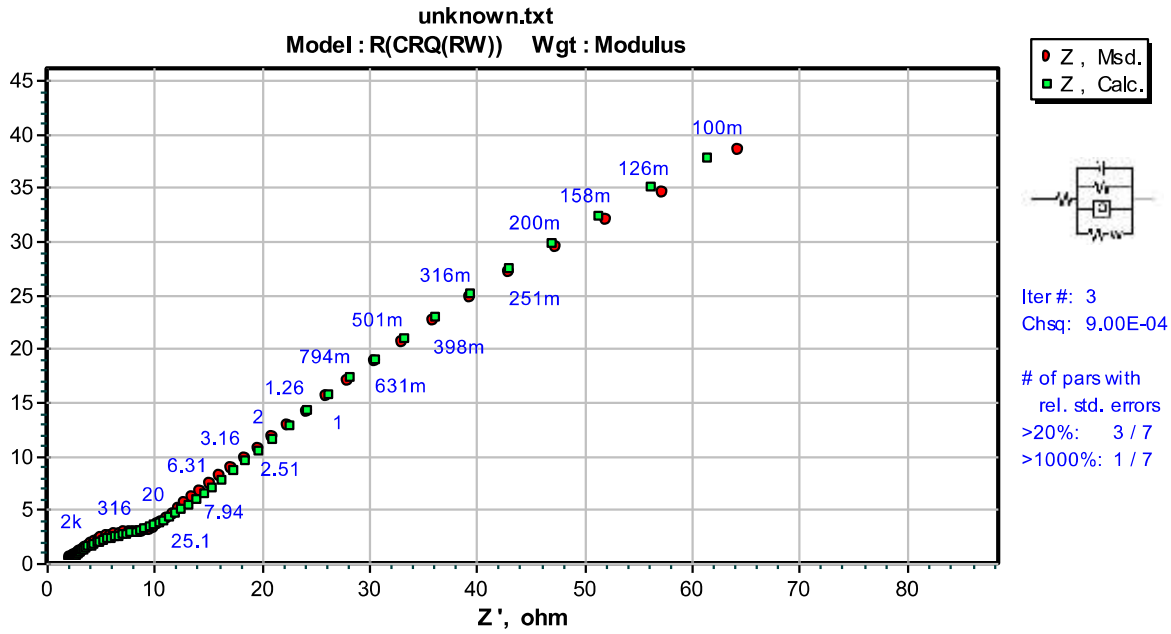


**Figure A7:** Fitted circuit curve of PANI/$CoFe_2O_4$

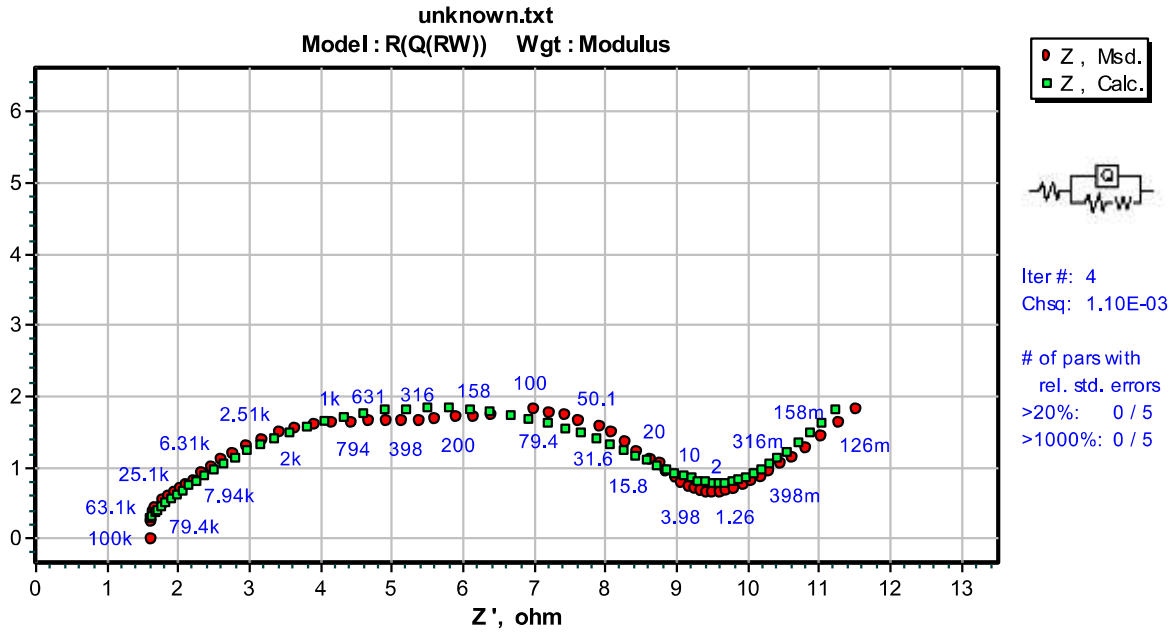


**Figure A8:** Fitted circuit curve of GO/PANI/$CoFe_2O_4$

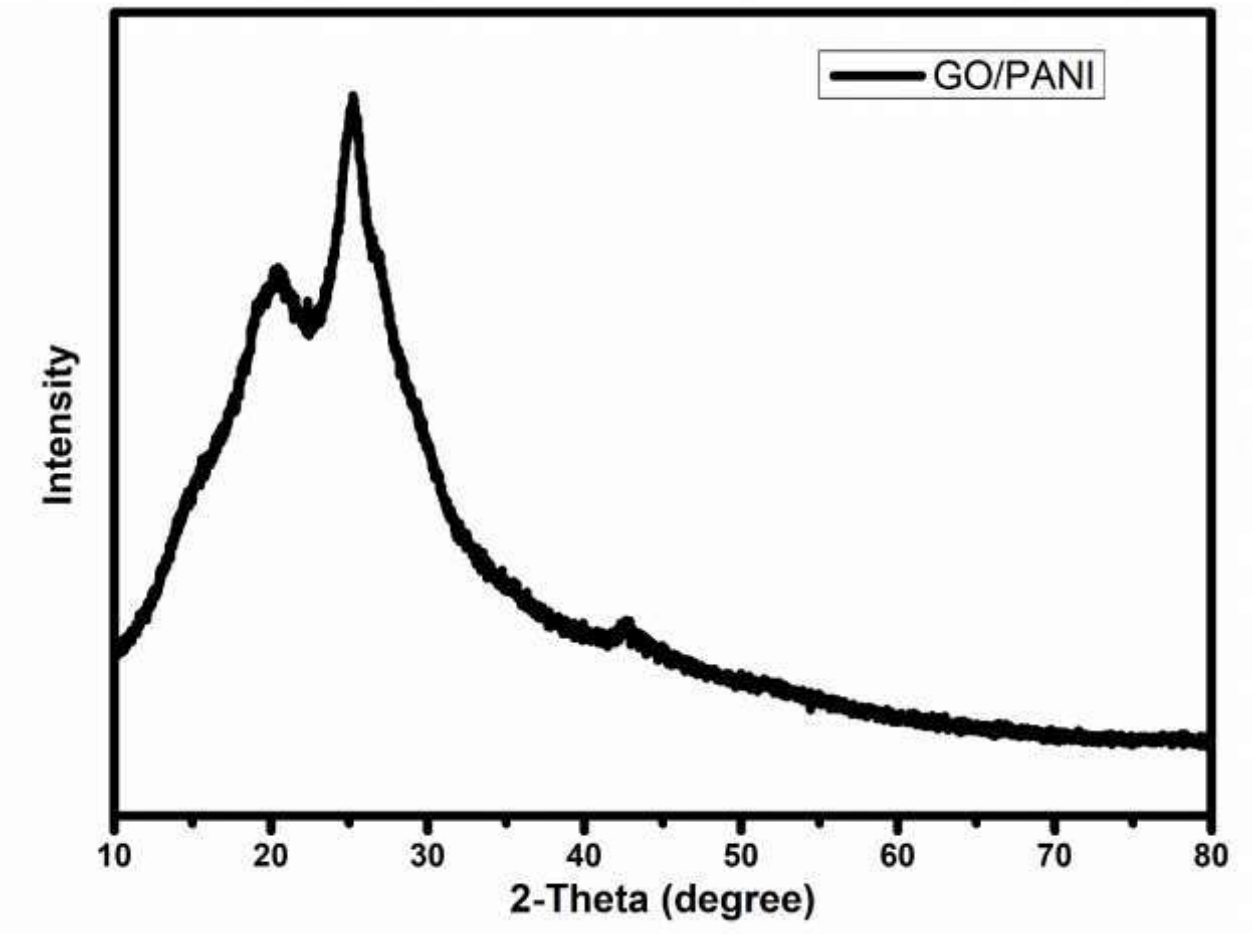


**Figure A9:** XRD pattern of GO/PANI

# *PUBLICATIONS*

**List of published articles**

1. **Verma, S.**, Pandey, V.K. and Verma, B., 2022. Facile synthesis of graphene oxide-polyaniline-copper cobaltite (GO/PANI/CuCo2O4) hybrid nanocomposite for supercapacitor applications. *Synthetic Metals*, *286*, p.117036.

2. **Verma, S.**, Pandey, V.K. and Verma, B., 2022. Synthesis and supercapacitor performance studies of graphene oxide based ternary composite. *Materials Technology*, pp.1-17.

3. **Verma, S.**, Das, T., Pandey, V.K. and Verma, B., 2022. Nanoarchitectonics of GO/PANI/CoFe2O4 (Graphene Oxide/polyaniline/Cobalt Ferrite) based hybrid composite and its use in fabricating symmetric supercapacitor devices. *Journal of Molecular Structure*, *1266*, p.133515.

4. **Verma, S.**, Das, T., Pandey, V.K. and Verma, B., 2022. Facile and scalable synthesis of reduced-graphene oxide using different green reducing agents and its characterizations. *Diamond and Related Materials*, *129*, p.109361.

5. **Verma, S.** and Verma, B., 2023. Synergistic interaction of bacteria with graphene oxide for high performance supercapacitor. *Bioresource Technology Reports*, *21*, p.101354.

**Book Chapters**

1. **Verma, S.** and Verma, B., 2022. Graphene-based nanomaterial for supercapacitor application. In *Nanostructured Materials for Supercapacitors* (pp. 221-244). Springer, Cham.

2. **Verma, S.,** Verma, S., Kumar, S. and Verma, B., 2023. Nanowires for Supercapacitors. In *Nanowires* (pp. 135-148). Boca Raton: CRC Press.

**List of manuscripts communicated**

1. **Sanjeev Verma**, and Bhawna Verma (2022). The influence of spinel copper cobaltite on CNT-reinforced multilayer graphene oxide nanochannel towards efficient energy storage and harvesting. "*Materials Research Bulletin*" (MRB-D-22-01994) [Under Review]
2. **Sanjeev Verma**, and Bhawna Verma (2022). Investigating the electrochemical performance of COF-anchored carbon nanotubes accumulated on graphene oxide nanostructured as an advanced electrode material for supercapacitors. "*Materials Science in Semiconductor Processing*" (MSSP-D-22-02510) [Under Review]
3. **Sanjeev Verma**, Shivani Verma, Tapas Das, and Bhawna Verma (2022). Graphene-based nanocomposites: An efficient detoxification agent for heavy metal removal from wastewater. "Indian Journal of Chemical Technology" (IJCT-4505) [Accepted]