

## References

- [1] A. Kumar, A. Sanger, A. K. Singh, A. Kumar, M. Kumar, and R. Chandra, "Experimental evidence of spin glass and exchange bias behavior in sputtered grown  $\alpha$ -MnO<sub>2</sub> nanorods," *Journal of Magnetism and Magnetic Materials*, vol. 433, pp. 227–233, 2017, doi: 10.1016/j.jmmm.2017.02.061.
- [2] J. Yu, L. Wang, K. Huang, Z. Chen, and Y. Guo, "Large zero-field cooled exchange bias in Ba 1+ $\delta$  Mn<sub>8</sub>O<sub>16</sub> nanoribbons," *Applied Surface Science*, vol. 357, pp. 2343–2346, 2015, doi: 10.1016/j.apsusc.2015.09.239.
- [3] J. Luo, H. T. Zhu, J. K. Liang, G. H. Rao, J. B. Li, and Z. M. Du, "Tuning magnetic properties of  $\alpha$ -MnO<sub>2</sub> nanotubes by K<sup>+</sup> Doping," *Journal of Physical Chemistry C*, vol. 114, no. 19, pp. 8782–8786, 2010, doi: 10.1021/jp1006928.
- [4] P. Strobel, J. Vicat, and D. T. Qui, "Thermal and physical properties of hollandite-type K<sub>1.3</sub>Mn<sub>8</sub>O<sub>16</sub> and (K,H<sub>3</sub>O)<sub>x</sub>Mn<sub>8</sub>O<sub>16</sub>," *Journal of Solid State Chemistry*, vol. 55, no. 1, pp. 67–73, 1984, doi: 10.1016/0022-4596(84)90248-2.
- [5] L. T. Tseng *et al.*, "Magnetic properties in  $\alpha$ -MnO<sub>2</sub> doped with alkaline elements," *Scientific Reports*, vol. 5, pp. 1–8, 2015, doi: 10.1038/srep09094.
- [6] T. Barudžija, V. Kusigerski, N. Cvjetičanin, S. Šorgić, M. Perović, and M. Mitrić, "Structural and magnetic properties of hydrothermally synthesized  $\beta$ -MnO<sub>2</sub> and  $\alpha$ -K<sub>x</sub>MnO<sub>2</sub> nanorods," *Journal of Alloys and Compounds*, vol. 665, pp. 261–270, 2016, doi: 10.1016/j.jallcom.2016.01.024.
- [7] N. Li, X. Zhu, C. Zhang, L. Lai, R. Jiang, and J. Zhu, "Controllable synthesis of different microstructured MnO<sub>2</sub> by a facile hydrothermal method for supercapacitors," *Journal of Alloys and Compounds*, vol. 692, pp. 26–33, 2017, doi: <https://doi.org/10.1016/j.jallcom.2016.08.321>.
- [8] Y. Wang *et al.*, "Structural-controlled synthesis of manganese oxide nanostructures and their electrochemical properties," *Journal of Alloys and Compounds*, vol. 509, no. 33, pp. 8306–8312, 2011, doi: <https://doi.org/10.1016/j.jallcom.2011.05.085>.
- [9] C. L. Tang *et al.*, "Cobalt-doped MnO<sub>2</sub> hierarchical yolk-shell spheres with improved supercapacitive performance," *Journal of Physical Chemistry C*, vol. 119, no. 16, pp. 8465–8471, 2015, doi: 10.1021/jp512795g.
- [10] S. Zhao *et al.*, "Cr-doped MnO<sub>2</sub> nanostructure: morphology evolution and electrochemical properties," *Journal of Materials Science: Materials in Electronics*, vol. 27, no. 4, pp. 3265–3270, 2016, doi: 10.1007/s10854-015-4154-1.
- [11] Z. Qi, S. Huang, A. Younis, D. Chu, and S. Li, "Nanostructured Metal Oxides-Based Electrode in Supercapacitor Applications," *Supercapacitor Design and Applications*, 2016, doi: 10.5772/65155.

- [12] N. Mehtougui, D. Rached, R. Khenata, H. Rached, M. Rabah, and S. Bin-Omran, "Structural, electronic and mechanical properties of RuO<sub>2</sub> from first-principles calculations," *Materials Science in Semiconductor Processing*, vol. 15, no. 4, pp. 331–339, 2012, doi: <https://doi.org/10.1016/j.mssp.2012.02.001>.
- [13] H. H. Sønsteby *et al.*, "Tuning electronic properties in LaNiO<sub>3</sub> thin films by B-site Cu-substitution," *J. Mater. Chem. C*, vol. 8, no. 36, pp. 12662–12668, 2020, doi: [10.1039/D0TC03406A](https://doi.org/10.1039/D0TC03406A).
- [14] R. Thomas, D. C. Dube, M. N. Kamalasanan, and N. D. Kumar, "Electrical Properties of Sol-Gel Processed Amorphous BaTiO<sub>3</sub> Thin Films," *Journal of Sol-Gel Science and Technology*, vol. 16, no. 1, pp. 101–107, 1999, doi: [10.1023/A:1008735820089](https://doi.org/10.1023/A:1008735820089).
- [15] B. S. Nagaraja, A. Rao, P. Poornesh, and G. S. Okram, "Effect of Rare Earth Ionic Radii on Structural, Electric, Magnetic and Thermoelectric Properties of REMnO<sub>3</sub> (RE = Dy, Gd, Eu and Sm) Manganites," *Journal of Superconductivity and Novel Magnetism*, vol. 31, no. 7, pp. 2271–2281, 2018, doi: [10.1007/s10948-017-4505-7](https://doi.org/10.1007/s10948-017-4505-7).
- [16] T. Saito, T. Iwase, J. Horie, and T. Morioka, "Mode of photocatalytic bactericidal action of powdered semiconductor TiO<sub>2</sub> on mutans streptococci," *Journal of Photochemistry and Photobiology B: Biology*, vol. 14, no. 4, pp. 369–379, 1992, doi: [https://doi.org/10.1016/1011-1344\(92\)85115-B](https://doi.org/10.1016/1011-1344(92)85115-B).
- [17] K. Vinodgopal and P. V Kamat, "Enhanced Rates of Photocatalytic Degradation of an Azo Dye Using SnO<sub>2</sub>/TiO<sub>2</sub> Coupled Semiconductor Thin Films," *Environmental Science & Technology*, vol. 29, no. 3, pp. 841–845, Mar. 1995, doi: [10.1021/es00003a037](https://doi.org/10.1021/es00003a037).
- [18] D. Mondal *et al.*, "Synthesis and Property of Copper-Impregnated  $\alpha$ -MnO<sub>2</sub> Semiconductor Quantum Dots," *Langmuir*, vol. 34, no. 43, pp. 12702–12712, Oct. 2018, doi: [10.1021/acs.langmuir.8b01745](https://doi.org/10.1021/acs.langmuir.8b01745).
- [19] H. Chen, Y. Wang, and Y. K. Lv, "Catalytic oxidation of NO over MnO<sub>2</sub> with different crystal structures," *RSC Advances*, vol. 6, no. 59, pp. 54032–54040, 2016, doi: [10.1039/c6ra10103h](https://doi.org/10.1039/c6ra10103h).
- [20] Y. Du, L. Wang, J. Wang, G. Zheng, J. Wu, and H. Dai, "Flower-, wire-, and sheet-like MnO<sub>2</sub>-deposited diatomites: Highly efficient absorbents for the removal of Cr(VI)," *Journal of Environmental Sciences*, vol. 29, pp. 71–81, 2015, doi: <https://doi.org/10.1016/j.jes.2014.06.047>.
- [21] J. Huang *et al.*, "Silver-Containing  $\alpha$ -MnO<sub>2</sub> Nanorods: Electrochemistry in Na-Based Battery Systems," *ACS Applied Materials and Interfaces*, vol. 9, no. 5, pp. 4333–4342, 2017, doi: [10.1021/acsami.6b08549](https://doi.org/10.1021/acsami.6b08549).
- [22] B. Xu, M.-L. Ye, Y.-X. Yu, and W.-D. Zhang, "A highly sensitive hydrogen peroxide amperometric sensor based on MnO<sub>2</sub>-modified vertically aligned multiwalled carbon nanotubes," *Analytica Chimica Acta*, vol. 674, no. 1, pp. 20–26,

2010, doi: <https://doi.org/10.1016/j.aca.2010.06.004>.

- [23] L. Xiao, W. Sun, X. Zhou, Z. Cai, and F. Hu, “Facile synthesis of mesoporous MnO<sub>2</sub> nanosheet and microflower with efficient photocatalytic activities for organic dyes,” *Vacuum*, vol. 156, no. April, pp. 291–297, 2018, doi: [10.1016/j.vacuum.2018.07.045](https://doi.org/10.1016/j.vacuum.2018.07.045).
- [24] M. Lu, S. Kharkwal, H. Y. Ng, and S. F. Y. Li, “Carbon nanotube supported MnO<sub>2</sub> catalysts for oxygen reduction reaction and their applications in microbial fuel cells,” *Biosensors and Bioelectronics*, vol. 26, no. 12, pp. 4728–4732, 2011, doi: <https://doi.org/10.1016/j.bios.2011.05.036>.
- [25] M. Sugantha, P. A. Ramakrishnan, A. M. Hermann, C. P. Warmsingh, and D. S. Ginley, “Nanostructured MnO<sub>2</sub> for Li batteries,” *International Journal of Hydrogen Energy*, vol. 28, no. 6, pp. 597–600, 2003, doi: [10.1016/S0360-3199\(02\)00148-9](https://doi.org/10.1016/S0360-3199(02)00148-9).
- [26] H. Kim *et al.*, “Ab initio study of the sodium intercalation and intermediate phases in Na<sub>0.44</sub>MnO<sub>2</sub> for sodium-ion battery,” *Chemistry of Materials*, vol. 24, no. 6, pp. 1205–1211, 2012, doi: [10.1021/cm300065y](https://doi.org/10.1021/cm300065y).
- [27] K. W. Nam *et al.*, “The High Performance of Crystal Water Containing Manganese Birnessite Cathodes for Magnesium Batteries,” *Nano Letters*, vol. 15, no. 6, pp. 4071–4079, 2015, doi: [10.1021/acs.nanolett.5b01109](https://doi.org/10.1021/acs.nanolett.5b01109).
- [28] J. G. Wang, F. Kang, and B. Wei, “Engineering of MnO<sub>2</sub>-based nanocomposites for high-performance supercapacitors,” *Progress in Materials Science*, vol. 74, pp. 51–124, 2015, doi: [10.1016/j.pmatsci.2015.04.003](https://doi.org/10.1016/j.pmatsci.2015.04.003).
- [29] K. E. College, P. Organize, A. A. Deshmane, and R. B. Bhosale, “Review of Metal Oxide Thin Film Based Supercapacitors,” vol. 2, no. 1, pp. 1–5, 2016.
- [30] A. Byström and A. M. Byström, “The crystal structure of hollandite, the related manganese oxide minerals, and  $\alpha$ -MnO<sub>2</sub>,” *Acta Crystallographica*, vol. 3, no. 2, pp. 146–154, Mar. 1950, doi: [10.1107/S0365110X5000032X](https://doi.org/10.1107/S0365110X5000032X).
- [31] C. Sun, Y. Zhang, S. Song, and D. Xue, “Tunnel-dependent supercapacitance of MnO<sub>2</sub>: effects of crystal structure,” *Journal of Applied Crystallography*, vol. 46, no. 4, pp. 1128–1135, Aug. 2013, doi: [10.1107/S0021889813015999](https://doi.org/10.1107/S0021889813015999).
- [32] M. H. Rossouw, D. C. Liles, M. M. Thackeray, W. I. F. David, and S. Hull, “Alpha manganese dioxide for lithium batteries: A structural and electrochemical study,” *Materials Research Bulletin*, vol. 27, no. 2, pp. 221–230, 1992, doi: [https://doi.org/10.1016/0025-5408\(92\)90216-M](https://doi.org/10.1016/0025-5408(92)90216-M).
- [33] D. A. Kitchaev, S. T. Dacek, W. Sun, and G. Ceder, “Thermodynamics of Phase Selection in MnO<sub>2</sub> Framework Structures through Alkali Intercalation and Hydration,” *Journal of the American Chemical Society*, vol. 139, no. 7, pp. 2672–2681, Feb. 2017, doi: [10.1021/jacs.6b11301](https://doi.org/10.1021/jacs.6b11301).
- [34] H.-J. Cui, H.-Z. Huang, M.-L. Fu, B.-L. Yuan, and W. Pearl, “Facile synthesis and

- catalytic properties of single crystalline  $\beta$ -MnO<sub>2</sub> nanorods,” *Catalysis Communications*, vol. 12, no. 14, pp. 1339–1343, 2011, doi: <https://doi.org/10.1016/j.catcom.2011.05.013>.
- [35] L. Jin *et al.*, “Titanium Containing  $\gamma$ -MnO<sub>2</sub> (TM) Hollow Spheres: One-step synthesis and catalytic activities in li/air batteries and oxidative chemical reactions,” *Advanced Functional Materials*, vol. 20, no. 19, pp. 3373–3382, 2010, doi: [10.1002/adfm.201001080](https://doi.org/10.1002/adfm.201001080).
- [36] A. V. Radhamani, M. Krishna Surendra, and M. S. R. Rao, “Zn doped  $\delta$ -MnO<sub>2</sub> nano flakes: An efficient electrode material for aqueous and solid state asymmetric supercapacitors,” *Applied Surface Science*, vol. 450, pp. 209–218, 2018, doi: [10.1016/j.apsusc.2018.04.081](https://doi.org/10.1016/j.apsusc.2018.04.081).
- [37] N. Wang, X. Cao, G. Lin, and Y. Shihe, “ $\lambda$ -MnO<sub>2</sub> nanodisks and their magnetic properties,” *Nanotechnology*, vol. 18, no. 47, 2007, doi: [10.1088/0957-4484/18/47/475605](https://doi.org/10.1088/0957-4484/18/47/475605).
- [38] Q. Li *et al.*, “Faradaic Electrodes Open a New Era for Capacitive Deionization,” *Advanced Science*, vol. 7, no. 22, p. 2002213, 2020, doi: <https://doi.org/10.1002/advs.202002213>.
- [39] C. Zhou *et al.*, “Magnetic and thermodynamic properties of  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\delta$ -MnO<sub>2</sub>,” *New Journal of Chemistry*, vol. 42, no. 11, pp. 8400–8407, 2018, doi: [10.1039/c8nj00896e](https://doi.org/10.1039/c8nj00896e).
- [40] X. Peng *et al.*, “Double-Exchange Effect in Two-Dimensional MnO<sub>2</sub> Nanomaterials,” *Journal of the American Chemical Society*, vol. 139, no. 14, pp. 5242–5248, 2017, doi: [10.1021/jacs.7b01903](https://doi.org/10.1021/jacs.7b01903).
- [41] P. Tiwari and C. Rath, “Evolution of structure and magnetic properties of stoichiometry and oxygen rich LaMnO<sub>3</sub> nanoparticles,” *Journal of Magnetism and Magnetic Materials*, vol. 441, pp. 635–641, 2017, doi: [10.1016/j.jmmm.2017.06.020](https://doi.org/10.1016/j.jmmm.2017.06.020).
- [42] M. Nasir *et al.*, “Influence of Cation Order and Valence States on Magnetic Ordering in La<sub>2</sub>Ni<sub>1-x</sub>Mn<sub>1+x</sub>O<sub>6</sub>,” *physica status solidi (b)*, vol. 256, no. 11, p. 1900019, 2019, doi: <https://doi.org/10.1002/pssb.201900019>.
- [43] I. V Golosovsky, I. Mirebeau, G. André, D. A. Kurdyukov, Y. A. Kumzerov, and S. B. Vakhruhev, “Magnetic Ordering and Phase Transition in MnO Embedded in a Porous Glass,” *Phys. Rev. Lett.*, vol. 86, no. 25, pp. 5783–5786, Jun. 2001, doi: [10.1103/PhysRevLett.86.5783](https://doi.org/10.1103/PhysRevLett.86.5783).
- [44] C. Rödl, F. Fuchs, J. Furthmüller, and F. Bechstedt, “Quasiparticle band structures of the antiferromagnetic transition-metal oxides MnO, FeO, CoO, and NiO,” *Phys. Rev. B*, vol. 79, no. 23, p. 235114, Jun. 2009, doi: [10.1103/PhysRevB.79.235114](https://doi.org/10.1103/PhysRevB.79.235114).
- [45] S. L. Strong, “Crystal structure distortions in MnO<sub>2</sub> and MnF<sub>2</sub> at their

- antiferromagnetic curie temperature,” *Journal of Physics and Chemistry of Solids*, vol. 19, no. 1, pp. 51–53, 1961, doi: [https://doi.org/10.1016/0022-3697\(61\)90055-5](https://doi.org/10.1016/0022-3697(61)90055-5).
- [46] T. S. Srivatsan, *Physical Properties of Materials*, vol. 30, no. 1. 2015.
- [47] B.D. Cullity, *Introduction to Magnetic materials*, Second Edi. Wiley, 1387.
- [48] J. H. Van Vleck, “On the Theory of Antiferromagnetism,” *The Journal of Chemical Physics*, vol. 9, no. 1, pp. 85–90, 1941, doi: 10.1063/1.1750830.
- [49] C. Schwink and U. Schulze, “On the magnetization curves of CuMn alloys,” *Journal of Magnetism and Magnetic Materials*, vol. 9, no. 1, pp. 31–33, 1978, doi: [https://doi.org/10.1016/0304-8853\(78\)90014-8](https://doi.org/10.1016/0304-8853(78)90014-8).
- [50] L. E. Wenger and P. H. Keesom, “Calorimetric investigation of a spin-glass alloy: CuMn,” *Phys. Rev. B*, vol. 13, no. 9, pp. 4053–4059, May 1976, doi: 10.1103/PhysRevB.13.4053.
- [51] D. Bohm and D. Pines, “A Collective Description of Electron Interactions. I. Magnetic Interactions,” *Phys. Rev.*, vol. 82, no. 5, pp. 625–634, Jun. 1951, doi: 10.1103/PhysRev.82.625.
- [52] V. P. Antropov, B. N. Harmon, and A. N. Smirnov, “Aspects of spin dynamics and magnetic interactions,” *Journal of Magnetism and Magnetic Materials*, vol. 200, no. 1, pp. 148–166, 1999, doi: [https://doi.org/10.1016/S0304-8853\(99\)00425-4](https://doi.org/10.1016/S0304-8853(99)00425-4).
- [53] Y. Wang, Y. Sui, X. Wang, and W. Su, “Structure, transport and magnetic properties of electron-doped perovskites  $R_x\text{Ca}_{1-x}\text{MnO}_3$  ( $R = \text{La}, \text{Y}$  and  $\text{Ce}$ ),” vol. 21, no. 19, p. 196004, Apr. 2009, doi: 10.1088/0953-8984/21/19/196004.
- [54] S. Kumar, S. B. Rai, and C. Rath, “Multifunctional role of dysprosium in  $\text{HfO}_2$ : Stabilization of the high temperature cubic phase, and magnetic and photoluminescence properties,” *Physical Chemistry Chemical Physics*, vol. 19, no. 29, pp. 18957–18967, 2017, doi: 10.1039/c7cp02800h.
- [55] B. Bharati, N. C. Mishra, D. Kanjilal, and C. Rath, “500 keV  $\text{Ar}^{2+}$  ion irradiation induced anatase to brookite phase transformation and ferromagnetism at room temperature in  $\text{TiO}_2$  thin films,” *Applied Surface Science*, vol. 428, pp. 723–729, 2018, doi: 10.1016/j.apsusc.2017.09.070.
- [56] A. González, E. Goikolea, J. A. Barrena, and R. Mysyk, “Review on supercapacitors: Technologies and materials,” *Renewable and Sustainable Energy Reviews*, vol. 58, pp. 1189–1206, 2016, doi: 10.1016/j.rser.2015.12.249.
- [57] C. M. Julien and A. Mauger, “Nanostructured  $\text{MnO}_2$  as electrode materials for energy storage,” *Nanomaterials*, vol. 7, no. 11, 2017, doi: 10.3390/nano7110396.
- [58] D. Li, W. Li, Y. Deng, X. Wu, N. Han, and Y. Chen, “Effective Ti Doping of  $\Delta\text{-MnO}_2$  via Anion Route for Highly Active Catalytic Combustion of Benzene,” *Journal of Physical Chemistry C*, vol. 120, no. 19, pp. 10275–10282, 2016, doi:

10.1021/acs.jpcc.6b00931.

- [59] M. Chen *et al.*, “FeOOH-loaded MnO<sub>2</sub> nano-composite: An efficient emergency material for thallium pollution incident,” *Journal of Environmental Management*, vol. 192, pp. 31–38, 2017, doi: <https://doi.org/10.1016/j.jenvman.2017.01.038>.
- [60] V. Anbumannan, M. Dinesh, R. T. Rajendra Kumar, and K. Suresh, “Hierarchical  $\alpha$ -MnO<sub>2</sub> wrapped MWCNTs sensor for low level detection of p-nitrophenol in water,” *Ceramics International*, vol. 45, no. 17, Part B, pp. 23097–23103, 2019, doi: <https://doi.org/10.1016/j.ceramint.2019.08.002>.
- [61] A. Kozawa and R. A. Powers, “Electrochemical reactions in batteries: Emphasizing the MnO<sub>2</sub> cathode of dry cells,” *Journal of Chemical Education*, vol. 49, no. 9, pp. 587–591, 1972, doi: 10.1021/ed049p587.
- [62] Y. A. El-Nadi, J. A. Daoud, and H. F. Aly, “Leaching and separation of zinc from the black paste of spent MnO<sub>2</sub>-Zn dry cell batteries,” *Journal of Hazardous Materials*, vol. 143, no. 1, pp. 328–334, 2007, doi: <https://doi.org/10.1016/j.jhazmat.2006.09.027>.
- [63] C. Sikalidis and V. Zaspalis, “Utilization of Mn-Fe solid wastes from electrolytic MnO<sub>2</sub> production in the manufacture of ceramic building products,” *Construction and Building Materials*, vol. 21, no. 5, pp. 1061–1068, 2007, doi: <https://doi.org/10.1016/j.conbuildmat.2006.02.009>.
- [64] L. I. Hill, A. Verbaere, and D. Guyomard, “MnO<sub>2</sub> ( $\alpha$ -,  $\beta$ -,  $\gamma$ -) compounds prepared by hydrothermal-electrochemical synthesis: Characterization, morphology, and lithium insertion behavior,” *Journal of Power Sources*, vol. 119–121, pp. 226–231, 2003, doi: 10.1016/S0378-7753(03)00238-6.
- [65] W. Zhang, H. Jin, Y. Du, Y. Zhang, Z. Wang, and J. Zhang, “Hierarchical Lamellar-Structured MnO<sub>2</sub>@graphene for High Performance Li, Na and K ion Batteries,” *ChemistrySelect*, vol. 5, no. 40, pp. 12481–12486, 2020, doi: <https://doi.org/10.1002/slct.202003584>.
- [66] R. Zhang *et al.*, “ $\alpha$ -MnO<sub>2</sub> as a cathode material for rechargeable Mg batteries,” *Electrochemistry Communications*, vol. 23, pp. 110–113, 2012, doi: <https://doi.org/10.1016/j.elecom.2012.07.021>.
- [67] Rusi and S. R. Majid, “Green synthesis of in situ electrodeposited rGO/MnO<sub>2</sub> nanocomposite for high energy density supercapacitors,” *Scientific Reports*, vol. 5, no. July, pp. 1–13, 2015, doi: 10.1038/srep16195.
- [68] R. Jiang, T. Huang, J. Liu, J. Zhuang, and A. Yu, “A novel method to prepare nanostructured manganese dioxide and its electrochemical properties as a supercapacitor electrode,” *Electrochimica Acta*, vol. 54, no. 11, pp. 3047–3052, 2009, doi: 10.1016/j.electacta.2008.12.007.
- [69] Y. L. Chan, S. Y. Pung, S. Sreekantan, and F. Y. Yeoh, “Photocatalytic activity of  $\beta$ -

- MnO<sub>2</sub> nanotubes grown on PET fibre under visible light irradiation,” *Journal of Experimental Nanoscience*, vol. 11, no. 8, pp. 603–618, 2016, doi: 10.1080/17458080.2015.1102342.
- [70] B. Yin, S. Zhang, Y. Jiao, Y. Liu, F. Qu, and X. Wu, “Facile synthesis of ultralong MnO<sub>2</sub> nanowires as high performance supercapacitor electrodes and photocatalysts with enhanced photocatalytic activities,” *CrystEngComm*, vol. 16, no. 43, pp. 9999–10005, 2014, doi: 10.1039/c4ce01302f.
- [71] Y. He, D. Bin Jiang, J. Chen, D. Y. Jiang, and Y. X. Zhang, “Synthesis of MnO<sub>2</sub> nanosheets on montmorillonite for oxidative degradation and adsorption of methylene blue,” *Journal of Colloid and Interface Science*, vol. 510, pp. 207–220, 2018, doi: 10.1016/j.jcis.2017.09.066.
- [72] T. Shi, F. Jiang, P. Wang, T. Yue, and W. Sun, “Deep purification of As(V) in drinking water by silica gel loaded with FeOOH and MnO<sub>2</sub>,” *Journal of Central South University*, vol. 28, no. 6, pp. 1692–1706, 2021, doi: 10.1007/s11771-021-4727-5.
- [73] Z. S. Iro, C. Subramani, and S. S. Dash, “A brief review on electrode materials for supercapacitor,” *International Journal of Electrochemical Science*, vol. 11, no. 12, pp. 10628–10643, 2016, doi: 10.20964/2016.12.50.
- [74] C.-C. Hu, K.-H. Chang, M.-C. Lin, and Y.-T. Wu, “Design and Tailoring of the Nanotubular Arrayed Architecture of Hydrrous RuO<sub>2</sub> for Next Generation Supercapacitors,” *Nano Letters*, vol. 6, no. 12, pp. 2690–2695, Dec. 2006, doi: 10.1021/nl061576a.
- [75] I. I. Misnon and R. Jose, “Synthesis and electrochemical evaluation of the PANI/δ-MnO<sub>2</sub> electrode for high performing asymmetric supercapacitors,” *New Journal of Chemistry*, vol. 41, no. 14, pp. 6574–6584, 2017, doi: 10.1039/c7nj00679a.
- [76] Y. Zhang *et al.*, “Carbon nanotube–ZnO nanocomposite electrodes for supercapacitors,” *Solid State Ionics*, vol. 180, no. 32, pp. 1525–1528, 2009, doi: <https://doi.org/10.1016/j.ssi.2009.10.001>.
- [77] C. Xiang, M. Li, M. Zhi, A. Manivannan, and N. Wu, “A reduced graphene oxide/Co<sub>3</sub>O<sub>4</sub> composite for supercapacitor electrode,” *Journal of Power Sources*, vol. 226, pp. 65–70, 2013, doi: <https://doi.org/10.1016/j.jpowsour.2012.10.064>.
- [78] S. Sahoo, S. Zhang, and J.-J. Shim, “Porous Ternary High Performance Supercapacitor Electrode Based on Reduced Graphene Oxide, NiMn<sub>2</sub>O<sub>4</sub>, and Polyaniline,” *Electrochimica Acta*, vol. 216, pp. 386–396, 2016, doi: <https://doi.org/10.1016/j.electacta.2016.09.030>.
- [79] H. Y. Lee and J. B. Goodenough, “Supercapacitor Behavior with KCl Electrolyte,” *Journal of Solid State Chemistry*, vol. 144, no. 1, pp. 220–223, 1999, doi: <https://doi.org/10.1006/jssc.1998.8128>.

- [80] S.-C. Pang and M. Anderson, "Novel Electrode Materials for Ultracapacitors: Structural and Electrochemical Properties of Sol-Gel-Derived Manganese Dioxide Thin Films," *MRS Proceedings*, vol. 575, p. 415, 1999, doi: 10.1557/PROC-575-415.
- [81] S. Dawadi, A. Gupta, M. Khatri, B. Budhathoki, G. Lamichhane, and N. Parajuli, "Manganese dioxide nanoparticles: synthesis, application and challenges," *Bulletin of Materials Science*, vol. 43, no. 1, pp. 1–10, 2020, doi: 10.1007/s12034-020-02247-8.
- [82] Y. Wang *et al.*, "Structural-controlled synthesis of manganese oxide nanostructures and their electrochemical properties," *Journal of Alloys and Compounds*, vol. 509, no. 33, pp. 8306–8312, 2011, doi: 10.1016/j.jallcom.2011.05.085.
- [83] Z. Guo and X. Xia, "Performance improvement of a MH/MnO<sub>2</sub> rechargeable battery," *Journal of Applied Electrochemistry*, vol. 29, no. 12, pp. 1417–1421, 1999, doi: 10.1023/A:1003821412087.
- [84] L. Song, Y. Duan, Y. Zhang, and T. Wang, "Promoting defect formation and microwave loss properties in  $\delta$ -MnO<sub>2</sub> via Co doping: A first-principles study," *Computational Materials Science*, vol. 138, pp. 288–294, 2017, doi: 10.1016/j.commatsci.2017.06.020.
- [85] J. C. Villegas, L. J. Garces, S. Gomez, J. P. Durand, and S. L. Suib, "Particle Size Control of Cryptomelane Nanomaterials by Use of H<sub>2</sub>O<sub>2</sub> in Acidic Conditions," *Chemistry of Materials*, vol. 17, no. 7, pp. 1910–1918, Apr. 2005, doi: 10.1021/cm048391u.
- [86] N. Tang, X. Tian, C. Yang, Z. Pi, and Q. Han, "Facile synthesis of  $\alpha$ -MnO<sub>2</sub> nanorods for high-performance alkaline batteries," *Journal of Physics and Chemistry of Solids*, vol. 71, no. 3, pp. 258–262, 2010, doi: 10.1016/j.jpics.2009.11.016.
- [87] H. Kumar and P. Sangwan, "Synthesis and Characterization of MnO<sub>2</sub> Nanoparticles using Co-precipitation Technique," *International Journal of Chemistry and Chemical Engineering*, vol. 3, no. 3, pp. 155–160, 2013.
- [88] Y. Chen, Y. Hong, Y. Ma, and J. Li, "Synthesis and formation mechanism of urchin-like nano/micro-hybrid  $\alpha$ -MnO<sub>2</sub>," *Journal of Alloys and Compounds*, vol. 490, no. 1, pp. 331–335, 2010, doi: <https://doi.org/10.1016/j.jallcom.2009.10.004>.
- [89] V. Subramanian, H. Zhu, R. Vajtai, P. M. Ajayan, and B. Wei, "Hydrothermal Synthesis and Pseudocapacitance Properties of MnO<sub>2</sub> Nanostructures," *The Journal of Physical Chemistry B*, vol. 109, no. 43, pp. 20207–20214, Nov. 2005, doi: 10.1021/jp0543330.
- [90] X. Duan, J. Yang, H. Gao, J. Ma, L. Jiao, and W. Zheng, "Controllable hydrothermal synthesis of manganese dioxide nanostructures: Shape evolution, growth mechanism and electrochemical properties," *CrystEngComm*, vol. 14, no. 12, pp. 4196–4204, 2012, doi: 10.1039/c2ce06587h.



- [91] W. Xiao, D. Wang, and X. W. Lou, "Shape-Controlled Synthesis of MnO<sub>2</sub> Nanostructures with Enhanced Electrocatalytic Activity for Oxygen Reduction," *The Journal of Physical Chemistry C*, vol. 114, no. 3, pp. 1694–1700, Jan. 2010, doi: 10.1021/jp909386d.
- [92] T. Gao, M. Glerup, F. Krumeich, R. Nesper, H. Fjellvåg, and P. Norby, "Microstructures and spectroscopic properties of cryptomelane-type manganese dioxide nanofibers," *Journal of Physical Chemistry C*, vol. 112, no. 34, pp. 13134–13140, 2008, doi: 10.1021/jp804924f.
- [93] D. E. Zhang *et al.*, "Fabrication and characterisation of MnOOH and  $\beta$ -MnO<sub>2</sub> nanorods with rectangular cross-sections," *Journal of Experimental Nanoscience*, vol. 8, no. 1, pp. 77–83, 2013, doi: 10.1080/17458080.2011.561444.
- [94] Z. Fan, Z. Qie, T. Wei, J. Yan, and S. Wang, "Preparation and characteristics of nanostructured MnO<sub>2</sub>/MWCNTs using microwave irradiation method," *Materials Letters*, vol. 62, no. 19, pp. 3345–3348, 2008, doi: 10.1016/j.matlet.2008.02.060.
- [95] Z. Li, A. Gu, Z. Lou, J. Sun, Q. Zhou, and K. Y. Chan, "Facile synthesis of iron-doped hollow urchin-like MnO<sub>2</sub> for supercapacitors," *Journal of Materials Science*, vol. 52, no. 9, pp. 4852–4865, 2017, doi: 10.1007/s10853-016-0720-z.
- [96] M. Musil, B. Choi, and A. Tsutsumi, "Morphology and Electrochemical Properties of  $\alpha$ -,  $\beta$ -,  $\gamma$ -, and  $\delta$ -MnO<sub>2</sub> Synthesized by Redox Method," *Journal of The Electrochemical Society*, vol. 162, no. 10, pp. A2058–A2065, 2015, doi: 10.1149/2.0201510jes.
- [97] C. Wei, C. Xu, B. Li, D. Nan, J. Ma, and F. Kang, "Formation and conversion mechanisms between single-crystal gamma-MnOOH and manganese oxides," *Materials Research Bulletin*, vol. 47, no. 7, pp. 1740–1746, 2012, doi: 10.1016/j.materresbull.2012.03.041.
- [98] X.-F. Shen *et al.*, "Control of Nanometer-Scale Tunnel Sizes of Porous Manganese Oxide Octahedral Molecular Sieve Nanomaterials," *Advanced Materials*, vol. 17, no. 7, pp. 805–809, 2005, doi: <https://doi.org/10.1002/adma.200401225>.
- [99] N. Zhang *et al.*, "Precisely controlled synthesis of  $\alpha$ -/ $\beta$ -MnO<sub>2</sub> materials by adding Zn(acac)<sub>2</sub> as a phase transformation-inducing agent," *Chemical Communications*, vol. 54, no. 12, pp. 1477–1480, 2018, doi: 10.1039/c7cc08253c.
- [100] X. Sun, V. Duffort, B. L. Mehdi, N. D. Browning, and L. F. Nazar, "Investigation of the Mechanism of Mg Insertion in Birnessite in Nonaqueous and Aqueous Rechargeable Mg-Ion Batteries," *Chemistry of Materials*, vol. 28, no. 2, pp. 534–542, Jan. 2016, doi: 10.1021/acs.chemmater.5b03983.
- [101] E. Hastuti, A. Subhan, P. Amonpattaratkit, M. Zainuri, and S. Suasmoro, "The effects of Fe-doping on MnO<sub>2</sub>: phase transitions, defect structures and its influence on electrical properties," *RSC Advances*, vol. 11, no. 14, pp. 7808–7823, 2021, doi: 10.1039/d0ra10376d.

- [102] W. Li *et al.*, “Performance modulation of  $\alpha$ -MnO<sub>2</sub> nanowires by crystal facet engineering,” *Scientific Reports*, vol. 5, pp. 1–8, 2015, doi: 10.1038/srep08987.
- [103] J. Yu, S. Tang, L. Wang, and Y. Du, “Spin-glass-like behavior in hollandite Ba<sub>1+ $\delta$</sub> Mn<sub>8</sub>O<sub>16</sub> nanoribbons synthesized by molten-salt method,” *Chemical Physics Letters*, vol. 496, no. 1–3, pp. 117–121, 2010, doi: 10.1016/j.cplett.2010.07.029.
- [104] J. Luo, H. T. Zhu, J. K. Liang, G. H. Rao, J. B. Li, and Z. M. Du, “Tuning Magnetic Properties of  $\gamma$ -MnO<sub>2</sub> Nanotubes by K<sup>+</sup> Doping,” pp. 8782–8786, 2010.
- [105] S. Zhao *et al.*, “Hydrothermal synthesis of urchin-like MnO<sub>2</sub> nanostructures and its electrochemical character for supercapacitor,” *Applied Surface Science*, vol. 351, pp. 862–868, 2015, doi: 10.1016/j.apsusc.2015.06.045.
- [106] H. Wei, J. Wang, S. Yang, Y. Zhang, T. Li, and S. Zhao, “Facile hydrothermal synthesis of one-dimensional nanostructured  $\alpha$ -MnO<sub>2</sub> for supercapacitors,” *Physica E: Low-Dimensional Systems and Nanostructures*, vol. 83, pp. 41–46, 2016, doi: 10.1016/j.physe.2016.04.008.
- [107] K. Chen, W. Pan, and D. Xue, “Phase transformation of Ce<sup>3+</sup>-Doped MnO<sub>2</sub> for pseudocapacitive electrode materials,” *Journal of Physical Chemistry C*, vol. 120, no. 36, pp. 20077–20081, 2016, doi: 10.1021/acs.jpcc.6b07708.
- [108] Y. Zhang, Y. Liu, F. Guo, Y. Hu, X. Liu, and Y. Qian, “Single-crystal growth of MnOOH and beta-MnO<sub>2</sub> microrods at lower temperatures,” *Solid State Communications*, vol. 134, no. 8, pp. 523–527, 2005, doi: 10.1016/j.ssc.2005.03.002.
- [109] L. Gao, L. Zhang, S. Jia, X. Liu, Y. Wang, and S. Xing, “Facile route to achieve hierarchical hollow MnO<sub>2</sub> nanostructures,” *Electrochimica Acta*, vol. 203, pp. 59–65, 2016, doi: 10.1016/j.electacta.2016.04.035.
- [110] D. Zheng, Y. Qiang, S. Xu, W. Li, S. Yu, and S. Zhang, “Hierarchical MnO<sub>2</sub> nanosheets synthesized via electrodeposition-hydrothermal method for supercapacitor electrodes,” *Applied Physics A: Materials Science and Processing*, vol. 123, no. 2, pp. 1–10, 2017, doi: 10.1007/s00339-016-0728-x.
- [111] Y. Li, Z. Xu, D. Wang, J. Zhao, and H. Zhang, “Snowflake-like core-shell  $\alpha$ -MnO<sub>2</sub>@ $\delta$ -MnO<sub>2</sub> for high performance asymmetric supercapacitor,” *Electrochimica Acta*, vol. 251, pp. 344–354, 2017, doi: 10.1016/j.electacta.2017.08.146.
- [112] M. Huang *et al.*, “Self-assembly of mesoporous nanotubes assembled from interwoven ultrathin birnessite-type MnO<sub>2</sub> nanosheets for asymmetric supercapacitors,” *Scientific Reports*, vol. 4, pp. 1–8, 2014, doi: 10.1038/srep03878.
- [113] M. Wei, Y. Konishi, H. Zhou, H. Sugihara, and H. Arakawa, “Synthesis of single-crystal manganese dioxide nanowires by a soft chemical process,” *Nanotechnology*, vol. 16, no. 2, pp. 245–249, Jan. 2005, doi: 10.1088/0957-4484/16/2/011.
- [114] X. Ren, C. Tian, S. Li, Y. Zhao, and C. A. Wang, “Facile synthesis of tremella-like

- MnO<sub>2</sub> and its application as supercapacitor electrodes,” *Frontiers of Materials Science*, vol. 9, no. 3, pp. 234–240, 2015, doi: 10.1007/s11706-015-0306-8.
- [115] I. I. Misnon, R. A. Aziz, N. K. M. Zain, B. Vidhyadharan, S. G. Krishnan, and R. Jose, “High performance MnO<sub>2</sub> nanoflower electrode and the relationship between solvated ion size and specific capacitance in highly conductive electrolytes,” *Materials Research Bulletin*, vol. 57, pp. 221–230, 2014, doi: 10.1016/j.materresbull.2014.05.044.
- [116] W. Xiao, H. Xia, J. Y. H. Fuh, and L. Lu, “Growth of single-crystal  $\alpha$ -MnO<sub>2</sub> nanotubes prepared by a hydrothermal route and their electrochemical properties,” *Journal of Power Sources*, vol. 193, no. 2, pp. 935–938, 2009, doi: 10.1016/j.jpowsour.2009.03.073.
- [117] V. Subramanian, H. Zhu, and B. Wei, “Nanostructured MnO<sub>2</sub>: Hydrothermal synthesis and electrochemical properties as a supercapacitor electrode material,” *Journal of Power Sources*, vol. 159, no. 1 SPEC. ISS., pp. 361–364, 2006, doi: 10.1016/j.jpowsour.2006.04.012.
- [118] R. Poonguzhali, N. Shanmugam, R. Gobi, A. Senthilkumar, G. Viruthagiri, and N. Kannadasan, “Effect of Fe doping on the electrochemical capacitor behavior of MnO<sub>2</sub> nanocrystals,” *Journal of Power Sources*, vol. 293, pp. 790–798, 2015, doi: 10.1016/j.jpowsour.2015.06.021.
- [119] Z. Hu *et al.*, “2D vanadium doped manganese dioxides nanosheets for pseudocapacitive energy storage,” *Nanoscale*, vol. 7, no. 38, pp. 16094–16099, 2015, doi: 10.1039/c5nr04682c.
- [120] C. K. King’Ondu *et al.*, “Manganese oxide octahedral molecular sieves (OMS-2) multiple framework substitutions: A new route to OMS-2 particle size and morphology control,” *Advanced Functional Materials*, vol. 21, no. 2, pp. 312–323, 2011, doi: 10.1002/adfm.201001020.
- [121] S. Shen *et al.*, “Effect of Sm-doped Ni-Al layered double hydroxide on electrochemical performance for supercapacitors,” vol. 2009, no. 1, p. 12008, Aug. 2021, doi: 10.1088/1742-6596/2009/1/012008.
- [122] M. Naveed ur Rehman *et al.*, “Facile synthesis and characterization of conducting polymer-metal oxide based core-shell PANI-Pr<sub>2</sub>O–NiO–Co<sub>3</sub>O<sub>4</sub> nanocomposite: As electrode material for supercapacitor,” *Ceramics International*, vol. 47, no. 13, pp. 18497–18509, 2021, doi: <https://doi.org/10.1016/j.ceramint.2021.03.173>.
- [123] H. Lin *et al.*, “Synthesis and electrochemical properties of Er/ $\alpha$ -MnO<sub>2</sub> microspheres for supercapacitors application,” *Ionics*, vol. 25, no. 8, pp. 3867–3873, 2019, doi: 10.1007/s11581-019-02939-0.
- [124] K. Prasanna *et al.*, “Highly porous CeO<sub>2</sub> nanostructures prepared via combustion synthesis for supercapacitor applications,” *Applied Surface Science*, vol. 449, pp. 454–460, 2018, doi: <https://doi.org/10.1016/j.apsusc.2017.12.130>.

- [125] G. Zhang *et al.*, “Preparation of Ag-nanoparticle-loaded MnO<sub>2</sub> nanosheets and their capacitance behavior,” *Energy and Fuels*, vol. 26, no. 1, pp. 618–623, 2012, doi: 10.1021/ef201446h.
- [126] D. P. Dubal and C. D. Lokhande, “Significant improvement in the electrochemical performances of nano-nest like amorphous MnO<sub>2</sub> electrodes due to Fe doping,” *Ceramics International*, vol. 39, no. 1, pp. 415–423, 2013, doi: 10.1016/j.ceramint.2012.06.042.
- [127] R. Poonguzhali, R. Gobi, N. Shanmugam, A. Senthil Kumar, G. Viruthagiri, and N. Kannadasan, “Enhancement in electrochemical behavior of copper doped MnO<sub>2</sub> electrode,” *Materials Letters*, vol. 157, no. 44, pp. 116–122, 2015, doi: 10.1016/j.matlet.2015.05.086.
- [128] Q. Liu, S. Wang, and H. Cheng, “High rate capabilities Fe-doped EMD electrodes for Li/MnO<sub>2</sub> primary battery,” *International Journal of Electrochemical Science*, vol. 8, no. 8, pp. 10540–10548, 2013.
- [129] Y.-L. Li, L.-H. Li, S.-F. Lin, and Q.-Q. He, “Ni-doped MnO<sub>2</sub> and Its Electrochemical Properties,” *DEStech Transactions on Engineering and Technology Research*, no. apetc, pp. 1088–1094, 2017, doi: 10.12783/dtetr/apetc2017/11128.
- [130] S. Zhao *et al.*, “Rational synthesis of Cu-doped porous  $\delta$ -MnO<sub>2</sub> microsphere for high performance supercapacitor applications,” *Electrochimica Acta*, vol. 191, pp. 716–723, 2016, doi: 10.1016/j.electacta.2016.01.106.
- [131] B. C. Kim, C. Justin Raj, W. J. Cho, W. G. Lee, H. T. Jeong, and K. H. Yu, “Enhanced electrochemical properties of cobalt doped manganese dioxide nanowires,” *Journal of Alloys and Compounds*, vol. 617, pp. 491–497, 2014, doi: 10.1016/j.jallcom.2014.08.018.
- [132] H. Lin, J. Miao, Z. Mao, S. He, M. Zhang, and Q. Li, “Effects of Sn doping on capacitive performance of  $\sigma$ -MnO<sub>2</sub> on the high operating temperatures,” *Functional Materials Letters*, vol. 11, no. 1, pp. 1–4, 2018, doi: 10.1142/S1793604718500078.
- [133] R. Poonguzhali, N. Shanmugam, R. Gobi, A. Senthilkumar, R. Shanmugam, and K. Sathishkumar, “Influence of Zn doping on the electrochemical capacitor behavior of MnO<sub>2</sub> nanocrystals,” *RSC Advances*, vol. 5, no. 56, pp. 45407–45415, 2015, doi: 10.1039/c5ra01326g.
- [134] Q. Gao, J. Wang, B. Ke, J. Wang, and Y. Li, “Fe doped  $\delta$ -MnO<sub>2</sub> nanoneedles as advanced supercapacitor electrodes,” *Ceramics International*, vol. 44, no. 15, pp. 18770–18775, 2018, doi: 10.1016/j.ceramint.2018.07.108.
- [135] H. Z. Chi, Y. Li, Y. Xin, and H. Qin, “Boron-doped manganese dioxide for supercapacitors,” *Chemical Communications*, vol. 50, no. 87, pp. 13349–13352, 2014, doi: 10.1039/c4cc05457a.
- [136] H. Lin *et al.*, “Synthesis and electrochemical properties of Er/A-MnO<sub>2</sub> microspheres

- for supercapacitors application,” *Ionics*, vol. 25, no. 8, pp. 3867–3873, 2019, doi: 10.1007/s11581-019-02939-0.
- [137] B. Lan, S. Huang, C. Ye, Q. Qin, J. Yan, and Y. Wu, “Enhanced electrochemical performance of Sn-doped MnO<sub>2</sub> and study on morphology evolution,” *Journal of Alloys and Compounds*, vol. 788, pp. 302–310, 2019, doi: 10.1016/j.jallcom.2019.02.171.
- [138] R. Rajagopal and K. S. Ryu, “Influence of rare earth elements on porosity controlled synthesis of MnO<sub>2</sub> nanostructures for supercapacitor applications,” *Electrochimica Acta*, vol. 265, pp. 532–546, 2018, doi: 10.1016/j.electacta.2018.01.161.
- [139] H. Yang *et al.*, “Influences of graphene oxide support on the electrochemical performances of graphene oxide-MnO<sub>2</sub> nanocomposites,” *Nanoscale Research Letters*, vol. 6, pp. 1–8, 2011, doi: 10.1186/1556-276X-6-531.
- [140] L. Wang, D. Deng, S. O. Salley, and K. Y. S. Ng, “Facile synthesis of 3-D composites of MnO<sub>2</sub> nanorods and holey graphene oxide for supercapacitors,” *Journal of Materials Science*, vol. 50, no. 19, pp. 6313–6320, 2015, doi: 10.1007/s10853-015-9169-8.
- [141] X. Chang, X. Zhai, S. Sun, D. Gu, and L. Dong, “MnO<sub>2</sub> / g-C<sub>3</sub>N<sub>4</sub> nanocomposite with highly enhanced supercapacitor performance.”
- [142] H. R. Naderi, P. Norouzi, and M. R. Ganjali, “Electrochemical study of a novel high performance supercapacitor based on MnO<sub>2</sub> /nitrogen-doped graphene nanocomposite,” *Applied Surface Science*, vol. 366, no. March 2018, pp. 552–560, 2016, doi: 10.1016/j.apsusc.2016.01.058.
- [143] J. Yan, Z. Fan, T. Wei, Z. Qie, S. Wang, and M. Zhang, “Preparation and electrochemical characteristics of manganese dioxide/graphite nanoplatelet composites,” *Materials Science and Engineering B: Solid-State Materials for Advanced Technology*, vol. 151, no. 2, pp. 174–178, 2008, doi: 10.1016/j.mseb.2008.05.018.
- [144] X. Xie and L. Gao, “Characterization of a manganese dioxide/carbon nanotube composite fabricated using an in situ coating method,” *Carbon*, vol. 45, no. 12, pp. 2365–2373, 2007, doi: 10.1016/j.carbon.2007.07.014.
- [145] Q. Cheng, J. Tang, J. Ma, H. Zhang, N. Shinya, and L. C. Qin, “Graphene and nanostructured MnO<sub>2</sub> composite electrodes for supercapacitors,” *Carbon*, vol. 49, no. 9, pp. 2917–2925, 2011, doi: 10.1016/j.carbon.2011.02.068.
- [146] W. Liu *et al.*, “Fabrication of ternary hierarchical nanofibers MnO<sub>2</sub>/PANI/CNT and theirs application in electrochemical supercapacitors,” *Chemical Engineering Science*, vol. 156, pp. 178–185, 2016, doi: 10.1016/j.ces.2016.09.025.
- [147] Y. Song, M. Shang, J. Li, and Y. Su, *Continuous and controllable synthesis of MnO<sub>2</sub>/PPy composites with core-shell structures for supercapacitors*, vol. 405.

Elsevier B.V., 2021.

- [148] M. Dirican, M. Yanilmaz, A. M. Asiri, and X. Zhang, "Polyaniline/MnO<sub>2</sub>/porous carbon nanofiber electrodes for supercapacitors," *Journal of Electroanalytical Chemistry*, vol. 861, 2020, doi: 10.1016/j.jelechem.2020.113995.
- [149] G. E. Jauncey, "The Scattering of X-Rays and Bragg's Law.," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 10, no. 2, pp. 57–60, Feb. 1924, doi: 10.1073/pnas.10.2.57.
- [150] F. T. L. Muniz, M. A. R. Miranda, C. dos Santos, and J. M. Sasaki, "The Scherrer equation and the dynamical theory of X-ray diffraction," *Acta Crystallographica Section A*, vol. 72, no. 3, pp. 385–390, May 2016, doi: 10.1107/S205327331600365X.
- [151] M. C. Militello and S. W. Gaarenstroom, "Manganese Dioxide (MnO<sub>2</sub>) by XPS," *Surface Science Spectra*, vol. 8, no. 3, pp. 200–206, 2001, doi: 10.1116/11.20020401.
- [152] Autolab Application Note EC08, "Basic overview of the working principle of a potentiostat/galvanostat (PGSTAT) – Electrochemical cell setup," *Metrohm Autolab.B.V.*, pp. 1–3, 2011.
- [153] W. Li *et al.*, "Performance modulation of  $\alpha$ -MnO<sub>2</sub> nanowires by crystal facet engineering," *Scientific Reports*, vol. 5, no. March, 2015, doi: 10.1038/srep08987.
- [154] A. M. Toufiq, F. Wang, and H. Ullah Shah, "Synthesis and Characterization of MnO<sub>2</sub> Nanowires: Lattice Vibrations and Photoluminescence Properties," *Physica Status Solidi (C) Current Topics in Solid State Physics*, vol. 14, no. 10, pp. 2–4, 2017, doi: 10.1002/pssc.201700176.
- [155] T. Gao, H. Fjellvåg, and P. Norby, "A comparison study on Raman scattering properties of  $\alpha$ - and  $\beta$ -MnO<sub>2</sub>," *Analytica Chimica Acta*, vol. 648, no. 2, pp. 235–239, 2009, doi: 10.1016/j.aca.2009.06.059.
- [156] E. Cockayne and L. Li, "First-Principles Studies of the Atomic , Electronic , and Magnetic," *Chemical Physics Letters*, vol. 2, no. 544, pp. 53–58, 2012.
- [157] L. Feng *et al.*, "MnO<sub>2</sub> prepared by hydrothermal method and electrochemical performance as anode for lithium-ion battery," *Nanoscale Research Letters*, vol. 9, no. 1, pp. 1–8, 2014, doi: 10.1186/1556-276X-9-290.
- [158] Y. Wang, Y. Song, and Y. Xia, "Electrochemical capacitors: Mechanism, materials, systems, characterization and applications," *Chemical Society Reviews*, vol. 45, no. 21, pp. 5925–5950, 2016, doi: 10.1039/c5cs00580a.
- [159] S. Xu *et al.*, "Hydrothermal synthesis of Cu-doped  $\beta$ -MnO<sub>2</sub> nanorods as cathode material for lithium ion battery applications," *Journal of Nanoscience and Nanotechnology*, vol. 17, no. 3, pp. 2109–2115, 2017, doi: 10.1166/jnn.2017.12929.

- [160] I. Vi, "(Received 17 August 1972 by G.W. Rathenau)," vol. 11, pp. 1253–1256, 1972.
- [161] J. Zhang, D. Yuping, L. Shuqing, L. Xiaogang, and L. Shunhua, "The effects of high magnetic field on the morphology and microwave electromagnetic properties of MnO<sub>2</sub> powder," *Journal of Solid State Chemistry*, vol. 183, no. 7, pp. 1490–1495, 2010, doi: 10.1016/j.jssc.2010.04.027.
- [162] A. M. Hashem *et al.*, "Urchin-like A-MnO<sub>2</sub> formed by nanoneedles for high-performance lithium batteries," *Ionics*, vol. 22, no. 12, pp. 2263–2271, 2016, doi: 10.1007/s11581-016-1771-5.
- [163] L. W., "Magnetic Nanomaterials Responsive MnO<sub>2</sub>," *Responsive Nanomaterials for Sustainable Applications.*, vol. 1, no. 297, p. 139., 2020.
- [164] L. J. Vera Stimpson, J. M. Powell, G. B. G. Stenning, M. Jura, and D. C. Arnold, "Spin-glass behavior in K<sub>x</sub>Ru<sub>4-y</sub>Ni<sub>y</sub>O<sub>8</sub> hollandite materials," *Physical Review B*, vol. 98, no. 17, pp. 1–10, 2018, doi: 10.1103/PhysRevB.98.174429.
- [165] I. G. Deac, J. F. Mitchell, and P. Schiffer, "Phase separation and low-field bulk magnetic properties of Pr<sub>0.7</sub>Ca<sub>0.3</sub>MnO<sub>3</sub>," *Physical Review B - Condensed Matter and Materials Physics*, vol. 63, no. 17, pp. 1724081–1724085, 2001, doi: 10.1103/PhysRevB.63.172408.
- [166] P. Bag, P. R. Baral, and R. Nath, "Cluster spin-glass behavior and memory effect in Cr<sub>0.5</sub>Fe<sub>0.5</sub>Ga," *Physical Review B*, vol. 98, no. 14, pp. 1–10, 2018, doi: 10.1103/PhysRevB.98.144436.
- [167] S. Pandya, Z. B. Coe, and P. Nanoparticles, "Size-dependent magnetic transitions in CoFe<sub>0.1</sub>Cr<sub>1.9</sub>O<sub>4</sub> nanoparticles studied by," 2016.
- [168] S. Mukherjee, R. Ranganathan, P. Anilkumar, and P. Joy, "Static and dynamic response of cluster glass," *Physical Review B - Condensed Matter and Materials Physics*, vol. 54, no. 13, pp. 9267–9274, 1996, doi: 10.1103/PhysRevB.54.9267.
- [169] P. A. Kumar *et al.*, "Evidence for Spin Glass Transition in Hexagonal DyMnO<sub>3</sub> without Substitutional Disorder," *Journal of Physical Chemistry C*, vol. 123, pp. 30499–30508, 2019, doi: 10.1021/acs.jpcc.9b07892.
- [170] V. K. Anand, D. T. Adroja, and A. D. Hillier, "Ferromagnetic cluster spin-glass behavior in PrRhSn<sub>3</sub>," *Physical Review B - Condensed Matter and Materials Physics*, vol. 85, no. 1, pp. 1–9, 2012, doi: 10.1103/PhysRevB.85.014418.
- [171] D. Gangwar and C. Rath, "Spin dynamics of hydrothermally synthesized  $\delta$ -MnO<sub>2</sub> nanowhiskers," *Physical Chemistry Chemical Physics*, vol. 22, no. 25, pp. 14236–14245, 2020, doi: 10.1039/d0cp02245d.
- [172] J. Ji, X. Lu, C. Chen, M. He, and H. Huang, "Potassium-modulated  $\delta$ -MnO<sub>2</sub> as robust catalysts for formaldehyde oxidation at room temperature," *Applied Catalysis B: Environmental*, vol. 260, no. June 2019, p. 118210, 2020, doi:

10.1016/j.apcatb.2019.118210.

- [173] Y. Duan, Z. Liu, H. Jing, Y. Zhang, and S. Li, "Novel microwave dielectric response of Ni/Co-doped manganese dioxides and their microwave absorbing properties," *Journal of Materials Chemistry*, vol. 22, no. 35, pp. 18291–18299, 2012, doi: 10.1039/c2jm33124a.
- [174] A. M. Toufiq, F. Wang, Q. U. A. Javed, and Y. Li, "Influence of SiO<sub>2</sub> on the structure-controlled synthesis and magnetic properties of prismatic MnO<sub>2</sub> nanorods," *Nanotechnology*, vol. 24, no. 41, 2013, doi: 10.1088/0957-4484/24/41/415703.
- [175] J. . Sherin, J. K. Thomas, and S. Manoj, "Facile Synthesis and Characterization of Pyrolusite,  $\beta$ -MnO<sub>2</sub>, Nano Crystal with Magnetic Studies," *International Journal of Science and Engineering Applications*, vol. 4, no. 5, pp. 250–252, 2015, doi: 10.7753/ijsea0405.1003.
- [176] H. L. Haile, T. Abi, and K. Tesfahun, "Synthesis, characterization and photocatalytic activity of MnO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub>/Fe<sub>2</sub>O<sub>3</sub> nanocomposite for degradation of malachite green," *African Journal of Pure and Applied Chemistry*, vol. 9, no. 11, pp. 211–222, 2015, doi: 10.5897/ajpac2015.0656.
- [177] C. Julien, M. Massot, R. Baddour-Hadjean, S. Franger, S. Bach, and J. P. Pereira-Ramos, "Raman spectra of birnessite manganese dioxides," *Solid State Ionics*, vol. 159, no. 3–4, pp. 345–356, 2003, doi: 10.1016/S0167-2738(03)00035-3.
- [178] D. Gangwar, "Enhanced Electrochemical Property of Dy Doped  $\alpha$ -MnO<sub>2</sub> Nanorods," vol. 455, p. 2018, 2018.
- [179] J. a. Mydosh, "Spin Glasses: An Experimental Introduction," *Taylor & Francis*, 1993.
- [180] M. Knobel, W. C. Nunes, L. M. Socolovsky, E. De Biasi, J. M. Vargas, and J. C. Denardin, "Superparamagnetism and other magnetic features in granular materials: A review on ideal and real systems," *Journal of Nanoscience and Nanotechnology*, vol. 8, no. 6, pp. 2836–2857, 2008, doi: 10.1166/jnn.2008.15348.
- [181] A. K. Pramanik and A. Banerjee, "Interparticle interaction and crossover in critical lines on field-temperature plane in Pr<sub>0.5</sub>Sr<sub>0.5</sub>MnO<sub>3</sub> nanoparticles," *Physical Review B - Condensed Matter and Materials Physics*, vol. 82, no. 9, pp. 1–9, 2010, doi: 10.1103/PhysRevB.82.094402.
- [182] B. Maji, K. G. Suresh, and A. K. Nigam, "Low temperature cluster glass behavior in Nd<sub>5</sub>Ge<sub>3</sub>," *Journal of Physics Condensed Matter*, vol. 23, no. 50, 2011, doi: 10.1088/0953-8984/23/50/506002.
- [183] X. H. Huang *et al.*, "Dynamic properties of cluster glass in La<sub>0.25</sub>Ca<sub>0.75</sub>MnO<sub>3</sub> nanoparticles," vol. 083904, no. 2009, pp. 0–6, 2014, doi: 10.1063/1.3246869.
- [184] J. Luo *et al.*, "Spin-glasslike behavior of K<sup>+</sup> -containing  $\alpha$  -MnO<sub>2</sub> nanotubes," *Journal of Applied Physics*, vol. 105, no. 9, 2009, doi: 10.1063/1.3117495.



- [185] A. M. Larson, P. Moetakef, K. Gaskell, C. M. Brown, G. King, and E. E. Rodriguez, "Inducing ferrimagnetism in insulating hollandite  $\text{Ba}_{1.2}\text{Mn}_8\text{O}_{16}$ ," *Chemistry of Materials*, vol. 27, no. 2, pp. 515–525, 2015, doi: 10.1021/cm503801j.
- [186] A. Malinowski, V. L. Bezusyy, R. Minikayev, P. Dziawa, Y. Syryanyy, and M. Sawicki, "Spin-glass behavior in Ni-doped  $\text{La}_{1.8}\text{Sr}_{0.15}\text{CuO}_4$ ," *Physical Review B - Condensed Matter and Materials Physics*, vol. 84, no. 2, pp. 1–19, 2011, doi: 10.1103/PhysRevB.84.024409.
- [187] T. Nishioka, Y. Tabata, T. Taniguchi, and Y. Miyako, "Canonical spin glass behavior in  $\text{Ce}_2\text{AgIn}_3$ ," *Journal of the Physical Society of Japan*, vol. 69, no. 4, pp. 1012–1015, 2000, doi: 10.1143/JPSJ.69.1012.
- [188] P. Singh, M. Shukla, and C. Upadhyay, "Signatures of consolidated superparamagnetic and spin-glass behavior in magnetite-silver core-shell nanoparticles," *Nanoscale*, vol. 10, no. 47, pp. 22583–22592, 2018, doi: 10.1039/c8nr08401g.
- [189] M. K. Singh, W. Prellier, M. P. Singh, R. S. Katiyar, and J. F. Scott, "Spin-glass transition in single-crystal  $\text{BiFeO}_3$ ," *Physical Review B - Condensed Matter and Materials Physics*, vol. 77, no. 14, pp. 1–5, 2008, doi: 10.1103/PhysRevB.77.144403.
- [190] M. D. Mukadam, S. M. Yusuf, P. Sharma, S. K. Kulshreshtha, and G. K. Dey, "Dynamics of spin clusters in amorphous  $\text{Fe}_2\text{O}_3$ ," *Physical Review B - Condensed Matter and Materials Physics*, vol. 72, no. 17, pp. 1–7, 2005, doi: 10.1103/PhysRevB.72.174408.
- [191] Z. Fu *et al.*, "Coexistence of magnetic order and spin-glass-like phase in the pyrochlore antiferromagnet  $\text{Na}_3\text{Co}(\text{CO}_3)_2\text{Cl}$ ," *Physical Review B - Condensed Matter and Materials Physics*, vol. 87, no. 21, pp. 1–14, 2013, doi: 10.1103/PhysRevB.87.214406.
- [192] D. Kumar, J. K. Galivarapu, A. Banerjee, K. S. Nemkovski, Y. Su, and C. Rath, "Size-dependent magnetic transitions in  $\text{CoFe}_{0.1}\text{Cr}_{1.9}\text{O}_4$  nanoparticles studied by magnetic and neutron-polarization analysis," *Nanotechnology*, vol. 27, no. 17, 2016, doi: 10.1088/0957-4484/27/17/175702.
- [193] A. Bunde, M. Ulrich, and J. Garcí, "Slow relaxation in ferromagnetic nanoparticles: 1 Indication of spin-glass behavior," vol. 3, pp. 1–4, 2003, doi: 10.1103/PhysRevB.67.024416.
- [194] W. R. Chen *et al.*, "Re-entrant spin glass behavior in Mn-rich  $\text{YMnO}_3$ ," *Applied Physics Letters*, vol. 87, no. 4, pp. 1–4, 2005, doi: 10.1063/1.1991980.
- [195] R. S. Freitas, L. Ghivelder, F. Damay, F. Dias, and L. F. Cohen, "Magnetic relaxation phenomena and cluster glass properties of  $\text{La}_{0.7-x}\text{Y}_x\text{Ca}_{0.3}\text{MnO}_3$  manganites," *Physical Review B - Condensed Matter and Materials Physics*, vol. 64, no. 14, pp. 1444041–1444046, 2001, doi: 10.1103/PhysRevB.64.144404.

- [196] G. Jagadish Kumar, A. Banerjee, A. S. K. Sinha, Y. Su, K. Nemkovski, and C. Rath, “Cation distribution and magnetic properties of Zn-substituted  $\text{CoCr}_2\text{O}_4$  nanoparticles,” *Journal of Applied Physics*, vol. 123, no. 22, 2018, doi: 10.1063/1.5027137.
- [197] B. C. Kim, C. Justin Raj, W. J. Cho, W. G. Lee, H. T. Jeong, and K. H. Yu, “Enhanced electrochemical properties of cobalt doped manganese dioxide nanowires,” *Journal of Alloys and Compounds*, vol. 617, pp. 491–497, 2014, doi: 10.1016/j.jallcom.2014.08.018.
- [198] S. Liang *et al.*, “Rare-earth based nanomaterials and their composites as electrode materials for high performance supercapacitors: A review,” *Sustainable Energy and Fuels*, vol. 4, no. 8, pp. 3825–3847, 2020, doi: 10.1039/d0se00669f.
- [199] A. M. Toufiq, F. Wang, Q. U. A. Javed, Q. Li, and Y. Li, “Hydrothermal synthesis of  $\text{MnO}_2$  nanowires: Structural characterizations, optical and magnetic properties,” *Applied Physics A: Materials Science and Processing*, vol. 116, no. 3, pp. 1127–1132, 2014, doi: 10.1007/s00339-013-8195-0.
- [200] J. Zeng *et al.*, “Al and/or Ni-doped nanomanganese dioxide with anisotropic expansion and their electrochemical characterisation in primary Li- $\text{MnO}_2$  batteries,” *Journal of Solid State Electrochemistry*, vol. 18, no. 6, pp. 1585–1591, 2014, doi: 10.1007/s10008-013-2372-0.
- [201] Z. Hu *et al.*, “2D vanadium doped manganese dioxides nanosheets for pseudocapacitive energy storage,” *Nanoscale*, vol. 7, no. 38, pp. 16094–16099, 2015, doi: 10.1039/c5nr04682c.
- [202] J. J. Wang *et al.*, “Enhanced magnetic properties in antiferromagnetic-core/ferrimagnetic-shell nanoparticles,” *Scientific Reports*, vol. 5, no. 2, pp. 1–8, 2015, doi: 10.1038/srep09609.
- [203] C. L. Perkins, S. H. Lee, X. Li, S. E. Asher, and T. J. Coutts, “Identification of nitrogen chemical states in N-doped ZnO via x-ray photoelectron spectroscopy,” *Journal of Applied Physics*, vol. 97, no. 3, 2005, doi: 10.1063/1.1847728.
- [204] O. Peña, M. Bahout, D. Gutierrez, P. Duran, and C. Moure, “Interacting networks and spin polarization in  $(\text{Dy}, \text{Ca})\text{MnO}_3$ ,” *Solid State Sciences*, vol. 5, no. 9, pp. 1217–1227, 2003, doi: [https://doi.org/10.1016/S1293-2558\(03\)00146-8](https://doi.org/10.1016/S1293-2558(03)00146-8).
- [205] H. T. Zhu *et al.*, “Birnessite-type  $\text{MnO}_2$  Nanowalls and Their Magnetic Properties,” pp. 17089–17094, 2008.
- [206] A. Kumar, S. D. Kaushik, V. Siruguri, and D. Pandey, “Evidence for two spin-glass transitions with magnetoelastic and magnetoelectric couplings in the multiferroic  $(\text{Bi}_{1-x}\text{Ba}_x)(\text{Fe}_{1-x}\text{Tl}_x)\text{O}_3$  system,” *Physical Review B*, vol. 97, no. 10, pp. 1–14, 2018, doi: 10.1103/PhysRevB.97.104402.
- [207] L. Li, Y. Pan, L. Chen, and G. Li, “One-dimensional  $\alpha\text{-MnO}_2$ : Trapping chemistry

- of tunnel structures, structural stability, and magnetic transitions,” *Journal of Solid State Chemistry*, vol. 180, no. 10, pp. 2896–2904, 2007, doi: <https://doi.org/10.1016/j.jssc.2007.08.017>.
- [208] C. Zhu, Z. Tian, L. Wang, and S. Yuan, “Exchange bias effect in spin glass  $\text{CoCr}_2\text{O}_4$  nanoparticles,” *Journal of Magnetism and Magnetic Materials*, vol. 393, pp. 116–120, 2015, doi: 10.1016/j.jmmm.2015.05.062.
- [209] M. P. Proenca, J. Ventura, C. T. Sousa, M. Vazquez, and J. P. Araujo, “Exchange bias, training effect, and bimodal distribution of blocking temperatures in electrodeposited core-shell nanotubes,” *Physical Review B - Condensed Matter and Materials Physics*, vol. 87, no. 13, pp. 1–7, 2013, doi: 10.1103/PhysRevB.87.134404.
- [210] L. Liu *et al.*, “Exchange bias training effect in  $\text{NiFe}_2\text{O}_4/\text{NiO}$  nanocomposites,” *Journal of Physics D: Applied Physics*, vol. 42, no. 3, 2009, doi: 10.1088/0022-3727/42/3/035008.
- [211] C. Binek, “Training of the exchange-bias effect: A simple analytic approach,” *Physical Review B - Condensed Matter and Materials Physics*, vol. 70, no. 1, pp. 1–5, 2004, doi: 10.1103/PhysRevB.70.014421.
- [212] S. K. Mishra, F. Radu, H. A. Dürr, and W. Eberhardt, “Training-induced positive exchange bias in  $\text{NiFe}/\text{IrMn}$  bilayers,” *Physical Review Letters*, vol. 102, no. 17, pp. 1–4, 2009, doi: 10.1103/PhysRevLett.102.177208.
- [213] V. Markovich *et al.*, “Exchange bias effect in  $\text{CaMn}_{1-x}\text{Re}_x\text{O}_3$ ,” *AIP Advances*, vol. 7, no. 5, 2017, doi: 10.1063/1.4972798.



## *List of Publications*

1. **Deepti Gangwar**, Priyanka Tiwari, Ajay Kumar, Rajiv Prakash, Chandana Rath. Effect of Dy on electrochemical supercapacitive behaviour of  $\alpha$ -MnO<sub>2</sub> nanorods. **Electrochimica Acta**. 2019.
2. **Deepti Gangwar**, Chandana Rath. Magnetic properties of  $\alpha$ -MnO<sub>2</sub>: Dy nanorods. **Journal of Magnetism and Magnetic Materials**. 2020.
3. **Deepti Gangwar**, Chandana Rath. Spin dynamics of Hydrothermally Synthesized  $\delta$ -MnO<sub>2</sub> Nanowhiskers. **Physical Chemistry Chemical Physics**. 2020.
4. **Deepti Gangwar**, Chandana Rath. Enhanced electrochemical property of Dy doped  $\alpha$ -MnO<sub>2</sub> nanorods; **AIP Proceeding** 2020.
5. **Deepti Gangwar**, Chandana Rath. Structural, Optical and Magnetic Properties of  $\alpha$ - and  $\beta$ -MnO<sub>2</sub> nanorods. **Applied Surface Science** 2021.
6. G. C. Pandey, **Deepti Gangwar**, Himanshu Tripathi and Chandana Rath. Crystal structure, local structure and magnetic properties of NiCr<sub>2-x</sub>FexO<sub>4</sub> (x = 0.3-0.6) spinel. **Materials Chemistry and Physics** 2021.
7. Priyanka Tiwari, **Deepti Gangwar**, Chandana Rath. Multifunctional role of Fe in GdMnO<sub>3</sub>: Jahn-Teller distortion, magnetic properties and electrochemical performance. **New Journal of Chemistry** 2021.