SURFACE ENGINEERING OF COMMERCIAL ACTIVATED CARBON FOR IMPROVING THE CHARGE STORABILITY OF ELECTROCHEMICAL CAPACITORS

SUNIL VAISHAK

MASTER OF SCIENCE

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

We hereby declare that We have checked this thesis and, in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

____

(Supervisor's Signature)

Full Name : DR. JOSE RAJAN

Position : PROFESSOR

Date :

____

(Co-supervisor's Signature)

Full Name : DR. IZAN IZWAN BIN MISNON

Position : SENIOR LECTURER

Date :

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

____

(Student's Signature)

Full Name : VAISHAK SUNIL

ID Number : MSM19008

Date :

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SUNIL VAISHAK

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ABSTRAK

Superkapasitor (SC) berasaskan karbon aktifan adalah contoh peranti mampan di kalangan peranti penyimpanan tenaga elektrokimia kerana bahan elektrod boleh diperbaharui, mesra alam, kitaran hayat yang lebih lama dan keupayaan kadar nyahcas caj yang unggul. Namun, untuk mengembangkan nilai komersil mereka, ketumpatan tenaga semasa mereka haruslah setanding dengan bateri Litium-ion yang terdapat di pasaran. Salah satu pendekatan bagi meningkatkan ketumpatan tenaga adalah dengan memaksimumkan bilangan liang untuk memudahkan penjerapan lebih banyak ion. Sebilangan besar penyelidikan mengenai SC telah menunjukkan keputusan yang sangat baik pada skala makmalmelalui peningkatan keliangan, di mana beban jisim elektrod yang dikaji mempunyai perbezaan yang mendadak daripada piawaian industri. Faktor-faktor ini merupakan sebahagian daripada cabaran inisiatif penkomersialan elektrod karbon biojisim, Untuk menangani isu ini, tesis ini memberi tumpuan kepada peningkatan performasi elektrokimia karbon aktifan cangkerang isi rong sawit melalui modifikasi permukaannya dengan cara yang mesra alam dan kos efektif. Dalam tesis ini, kaedah refluks asid nitrik telah digunakan untuk tujuan pengaktifan. Berbeza dengan kaedah konvensional, kaedah ini mengurangkan penggunaan bahan kimia yang keras, di mana bahan kimia ini boleh dikitar semula. Untuk mengoptimumkan prestasi elektrod, karbon teraktif telah direflukskan dengan pelbagai nisbah asid kepada pendahulu dan tempoh refluks. Prestasi elektrokimia bahan yang terhasil telah diuji dalam sistem konfigurasi tiga elektrod dalam 1 M elektrolit sodium sulfat. Kapasiti spesifik sampel optimum telah meningkat ~110% berikutan pengurangan ketara dalam impedans Warburg. Untuk memahami perubahan fizikokimia yang diperkenalkan semasa refluks, sampel karbon as-sintesis telah dicirikan menggunakan Difraksi sinar-X, Spektroskopi Inframerah Fourier Transformasi, Mikroskopi Elektron Pengimbasan, Spektroskopi Penyerakan Tenaga, dan ukuran penjerapan gas. Sampel refluks 72 jam telah mencatat kenaikan prestasi electrokimia sebanyak ~75% dan luas permukaan ~722 $m^2 \cdot g^{-1}$. Setelah sampel tersebutdioptimumkan melalui sistem tiga-elektrod, sifat elektrokimia sampel tersebut dikaji dengan mempelbagaikan muatan jisim (~ 3, ~ 6, ~ 9, ~ 12, dan ~ 14 $mg \cdot cm^{-2}$). Semua peranti yang direka telah mencapai tetingkap berpotensi 1.8 V dalam 1M sodium sulfat. Peranti yang memiliki muatan jisim tertinggi (~14 $mg \cdot cm^{-2}$) telah menghasilkan kapasitans maksimum ~494 $mF \cdot cm^{-2}$, ketumpatan tenaga ~13 $mWh \cdot cm^{-3}$, dan ketumpatan kuasa maksimum ~2189 $mW \cdot cm^{-3}$. Penyelidikan semasa telah menunjukkan pendekatan yang mesra alam dan ekonomi bagi kejuruteraan keliangan karbon aktifan komersil, untuk meningkatkan kebolehstoran cas bagi aplikasi praktikal.

ABSTRACT

Supercapacitors based on activated carbon are the representatives of sustainable devices among electrochemical energy storage devices because of their renewable electrode materials, eco-friendliness, longer life cycle and superior charge-discharge rate capabilities. However, to expand their commercial value, their current energy densities should be made comparable with the market leading Lithium-ion batteries. One of the approaches to increase the energy density is by maximizing the number of pores to incorporate more ions. A majority of the research on supercapacitors demonstrated excellent laboratory-scale results through improving porosity, where the mass loading of such electrodes has a staggering difference from the industrial standards. These factors predominantly suppressed the initiatives to lift the biomass-derived carbon-based electrodes into the commercial picture. To address this issue, the present thesis focuses on expanding the electrochemical properties of commercial activated carbon derived from palm kernel shells by engineering its porosity in an eco-friendly and cost-effective manner. Herein, we employ the nitric acid refluxing method for the activation purpose, which, unlike the conventional routes, not only limits the usage of harsh chemicals, but also enables recyclability. We have optimized the performance of the electrode materials by refluxing the activated carbon for various acid to precursor ratios and refluxing duration. The electrochemical performances of the resulting materials were examined in a three-electrode system configuration in 1 M sodium sulphate electrolyte. The specific capacitance of the optimum sample was increased ~110% following a significant reduction in Warburg impedance. To understand the physicochemical alterations introduced upon refluxing, the as-synthesized carbon samples were characterized using X-ray Diffraction, Fourier Transform Infrared Spectroscopy, Scanning Electron Microscopy, Energy Dispersive Spectroscopy, and gas adsorption measurements. With ~75% increment, a highest surface area of ~722 $m^2 \cdot g^{-1}$ was recorded for the 72 hours refluxed sample, which aligns with the increased electrochemical performance in corresponding electrodes. Further, supercapacitor devices were fabricated using this optimized sample by varying the mass loading (~3, ~6, ~9, ~12, and ~14 $mg \cdot cm^2$), and the electrochemical properties were studied. All the fabricated devices achieved a potential window of 1.8 V in 1 M sodium sulphate. The highest mass loaded (~14 $mg \cdot cm^{-2}$) device fabricated using the prepared material has delivered a maximum areal capacitance of ~494 $mF \cdot cm^{-2}$, an energy density of ~13 $mWh \cdot cm^{-3,}$ and a maximum power density of ~2189 $mW \cdot cm^{-3}$. The current research thereby demonstrates an environmentally friendly and economic approach for engineering the porosity of commercial activated carbon to enhance the charge storability for practical applications.

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REFERENCES

Ab. Rahim, A. H., Ramli, N., Nordin, A. N., & Abd. Wahab, M. F. (2021). Supercapacitor performance with activated carbon and graphene nanoplatelets composite electrodes, and insights from the equivalent circuit model. *Carbon Trends, 5*, 100101. doi:https://doi.org/10.1016/j.cartre.2021.100101

Abdullah, N., & Sulaiman, F. (2013). The oil palm wastes in Malaysia. *Biomass now-sustainable growth and use, 1*(3), 75-93.

Abioye, A. M., & Ani, F. N. (2015a). Recent development in the production of activated carbon electrodes from agricultural waste biomass for supercapacitors: A review. *Renewable and Sustainable Energy Reviews, 52*(C), 1282-1293. Retrieved from https://EconPapers.repec.org/RePEc:eee:rensus:v:52:y:2015:i:c:p:1282-1293

Abioye, A. M., & Ani, F. N. (2015b). Recent development in the production of activated carbon electrodes from agricultural waste biomass for supercapacitors: a review. *Renewable and Sustainable Energy Reviews, 52*, 1282-1293.

Abouelamaiem, D. I., Rasha, L., He, G., Neville, T. P., Millichamp, J., Mason, T. J., . . . Brett, D. J. L. (2018). Integration of supercapacitors into printed circuit boards. *Journal of Energy Storage, 19*, 28-34. doi:https://doi.org/10.1016/j.est.2018.06.016

Acerce, M., Chiovoloni, S., Hernandez, Y., Ortuno, C., Qian, J., & Lu, J. (2021). Poly(1,5-diaminonaphthalene)-Grafted Monolithic 3D Hierarchical Carbon as Highly Capacitive and Stable Supercapacitor Electrodes. *ACS applied materials & interfaces, 13*(45), 53736-53745. doi:10.1021/acsami.1c13746

Adinaveen, T., John Kennedy, L., Judith Vijaya, J., & Sekaran, G. (2015). Surface and porous characterization of activated carbon prepared from pyrolysis of biomass (rice straw) by two-stage procedure and its applications in supercapacitor electrodes. *Journal of Material Cycles and Waste Management, 17*(4), 736-747. doi:10.1007/s10163-014-0302-6

Adinaveen, T., Vijaya, J. J., & Kennedy, L. J. (2016). Comparative Study of Electrical Conductivity on Activated Carbons Prepared from Various Cellulose Materials. *Arabian Journal for Science and Engineering, 41*(1), 55-65. doi:10.1007/s13369-014-1516-6

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

Ajina, A., & Isa, D. (2010). Symmetrical supercapacitor using coconut shell-based activated carbon. *Pertanika J. Sci. Technol, 18*, 351-363.

Akinwolemiwa, B., Peng, C., & Chen, G. Z. (2015). Redox Electrolytes in Supercapacitors. *Journal of The Electrochemical Society, 162*(5), A5054-A5059. doi:10.1149/2.0111505jes

Alam, S. N., Sharma, N., & Kumar, L. (2017). Synthesis of graphene oxide (GO) by modified hummers method and its thermal reduction to obtain reduced graphene oxide (rGO). *Graphene, 6*(1), 1-18.

Allwar, A., Hartati, R., & Fatimah, I. (2017). Effect of nitric acid treatment on activated carbon derived from oil palm shell. *AIP Conference Proceedings, 1823*(1), 020129. doi:10.1063/1.4978202

Arango, D. I., Zapata-Benabithe, Z., Arenas, E. C., & Perez-Osorno, J. C. (2018). Influence of surface modification with nitric acid on electrochemical performance of agroindustrial waste-based activated carbon. *Journal of Materials Science: Materials in Electronics, 29*(18), 15557-15569.

Armynah, B., Tahir, D., & Jaya, N. (2014). Annealing effect on the particle size and chemical composition of activated carbon obtained from vacuum furnace of teak sawdust. *AIP Conference Proceedings, 1617*(1), 19-21. doi:10.1063/1.4897094

Augustyn, V., Simon, P., & Dunn, B. (2014). Pseudocapacitive oxide materials for high-rate electrochemical energy storage. *Energy & Environmental Science, 7*(5), 1597-1614.

Aworn, A., Thiravetyan, P., & Nakbanpote, W. (2008). Preparation and characteristics of agricultural waste activated carbon by physical activation having micro- and mesopores. *Journal of Analytical and Applied Pyrolysis, 82*(2), 279-285. doi:https://doi.org/10.1016/j.jaap.2008.04.007

Bai, S., Tan, G., Li, X., Zhao, Q., Meng, Y., Wang, Y., . . . Xiao, D. (2016). Pumpkin-Derived Porous Carbon for Supercapacitors with High Performance. *Chemistry–An Asian Journal, 11*(12), 1828-1836.

Banerjee, J., & Dutta, K. (2021). A short overview on the synthesis, properties and major applications of poly(p-phenylene vinylene). *Chemical Papers, 75*(10), 5139-5151. doi:10.1007/s11696-020-01492-9

Banuprabha, T., Karthikeyani, A., & Kalyani, P. (2021). Evaluation and application of phytomass derived activated carbons as electrodes for coin cell supercapacitors. *Int. J. Electrochem. Sci, 16*(211251), 2.

Baroutaji, A., Wilberforce, T., Ramadan, M., & Olabi, A. G. (2019). Comprehensive investigation on hydrogen and fuel cell technology in the aviation and aerospace sectors. *Renewable and Sustainable Energy Reviews, 106*, 31-40. doi:https://doi.org/10.1016/j.rser.2019.02.022

Bedia, J., Peñas-Garzón, M., Gómez-Avilés, A., Rodriguez, J. J., & Belver, C. (2020). Review on Activated Carbons by Chemical Activation with FeCl3. *C, 6*(2), 21. Retrieved from https://www.mdpi.com/2311-5629/6/2/21

Berge, N. D., Ro, K. S., Mao, J., Flora, J. R. V., Chappell, M. A., & Bae, S. (2011). Hydrothermal Carbonization of Municipal Waste Streams. *Environmental Science & Technology, 45*(13), 5696-5703. doi:10.1021/es2004528

Bhat, T. S., Patil, P. S., & Rakhi, R. B. (2022). Recent trends in electrolytes for supercapacitors. *Journal of Energy Storage, 50*, 104222. doi:https://doi.org/10.1016/j.est.2022.104222

Bo, Z., Wen, Z., Kim, H., Lu, G., Yu, K., & Chen, J. (2012). One-step fabrication and capacitive behavior of electrochemical double layer capacitor electrodes using vertically-oriented graphene directly grown on metal. *Carbon, 50*(12), 4379-4387. doi:https://doi.org/10.1016/j.carbon.2012.05.014

Bohrer, J. J., Blaszczyk, R., Gerondeau, P. J., Isken, J., Mette, E., Price, R., . . . VanKampen, T. E. (2002). 5 - Components or Parts. In W. M. Middleton & M. E. Van Valkenburg (Eds.), *Reference Data for Engineers (Ninth Edition)* (pp. 5-1-5-31). Woburn: Newnes.

Bose, S., Kuila, T., Mishra, A. K., Rajasekar, R., Kim, N. H., & Lee, J. H. (2012). Carbon-based nanostructured materials and their composites as supercapacitor electrodes. *Journal of Materials Chemistry, 22*(3), 767-784. doi:10.1039/C1JM14468E

Cai, X., Tan, G., Deng, Z., Liu, J., & Gui, D. (2019). Preparation of hierarchical porous carbon aerogels by microwave assisted sol-gel process for supercapacitors. *Polymers, 11*(3), 429.

Cai, Y., Zhang, A., Feng, Y. P., & Zhang, C. (2011). Switching and rectification of a single light-sensitive diarylethene molecule sandwiched between graphene nanoribbons. *The Journal of Chemical Physics, 135*(18), 184703. doi:10.1063/1.3657435

Cao, L., Xu, F., Liang, Y.-Y., & Li, H.-L. (2004). Preparation of the Novel Nanocomposite Co(OH)2/ Ultra-Stable Y Zeolite and Its Application as a Supercapacitor with High Energy Density. *Advanced Materials, 16*(20), 1853-1857. doi:https://doi.org/10.1002/adma.200400183

Chang, J., Gao, Z., Wang, X., Wu, D., Xu, F., Wang, X., . . . Jiang, K. (2015). Activated porous carbon prepared from paulownia flower for high performance supercapacitor electrodes. *Electrochimica Acta, 157*, 290-298. doi:https://doi.org/10.1016/j.electacta.2014.12.169

Chen, L.-F., Zhang, X.-D., Liang, H.-W., Kong, M., Guan, Q.-F., Chen, P., . . . Yu, S.-H. (2012). Synthesis of Nitrogen-Doped Porous Carbon Nanofibers as an Efficient Electrode Material for Supercapacitors. *ACS Nano, 6*(8), 7092-7102. doi:10.1021/nn302147s

Chen, S.-M., Ramachandran, R., Mani, V., & Ramiah, S. (2014). Recent Advancements in Electrode Materials for the High-performance Electrochemical Supercapacitors: A Review. *International journal of electrochemical science*.

Chen, X., Paul, R., & Dai, L. (2017). Carbon-based supercapacitors for efficient energy storage. *National Science Review, 4*(3), 453-489. doi:10.1093/nsr/nwx009

Chen, X., Wu, K., Gao, B., Xiao, Q., Kong, J., Xiong, Q., . . . Fu, J. (2016). Three-dimensional activated carbon recycled from rotten potatoes for high-performance supercapacitors. *Waste and biomass valorization, 7*(3), 551-557.

Cheng, Q., Tang, J., Ma, J., Zhang, H., Shinya, N., & Qin, L.-C. (2011). Graphene and carbon nanotube composite electrodes for supercapacitors with ultra-high energy density. *Physical Chemistry Chemical Physics, 13*(39), 17615-17624. doi:10.1039/C1CP21910C

Cherusseri, J., & Kar, K. K. (2015). Hierarchically mesoporous carbon nanopetal based electrodes for flexible supercapacitors with super-long cyclic stability. *Journal of Materials Chemistry A, 3*(43), 21586-21598. doi:10.1039/C5TA05603A

Chiu, Y.-H., & Lin, L.-Y. (2019). Effect of activating agents for producing activated carbon using a facile one-step synthesis with waste coffee grounds for symmetric supercapacitors. *Journal of the Taiwan Institute of Chemical Engineers, 101*, 177-185. doi:https://doi.org/10.1016/j.jtice.2019.04.050

Choi, B. G., Yang, M., Hong, W. H., Choi, J. W., & Huh, Y. S. (2012). 3D Macroporous Graphene Frameworks for Supercapacitors with High Energy and Power Densities. *ACS Nano, 6*(5), 4020-4028. doi:10.1021/nn3003345

Choi, J. W., & Aurbach, D. (2016). Promise and reality of post-lithium-ion batteries with high energy densities. *Nature Reviews Materials, 1*(4), 16013.

Conway, B. E., & Pell, W. G. (2003). Double-layer and pseudocapacitance types of electrochemical capacitors and their applications to the development of hybrid devices. *Journal of Solid State Electrochemistry, 7*(9), 637-644. doi:10.1007/s10008-003-0395-7

Cuña, A., Ortega Vega, M. R., da Silva, E. L., Tancredi, N., Radtke, C., & Malfatti, C. F. (2016). Nitric acid functionalization of carbon monoliths for supercapacitors: Effect on the electrochemical properties. *International Journal of Hydrogen Energy, 41*(28), 12127-12135. doi:https://doi.org/10.1016/j.ijhydene.2016.04.169

Das, H. T., Dutta, S., Balaji, T. E., Das, N., Das, P., Dheer, N., . . . Ujjain, S. K. (2022). Recent Trends in Carbon Nanotube Electrodes for Flexible Supercapacitors: A Review of Smart Energy Storage Device Assembly and Performance. *Chemosensors, 10*(6), 223. Retrieved from https://www.mdpi.com/2227-9040/10/6/223

Dat, N. T., Tran, T. T. V., Van, C. N., Vo, D.-V. N., Kongparakul, S., Zhang, H., . . . Samart, C. (2020). Carbon sequestration through hydrothermal carbonization of expired fresh milk and its application in supercapacitor. *Biomass and Bioenergy, 143*, 105836. doi:https://doi.org/10.1016/j.biombioe.2020.105836

Dettlaff, A., & Wilamowska, M. (2016). Electrochemical synthesis and characterization of nanocomposites based on poly(3,4-ethylenedioxythiophene) and functionalized carbon nanotubes. *Synthetic Metals, 212*, 31-43. doi:https://doi.org/10.1016/j.synthmet.2015.11.030

Deviprasath, C., Karuppiah, P., Chen, S.-M., Kim, H.-J., & Kandasamy, P. (2019). Metal-Free Multi-Porous Carbon for Electrochemical energy storage and Electrocatalysis Applications. *New Journal of Chemistry, 43*. doi:10.1039/C9NJ01875A

Dhandapani, E., S, P., Duraisamy, N., & R, R. (2021). Polyindole intercalated graphitic carbon nitride (PIn/g-C3N4) composites for high-performance supercapacitor application. *Journal of Energy Storage, 44*, 103360. doi:https://doi.org/10.1016/j.est.2021.103360

Ding, Y., Li, Y., Dai, Y., Han, X., Xing, B., Zhu, L., . . . Wang, S. (2021). A novel approach for preparing in-situ nitrogen doped carbon via pyrolysis of bean pulp for supercapacitors. *Energy, 216*, 119227. doi:https://doi.org/10.1016/j.energy.2020.119227

Dong, Y., Zhu, J., Li, Q., Zhang, S., Song, H., & Jia, D. (2020). Carbon materials for high mass-loading supercapacitors: filling the gap between new materials and practical applications. *Journal of Materials Chemistry A, 8*(42), 21930-21946. doi:10.1039/D0TA08265A

Du, C., & Pan, N. (2006). Supercapacitors using carbon nanotubes films by electrophoretic deposition. *Journal of Power Sources, 160*(2), 1487-1494. doi:https://doi.org/10.1016/j.jpowsour.2006.02.092

Du, H., Zhang, M., Liu, K., Parit, M., Jiang, Z., Zhang, X., . . . Si, C. (2022). Conductive PEDOT:PSS/cellulose nanofibril paper electrodes for flexible supercapacitors with superior areal capacitance and cycling stability. *Chemical Engineering Journal, 428*, 131994. doi:https://doi.org/10.1016/j.cej.2021.131994

Du, M., Wang, Z., Yang, C., Deng, Y., Wang, T., Zhong, W., . . . Chen, Y. (2022). N-doped reduced graphene oxide/Co0.85Se microflowers with high mass loading as battery-type materials for quasi-solid-state hybrid supercapacitors. *Journal of Alloys and Compounds, 890*, 161801. doi:https://doi.org/10.1016/j.jallcom.2021.161801

Du, W., Wang, X., Ju, X., Xu, K., Gao, M., & Zhang, X. (2017). Carbonized Enteromorpha prolifera with porous architecture and its polyaniline composites as high-performance electrode materials for supercapacitors. *Journal of Electroanalytical Chemistry, 802*, 15-21. doi:https://doi.org/10.1016/j.jelechem.2017.08.044

EIA. (2020). *Global electricity consumption continues to rise faster than population, https://www.eia.gov/todayinenergy/detail.php?id=44095*. Retrieved from

EIA. (2021). How much carbon dioxide is produced per kilowatthour of U.S. electricity generation?, https://www.eia.gov/tools/faqs/faq.php?id=74&t=11.

Elmouwahidi, A., Bailón-García, E., Romero-Cano, L. A., Zárate-Guzmán, A. I., Pérez-Cadenas, A. F., & Carrasco-Marín, F. (2019). Influence of Surface Chemistry on the Electrochemical Performance of Biomass-Derived Carbon Electrodes for its Use as Supercapacitors. *Materials, 12*(15), 2458. Retrieved from https://www.mdpi.com/1996-1944/12/15/2458

Endo, M., Takeda, T., Kim, Y., Koshiba, K., & Ishii, K. (2001). High power electric double layer capacitor (EDLC's); from operating principle to pore size control in advanced activated carbons. *Carbon letters, 1*(3_4), 117-128.

Fang, J., Guo, D., Kang, C., Wan, S., Li, S., Fu, L., . . . Liu, Q. (2019). Enhanced hetero-elements doping content in biomass waste-derived carbon for high performance supercapacitor. *International Journal of Energy Research, 43*(14), 8811-8821. doi:https://doi.org/10.1002/er.4834

Farma, R. (2019). Physical Properties Analysis of Activated Carbon From Oil Palm Empty Fruit Bunch Fiber On Methylene Blue Adsorption. *Journal of Technomaterial Physics, 1*(1), 67-73.

Farma, R., Deraman, M., Awitdrus, A., Talib, I., Taer, E., Basri, N., . . . Hashmi, S. (2013). Preparation of highly porous binderless activated carbon electrodes from fibres of oil palm empty fruit bunches for application in supercapacitors. *Bioresource technology, 132*, 254-261.

Feng, D., Lei, T., Lukatskaya, M. R., Park, J., Huang, Z., Lee, M., . . . Bao, Z. (2018). Robust and conductive two-dimensional metal−organic frameworks with exceptionally high volumetric and areal capacitance. *Nature Energy, 3*(1), 30-36. doi:10.1038/s41560-017-0044-5

Feng, D., Zhang, Y., Zhao, Y., Sun, S., & Gao, J. (2018). Improvement and maintenance of biochar catalytic activity for in-situ biomass tar reforming during pyrolysis and H2O/CO2 gasification. *Fuel Processing Technology, 172*, 106-114.

Feng, H., Hu, H., Dong, H., Xiao, Y., Cai, Y., Lei, B., . . . Zheng, M. (2016). Hierarchical structured carbon derived from bagasse wastes: A simple and efficient synthesis route and its improved electrochemical properties for high-performance supercapacitors. *Journal of Power Sources, 302*(Supplement C), 164-173. doi:https://doi.org/10.1016/j.jpowsour.2015.10.063

Fernández, J. A., Morishita, T., Toyoda, M., Inagaki, M., Stoeckli, F., & Centeno, T. A. (2008). Performance of mesoporous carbons derived from poly(vinyl alcohol) in electrochemical capacitors. *Journal of Power Sources, 175*(1), 675-679. doi:https://doi.org/10.1016/j.jpowsour.2007.09.042

Foley, N. J., Thomas, K. M., Forshaw, P. L., Stanton, D., & Norman, P. R. (1997). Kinetics of Water Vapor Adsorption on Activated Carbon. *Langmuir, 13*(7), 2083-2089. doi:10.1021/la960339s

Forouzandeh, P., Kumaravel, V., & Pillai, S. C. (2020). Electrode Materials for Supercapacitors: A Review of Recent Advances. *Catalysts, 10*(9), 969. Retrieved from https://www.mdpi.com/2073-4344/10/9/969

Frackowiak, E., Metenier, K., Bertagna, V., & Beguin, F. (2000). Supercapacitor electrodes from multiwalled carbon nanotubes. *Applied Physics Letters, 77*(15), 2421-2423. doi:10.1063/1.1290146

Fu, K., Yue, Q., Gao, B., Wang, Y., & Li, Q. (2017). Activated carbon from tomato stem by chemical activation with FeCl2. *Colloids and Surfaces A: Physicochemical and Engineering Aspects, 529*, 842-849.

Gayathiri, M., Pulingam, T., Lee, K. T., & Sudesh, K. (2022). Activated carbon from biomass waste precursors: Factors affecting production and adsorption mechanism. *Chemosphere, 294*, 133764. doi:https://doi.org/10.1016/j.chemosphere.2022.133764

Ge, L., Wu, Y., Wang, F., & Huang, Y. (2021). Algae-Derived Nitrogen Self-Doped Porous Carbon Materials with High Supercapacitor Performances. *Energy & Fuels, 35*(18), 15118-15125. doi:10.1021/acs.energyfuels.1c01827

Ghouma, I., Jeguirim, M., Sager, U., Limousy, L., Bennici, S., Däuber, E., . . . Ouederni, A. (2017). The potential of activated carbon made of agro-industrial residues in NOx immissions abatement. *Energies, 10*(10), 1508.

González, A., Goikolea, E., Barrena, J. A., & Mysyk, R. (2016). Review on supercapacitors: Technologies and materials. *Renewable and Sustainable Energy Reviews, 58*, 1189-1206. doi:https://doi.org/10.1016/j.rser.2015.12.249

Goodenough, J. B. (2013). Evolution of Strategies for Modern Rechargeable Batteries. *Accounts of Chemical Research, 46*(5), 1053-1061. doi:10.1021/ar2002705

Goodenough, J. B., & Park, K.-S. (2013). The Li-Ion Rechargeable Battery: A Perspective. *Journal of the American Chemical Society, 135*(4), 1167-1176. doi:10.1021/ja3091438

Gopiraman, M., Deng, D., Kim, B.-S., Chung, I.-M., & Kim, I. S. (2017). Three-dimensional cheese-like carbon nanoarchitecture with tremendous surface area and pore construction derived from corn as superior electrode materials for supercapacitors. *Applied Surface Science, 409*, 52-59. doi:https://doi.org/10.1016/j.apsusc.2017.02.209

Grishchenko, L. M., Tsapyuk, G. G., Ricco, M., Diyuk, V. E., Boldyrieva, O. Y., Mariychuk, R., . . . Scaravonati, S. (2020, 22-24 April 2020). *Enhancing the Performance of Supercapacitor Activated Carbon Electrodes by Oxidation.* Paper presented at the 2020 IEEE 40th International Conference on Electronics and Nanotechnology (ELNANO).

Gulzar, U., Goriparti, S., Miele, E., Li, T., Maidecchi, G., Toma, A., . . . Zaccaria, R. (2016). Next-Generation Textiles: From Embedded Supercapacitors to Lithium Ion Batteries. *J. Mater. Chem. A, 4*, 16771-16800. doi:10.1039/C6TA06437J

Gunasekaran, S. S., & Badhulika, S. (2021). High-performance solid-state supercapacitor based on sustainable synthesis of meso-macro porous carbon derived from hemp fibres via CO2 activation. *Journal of Energy Storage, 41*, 102997. doi:https://doi.org/10.1016/j.est.2021.102997

Gunasekaran, S. S., & Badhulika, S. (2022). Effect of pH and activation on macroporous carbon derived from cocoa-pods for high performance aqueous supercapacitor application. *Materials Chemistry and Physics, 276*, 125399. doi:https://doi.org/10.1016/j.matchemphys.2021.125399

Guo, W., Yu, C., Li, S., & Qiu, J. (2021). Toward commercial-level mass-loading electrodes for supercapacitors: opportunities, challenges and perspectives. *Energy & Environmental Science, 14*(2), 576-601. doi:10.1039/D0EE02649B

Gupta, V., & Miura, N. (2006a). High performance electrochemical supercapacitor from electrochemically synthesized nanostructured polyaniline. *Materials Letters, 60*(12), 1466-1469. doi:https://doi.org/10.1016/j.matlet.2005.11.047

Gupta, V., & Miura, N. (2006b). Polyaniline/single-wall carbon nanotube (PANI/SWCNT) composites for high performance supercapacitors. *Electrochimica Acta, 52*(4), 1721-1726. doi:https://doi.org/10.1016/j.electacta.2006.01.074

Hall, P. J., Mirzaeian, M., Fletcher, S. I., Sillars, F. B., Rennie, A. J. R., Shitta-Bey, G. O., . . . Carter, R. (2010). Energy storage in electrochemical capacitors: designing functional materials to improve performance. *Energy & Environmental Science, 3*(9), 1238-1251. doi:10.1039/C0EE00004C

Halper, M. S., & Ellenbogen, J. C. (2006a). Supercapacitors: A brief overview. *The MITRE Corporation, McLean, Virginia, USA, 1*.

Halper, M. S., & Ellenbogen, J. C. (2006b). Supercapacitors: A brief overview. *The MITRE Corporation, McLean, Virginia, USA*, 1-34.

Harris, D. C. (2010). *Quantitative chemical analysis* (8th ed.): Macmillan.

Harrop, D. P. (2020). *Supercapacitors: Applications, Players, Markets 2020-2040,* *http://www.carbon-ion.energy/wp-content/uploads/2020/12/IDTechEx_WebinarSlides_SupercapacitorsApplicationsPlayersMarkets20202040-2.pdf*. Retrieved from

He, D., Niu, J., Dou, M., Ji, J., Huang, Y., & Wang, F. (2017). Nitrogen and oxygen co-doped carbon networks with a mesopore-dominant hierarchical porosity for high energy and power density supercapacitors. *Electrochimica Acta, 238*, 310-318. doi:https://doi.org/10.1016/j.electacta.2017.03.218

He, H., Lian, J., Chen, C., Xiong, Q., & Zhang, M. (2021). Super hydrophilic carbon fiber film for freestanding and flexible cathodes of zinc-ion hybrid supercapacitors. *Chemical Engineering Journal, 421*, 129786. doi:https://doi.org/10.1016/j.cej.2021.129786

He, S., Hu, X., Chen, S., Hu, H., Hanif, M., & Hou, H. (2012). Needle-like polyaniline nanowires on graphite nanofibers: hierarchical micro/nano-architecture for high performance supercapacitors. *Journal of Materials Chemistry, 22*(11), 5114-5120. doi:10.1039/C2JM15668G

He, X., Ling, P., Yu, M., Wang, X., Zhang, X., & Zheng, M. (2013). Rice husk-derived porous carbons with high capacitance by ZnCl2 activation for supercapacitors. *Electrochimica Acta, 105*, 635-641. doi:https://doi.org/10.1016/j.electacta.2013.05.050

Herrero, E., Buller, L. J., & Abruña, H. D. (2001). Underpotential Deposition at Single Crystal Surfaces of Au, Pt, Ag and Other Materials. *Chemical Reviews, 101*(7), 1897-1930. doi:10.1021/cr9600363

Hidayat, A., & Sutrisno, B. (2016). Comparison on pore development of activated carbon produced by chemical and physical activation from palm empty fruit bunch. *IOP*

Conference Series: Materials Science and Engineering, 162, 012008. doi:10.1088/1757-899X/162/1/012008

Horng, Y.-Y., Lu, Y.-C., Hsu, Y.-K., Chen, C.-C., Chen, L.-C., & Chen, K.-H. (2010). Flexible supercapacitor based on polyaniline nanowires/carbon cloth with both high gravimetric and area-normalized capacitance. *Journal of Power Sources, 195*(13), 4418-4422. doi:https://doi.org/10.1016/j.jpowsour.2010.01.046

Hu, S.-C., Cheng, J., Wang, W.-P., Sun, G.-T., Hu, L.-L., Zhu, M.-Q., & Huang, X.-H. (2021). Structural changes and electrochemical properties of lacquer wood activated carbon prepared by phosphoric acid-chemical activation for supercapacitor applications. *Renewable Energy, 177*, 82-94. doi:https://doi.org/10.1016/j.renene.2021.05.113

Huang, S., Du, X., Ma, M., & Xiong, L. (2021). Recent progress in the synthesis and applications of vertically aligned carbon nanotube materials. *Nanotechnology Reviews, 10*(1), 1592-1623. doi:doi:10.1515/ntrev-2021-0102

Huang, Y.-F., Chiueh, P.-T., Shih, C.-H., Lo, S.-L., Sun, L., Zhong, Y., & Qiu, C. (2015). Microwave pyrolysis of rice straw to produce biochar as an adsorbent for CO2 capture. *Energy, 84*, 75-82.

IDTechEx. (2020). *Supercapacitors: Applications, Players, Markets 2020-2040, https://www.idtechex.com/en/research-report/supercapacitors-applications-players-markets-2020-2040/661*. Retrieved from

IEA. (2019a). *Global energy CO2 status report, https://www.iea.org/reports/global-energy-co2-status-report-2019/emissions*. Retrieved from

IEA. (2019b). *World gross electricity production by source, https://www.iea.org/data-and-statistics/charts/world-gross-electricity-production-by-source-2019*. Retrieved from

Iqbal, M., & Aziz, U. (2022). Supercapattery: Merging of battery-supercapacitor electrodes for hybrid energy storage devices. *The Journal of Energy Storage, 46*, 103823.

IRENA. (2020). *Global renewable outlook, https://irena.org/-/media/Files/IRENA/Agency/Publication/2020/Apr/IRENA_GRO_Summary_2020.pdf?la=en&hash=1F18E445B56228AF8C4893CAEF147ED0163A0E47*. Retrieved from

Iro, Z. S., Subramani, C., & Dash, S. (2016). A brief review on electrode materials for supercapacitor. *Int. J. Electrochem. Sci, 11*(12), 10628-10643.

Ismanto, A. E., Wang, S., Soetaredjo, F. E., & Ismadji, S. (2010). Preparation of capacitor's electrode from cassava peel waste. *Bioresour Technol, 101*(10), 3534-3540. doi:10.1016/j.biortech.2009.12.123

Jain, A., Balasubramanian, R., & Srinivasan, M. P. (2016). Hydrothermal conversion of biomass waste to activated carbon with high porosity: A review. *Chemical Engineering Journal, 283*, 789-805. doi:https://doi.org/10.1016/j.cej.2015.08.014

Jang, M., Ko, D., Choi, Y., Yan, B., Jin, X., Kim, D. K., & Piao, Y. (2021). Self-organized hierarchically porous carbon coated on carbon cloth for high-performance freestanding supercapacitor electrodes. *Journal of Electroanalytical Chemistry, 895*, 115456. doi:https://doi.org/10.1016/j.jelechem.2021.115456

Jiang, L., Sheng, L., Chen, X., Wei, T., & Fan, Z. (2016). Construction of nitrogen-doped porous carbon buildings using interconnected ultra-small carbon nanosheets for ultra-high rate supercapacitors. *Journal of Materials Chemistry A, 4*(29), 11388-11396. doi:10.1039/C6TA02570F

Jiang, L., Sheng, L., Long, C., Wei, T., & Fan, Z. (2015). Functional pillared graphene frameworks for ultrahigh volumetric performance supercapacitors. *Advanced Energy Materials, 5*(15), 1500771.

Jiang, Q., Qu, M., Zhou, G., Zhang, B., & Yu, Z. (2002). A study of activated carbon nanotubes as electrochemical super capacitors electrode materials. *Materials Letters - MATER LETT, 57*, 988-991. doi:10.1016/S0167-577X(02)00911-4

Jin, H., Wang, X., Gu, Z., & Polin, J. (2013). Carbon materials from high ash biochar for supercapacitor and improvement of capacitance with HNO3 surface oxidation. *Journal of Power Sources, 236*, 285-292.

Jose, R., & Ramakrishna, S. (2021). Comprehensiveness in the Research on Sustainability. *Materials Circular Economy, 3*(1), 1. doi:10.1007/s42824-020-00015-x

K, C., T, V. R., P, S., Reddy, N., Hu, C., Venkatesh, K., . . . N, K. (2017). KOH activated carbon derived from biomass-banana fibers as an efficient negative electrode in high performance asymmetric supercapacitor. *Journal of Energy Chemistry, 26*(1), 56-62. doi:https://doi.org/10.1016/j.jechem.2016.07.003

Kang, X., Zhu, H., Wang, C., Sun, K., & Yin, J. (2018). Biomass derived hierarchically porous and heteroatom-doped carbons for supercapacitors. *Journal of Colloid and Interface Science, 509*(Supplement C), 369-383. doi:https://doi.org/10.1016/j.jcis.2017.09.013

Karthika, P., Rajalakshmi, N., & Dhathathreyan, K. S. (2012). Functionalized exfoliated graphene oxide as supercapacitor electrodes.

Kate, R. S., Khalate, S. A., & Deokate, R. J. (2018). Overview of nanostructured metal oxides and pure nickel oxide (NiO) electrodes for supercapacitors: A review. *Journal of Alloys and Compounds, 734*(Supplement C), 89-111. doi:https://doi.org/10.1016/j.jallcom.2017.10.262

Ke, Q., & Wang, J. (2016). Graphene-based materials for supercapacitor electrodes – A review. *Journal of Materiomics, 2*(1), 37-54. doi:https://doi.org/10.1016/j.jmat.2016.01.001

Kierzek, K., Frackowiak, E., Lota, G., Gryglewicz, G., & Machnikowski, J. (2004). Electrochemical capacitors based on highly porous carbons prepared by KOH activation. *Electrochimica Acta, 49*, 515-523. doi:10.1016/j.electacta.2003.08.026

Kigozi, M. K., Ravi; Bello, Abdulhakeem; Padya, Balaji; Kaulu-uka, Godwin; Kasozi, Gabriel N; Jain, Pawan Kumar; Onwualu, Azikiwe Peter; Dzade, Nelson Y. (2020). Enhanced Activated Carbon with H2SO4-activation of African Maize Cobs biomass for Supercapacitor electrodes material application. *Zenodo*. Retrieved from https://doi.org/10.5061/dryad.9w0vt4bcd

Konikkara, N., Kennedy, L. J., & Vijaya, J. J. (2016). Preparation and characterization of hierarchical porous carbons derived from solid leather waste for supercapacitor applications. *Journal of Hazardous Materials, 318*, 173-185.

Kötz, R., & Carlen, M. (2000). Principles and applications of electrochemical capacitors. *Electrochimica Acta, 45*(15), 2483-2498. doi:https://doi.org/10.1016/S0013-4686(00)00354-6

Kuilla, T., Bhadra, S., Yao, D., Kim, N. H., Bose, S., & Lee, J. H. (2010). Recent advances in graphene based polymer composites. *Progress in Polymer Science, 35*(11), 1350-1375. doi:https://doi.org/10.1016/j.progpolymsci.2010.07.005

Kulkarni, C., Biswas, G., Celaya, J., & Goebel, K. (2011). *Prognostic Techniques for Capacitor Degradation and Health Monitoring*.

Kumar, R., Sahoo, S., Joanni, E., Singh, R. K., Tan, W. K., Kar, K. K., & Matsuda, A. (2019). Recent progress in the synthesis of graphene and derived materials for next generation electrodes of high performance lithium ion batteries. *Progress in Energy and Combustion Science, 75*, 100786. doi:https://doi.org/10.1016/j.pecs.2019.100786

Kumar, Y., Rawal, S., Joshi, B., & Hashmi, S. A. (2019). Background, fundamental understanding and progress in electrochemical capacitors. *Journal of Solid State Electrochemistry, 23*(3), 667-692. doi:10.1007/s10008-018-4160-3

Kurnia, J. C., Jangam, S. V., Akhtar, S., Sasmito, A. P., & Mujumdar, A. S. (2016). Advances in biofuel production from oil palm and palm oil processing wastes: A review. *Biofuel Research Journal, 3*(1), 332-346. doi:10.18331/brj2016.3.1.3

Lai, L., Yang, H., Wang, L., Teh, B. K., Zhong, J., Chou, H., . . . Lin, J. (2012). Preparation of Supercapacitor Electrodes through Selection of Graphene Surface Functionalities. *ACS Nano, 6*(7), 5941-5951. doi:10.1021/nn3008096

Lam, S. S., Russell, A. D., Lee, C. L., & Chase, H. A. (2012). Microwave-heated pyrolysis of waste automotive engine oil: Influence of operation parameters on the yield, composition, and fuel properties of pyrolysis oil. *Fuel, 92*(1), 327-339.

Largeot, C., Portet, C., Chmiola, J., Taberna, P.-L., Gogotsi, Y., & Simon, P. (2008). Relation between the Ion Size and Pore Size for an Electric Double-Layer Capacitor. *Journal of the American Chemical Society, 130*(9), 2730-2731. doi:10.1021/ja7106178

Lee, K.-C., Lim, M., Hong, Z.-Y., Chong, S., Tiong, J., Pan, G.-T., & Huang, C.-M. (2021a). Coconut Shell-Derived Activated Carbon for High-Performance Solid-State Supercapacitors. *Energies, 14*, 4546. doi:10.3390/en14154546

Lee, K.-C., Lim, M. S. W., Hong, Z.-Y., Chong, S., Tiong, T. J., Pan, G.-T., & Huang, C.-M. (2021b). Coconut Shell-Derived Activated Carbon for High-Performance Solid-State Supercapacitors. *Energies, 14*(15), 4546. Retrieved from https://www.mdpi.com/1996-1073/14/15/4546

Lewandowski, A., Olejniczak, A., Galinski, M., & Stepniak, I. (2010). Performance of carbon–carbon supercapacitors based on organic, aqueous and ionic liquid electrolytes. *Journal of Power Sources, 195*(17), 5814-5819. doi:https://doi.org/10.1016/j.jpowsour.2010.03.082

Li, J., Wang, Y., Xu, W., Wang, Y., Zhang, B., Luo, S., . . . Hu, C. (2019). Porous Fe2O3 nanospheres anchored on activated carbon cloth for high-performance symmetric supercapacitors. *Nano Energy, 57*, 379-387. doi:https://doi.org/10.1016/j.nanoen.2018.12.061

Li, Q., Mu, J., Zhou, J., Zhao, Y., & Zhuo, S. (2019). Avoiding the use of corrosive activator to produce nitrogen-doped hierarchical porous carbon materials for high-performance supercapacitor electrode. *Journal of Electroanalytical Chemistry, 832*, 284-292. doi:https://doi.org/10.1016/j.jelechem.2018.11.013

Li, R., Zhang, W., Zhang, M., Peng, Z., Wang, Y., Liu, Y., . . . Zhang, T. (2021). High performance Ni3S2/3D graphene/nickel foam composite electrode for supercapacitor applications. *Materials Chemistry and Physics, 257*, 123769. doi:https://doi.org/10.1016/j.matchemphys.2020.123769

Li, S., Zhang, L., Zhang, L., Zhang, J., Zhou, H., Chen, X., & Tang, T. (2021). The in situ construction of three-dimensional core–shell-structured TiO2@PPy/rGO nanocomposites for improved supercapacitor electrode performance. *New Journal of Chemistry, 45*(2), 1092-1099. doi:10.1039/D0NJ05328G

Li, X.-r., Jiang, Y.-h., Wang, P.-z., Mo, Y., Lai, W.-d., Li, Z.-j., . . . Chen, Y. (2020). Effect of the oxygen functional groups of activated carbon on its electrochemical performance for supercapacitors. *New Carbon Materials, 35*(3), 232-243. doi:https://doi.org/10.1016/S1872-5805(20)60487-5

Li, X., Tang, Y., Song, J., Yang, W., Wang, M., Zhu, C., . . . Lin, Y. (2018). Self-supporting activated carbon/carbon nanotube/reduced graphene oxide flexible electrode for high performance supercapacitor. *Carbon, 129*, 236-244. doi:https://doi.org/10.1016/j.carbon.2017.11.099

Li, Y., Zhang, D., Zhang, Y., He, J., Wang, Y., Wang, K., . . . Wang, Y. (2020). Biomass-derived microporous carbon with large micropore size for high-performance supercapacitors. *Journal of Power Sources, 448*, 227396. doi:https://doi.org/10.1016/j.jpowsour.2019.227396

Li, Y., Zhao, X., Yu, P., & Zhang, Q. (2013). Oriented arrays of polyaniline nanorods grown on graphite nanosheets for an electrochemical supercapacitor. *Langmuir, 29*(1), 493-500.

Li, Z.-Y., Akhtar, M. S., Kwak, D.-H., & Yang, O. B. (2017). Improvement in the surface properties of activated carbon via steam pretreatment for high performance supercapacitors. *Applied Surface Science, 404*, 88-93. doi:https://doi.org/10.1016/j.apsusc.2017.01.238

Li, Z., Guo, D., Liu, Y., Wang, H., & Wang, L. (2020). Recent advances and challenges in biomass-derived porous carbon nanomaterials for supercapacitors. *Chemical Engineering Journal, 397*, 125418. doi:https://doi.org/10.1016/j.cej.2020.125418

Libra, J. A., Ro, K. S., Kammann, C., Funke, A., Berge, N. D., Neubauer, Y., . . . Emmerich, K.-H. (2011). Hydrothermal carbonization of biomass residuals: a comparative review of the chemistry, processes and applications of wet and dry pyrolysis. *Biofuels, 2*(1), 71-106. doi:10.4155/bfs.10.81

Liu, B., Zhou, X., Chen, H., Liu, Y., & Li, H. (2016). Promising porous carbons derived from lotus seedpods with outstanding supercapacitance performance. *Electrochimica Acta, 208*, 55-63. doi:https://doi.org/10.1016/j.electacta.2016.05.020

Liu, H., Song, H., Chen, X., Zhang, S., Zhou, J., & Ma, Z. (2015). Effects of nitrogen- and oxygen-containing functional groups of activated carbon nanotubes on the electrochemical performance in supercapacitors. *Journal of Power Sources, 285*, 303-309. doi:https://doi.org/10.1016/j.jpowsour.2015.03.115

Liu, J., Duan, Q., Peng, W., Feng, L., Ma, M., Hu, S., . . . Wang, Q. (2022). Slight overcharging cycling failure of commercial lithium-ion battery induced by the jelly roll destruction. *Process Safety and Environmental Protection, 160*, 695-703. doi:https://doi.org/10.1016/j.psep.2022.02.067

Liu, M., Gan, L., Xiong, W., Zhao, F., Fan, X., Zhu, D., . . . Chen, L. (2013). Nickel-Doped Activated Mesoporous Carbon Microspheres with Partially Graphitic Structure for Supercapacitors. *Energy & Fuels, 27*(2), 1168-1173. doi:10.1021/ef302028j

Liu, X., Zhu, J., Wang, X., Sun, J., Tang, Z., Zhang, T., . . . Tang, D. (2013). Capacitive Properties and Structure of RuO2-HfO2 Films Prepared by Thermal Decomposition Method. *Physics Procedia, 50*, 416-420. doi:https://doi.org/10.1016/j.phpro.2013.11.064

Liu, Y., Chen, H., & Li, L. (2022). Applications and challenges of porous carbon with different dimensions in supercapacitors—a mini review. *Frontiers in Energy Research, 10*. doi:10.3389/fenrg.2022.951701

Liu, Y., Jiang, S. P., & Shao, Z. (2020). Intercalation pseudocapacitance in electrochemical energy storage: recent advances in fundamental understanding and materials development. *Materials Today Advances, 7*, 100072. doi:https://doi.org/10.1016/j.mtadv.2020.100072

Liu, Z., Hu, J., Shen, F., Tian, D., Huang, M., He, J., . . . Zeng, Y. (2021). Trichoderma bridges waste biomass and ultra-high specific surface area carbon to achieve a high-performance supercapacitor. *Journal of Power Sources, 497*, 229880. doi:https://doi.org/10.1016/j.jpowsour.2021.229880

Lu, W., Qu, L., Dai, L., & Henry, K. (2019). Superior Capacitive Performance of Aligned Carbon Nanotubes in Ionic Liquids. *ECS Transactions, 6*(25), 257-261. doi:10.1149/1.2943245

Lucian, M., & Fiori, L. (2017). Hydrothermal Carbonization of Waste Biomass: Process Design, Modeling, Energy Efficiency and Cost Analysis. *Energies, 10*(2), 211. Retrieved from https://www.mdpi.com/1996-1073/10/2/211

Luo, F., Iradukunda, Y., Yi, K., Hu, Y., Li, X., Wang, G., & Shi, G. (2021). Valorization of biomass waste from yellow horn (Xanthoceras sorbifolia) through the preparation of porous carbon for supercapacitors. *Int. J. Electrochem. Sci, 16*(210325), 210325.

Lussier, M., Zhang, Z., & Miller, D. J. (1998). Characterizing rate inhibition in steam/hydrogen gasification via analysis of adsorbed hydrogen. *Carbon, 36*(9), 1361-1369.

Ma, C., Fan, Q., Dirican, M., Subjalearndee, N., Cheng, H., Li, J., . . . Zhang, X. (2021). Rational design of meso-/micro-pores for enhancing ion transportation in highly-porous carbon nanofibers used as electrode for supercapacitors. *Applied Surface Science, 545*, 148933. doi:https://doi.org/10.1016/j.apsusc.2021.148933

Ma, X.-Q., Shan, Y.-Q., Duan, P.-G., Liao, J.-J., Chen, D.-B., & Xu, Z.-X. (2021). Fe(NO3)3 assisted hydrothermal carbonization of sewage sludge: Focusing on characteristics of hydrochar and aqueous phase. *Molecular Catalysis, 514*, 111823. doi:https://doi.org/10.1016/j.mcat.2021.111823

Mahmood, N., Tang, T., & Hou, Y. (2016). Nanostructured Anode Materials for Lithium Ion Batteries: Progress, Challenge and Perspective. *Advanced Energy Materials, 6*(17), 1600374. doi:https://doi.org/10.1002/aenm.201600374

Majumdar, D., Maiyalagan, T., & Jiang, Z. (2019). Recent Progress in Ruthenium Oxide-Based Composites for Supercapacitor Applications. *ChemElectroChem, 6*(17), 4343-4372. doi:https://doi.org/10.1002/celc.201900668

Mandal, D., Jeong, J. Y., Singu, B. S., Lee, S., Mun, W. J., & Kim, H. (2022). Flexible all solid-state niobium nitride//activated carbon lithium-ion hybrid capacitor with high volumetric power and energy densities. *Journal of Energy Storage, 48*, 104031. doi:https://doi.org/10.1016/j.est.2022.104031

Mao, L., Zhang, K., Chan, H. S. O., & Wu, J. (2012). Surfactant-stabilized graphene/polyaniline nanofiber composites for high performance supercapacitor electrode. *Journal of Materials Chemistry, 22*(1), 80-85.

Mao, Z. X., Zhang, W., Wang, M. J., Peng, L., Hong, W., Deng, J., . . . Wei, Z. (2019). Enhancing rate performances of carbon based supercapacitors. *ChemistrySelect, 4*(22), 6827-6832.

Marinho, B., Ghislandi, M., Tkalya, E., Koning, C. E., & de With, G. (2012). Electrical conductivity of compacts of graphene, multi-wall carbon nanotubes, carbon black, and graphite powder. *Powder Technology, 221*, 351-358. doi:https://doi.org/10.1016/j.powtec.2012.01.024

Massé, R. C., Liu, C., Li, Y., Mai, L., & Cao, G. (2016). Energy storage through intercalation reactions: electrodes for rechargeable batteries. *National Science Review, 4*(1), 26-53. doi:10.1093/nsr/nww093

Mclean, Virginia, A., Halper, M. S., & Ellenbogen, J. C. (2006). *Supercapacitors : A Brief Overview*.

Mei, B.-A., Munteshari, O., Lau, J., Dunn, B., & Pilon, L. (2018). Physical interpretations of Nyquist plots for EDLC electrodes and devices. *The Journal of Physical Chemistry C, 122*(1), 194-206.

Meng, Y., Zhao, Y., Hu, C., Cheng, H., Hu, Y., Zhang, Z., . . . Qu, L. (2013). All-Graphene Core-Sheath Microfibers for All-Solid-State, Stretchable Fibriform Supercapacitors and Wearable Electronic Textiles. *Advanced Materials, 25*(16), 2326-2331. doi:https://doi.org/10.1002/adma.201300132

MINVIRO. (2021). *Vulcan energy - zero carbon lithium, https://www.minviro.com/project-results-vulcan-energy-resources/*. Retrieved from

Misnon, I. I., Zain, N. K. M., Aziz, R. A., Vidyadharan, B., & Jose, R. (2015a). Electrochemical properties of carbon from oil palm kernel shell for high performance supercapacitors. *Electrochimica Acta, 174*(Supplement C), 78-86. doi:https://doi.org/10.1016/j.electacta.2015.05.163

Misnon, I. I., Zain, N. K. M., Aziz, R. A., Vidyadharan, B., & Jose, R. (2015b). Electrochemical properties of carbon from oil palm kernel shell for high performance supercapacitors. *Electrochimica Acta, 174*, 78-86. doi:https://doi.org/10.1016/j.electacta.2015.05.163

Misnon, I. I., Zain, N. K. M., Lei, T. S., Vijayan, B. L., & Jose, R. (2020). Activated carbon with graphitic content from stinky bean seedpod biowaste as supercapacitive electrode material. *Ionics, 26*(8), 4081-4093. doi:10.1007/s11581-020-03565-x

Mojoudi, N., Mirghaffari, N., Soleimani, M., Shariatmadari, H., Belver, C., & Bedia, J. (2019). Phenol adsorption on high microporous activated carbons prepared from oily sludge: equilibrium, kinetic and thermodynamic studies. *Scientific Reports, 9*(1), 19352. doi:10.1038/s41598-019-55794-4

Mosqueda, H., & Brousse, T. (2011). *Activated Carbon-MnO 2 Supercapacitor Tested in Function of Temperature and Voltage*.

Moyo, M., Nyamhere, G., Sebata, E., & Guyo, U. (2016). Kinetic and equilibrium modelling of lead sorption from aqueous solution by activated carbon from goat dung. *Desalination and Water Treatment, 57*(2), 765-775. doi:10.1080/19443994.2014.968217

Muralee Gopi, C. V. V., Ravi, S., Rao, S. S., Eswar Reddy, A., & Kim, H. J. (2017). Carbon nanotube/metal-sulfide composite flexible electrodes for high-performance quantum dot-sensitized solar cells and supercapacitors. *Sci Rep, 7*, 46519. doi:10.1038/srep46519

Muralidharan, N., Teblum, E., Westover, A. S., Schauben, D., Itzhak, A., Muallem, M., . . . Pint, C. L. (2018). Carbon nanotube reinforced structural composite supercapacitor. *Scientific Reports, 8*(1), 1-9.

Muzaffar, A., Ahamed, M. B., Deshmukh, K., & Thirumalai, J. (2019). A review on recent advances in hybrid supercapacitors: Design, fabrication and applications. *Renewable and Sustainable Energy Reviews, 101*, 123-145. doi:https://doi.org/10.1016/j.rser.2018.10.026

Nature. (2021). Lithium-ion batteries need to be greener and more ethical, https://doi.org/10.1038/d41586-021-01735-z [Press release]. Retrieved from https://www.nature.com/articles/d41586-021-01735-z

Nizamuddin, S., Jayakumar, N. S., Sahu, J. N., Ganesan, P., Bhutto, A. W., & Mubarak, N. M. (2015). Hydrothermal carbonization of oil palm shell. *Korean Journal of Chemical Engineering, 32*(9), 1789-1797. doi:10.1007/s11814-014-0376-9

Norouzi, O., Pourhosseini, S. E. M., Naderi, H. R., Di Maria, F., & Dutta, A. (2021). Integrated hybrid architecture of metal and biochar for high performance asymmetric supercapacitors. *Scientific Reports, 11*(1), 5387. doi:10.1038/s41598-021-84979-z

Oguz Erdogan, F. (2016). Characterization of the Activated Carbon Surface of Cherry Stones Prepared by Sodium and Potassium Hydroxide. *Analytical Letters, 49*(7), 1079-1090. doi:10.1080/00032719.2015.1065879

Okonkwo, C. A., Menkiti, M. C., Obiora-Okafo, I. A., & Ezenwa, O. N. (2021). Controlled pyrolysis of sugarcane bagasse enhanced mesoporous carbon for improving capacitance of supercapacitor electrode. *Biomass and Bioenergy, 146*, 105996. doi:https://doi.org/10.1016/j.biombioe.2021.105996

Olabi, A. G., Wilberforce, T., & Abdelkareem, M. A. (2021). Fuel cell application in the automotive industry and future perspective. *Energy, 214*, 118955. doi:https://doi.org/10.1016/j.energy.2020.118955

Osswald, S., Portet, C., Gogotsi, Y., Laudisio, G., Singer, J. P., Fischer, J. E., . . . Kravchik, A. E. (2009). Porosity control in nanoporous carbide-derived carbon by oxidation in air and carbon dioxide. *Journal of Solid State Chemistry, 182*(7), 1733-1741. doi:https://doi.org/10.1016/j.jssc.2009.04.017

Owusu, K. A., Wang, Z., Qu, L., Liu, Z. a., Mehrez, J. A.-A., Wei, Q., . . . Mai, L. (2020). Activated carbon clothes for wide-voltage high-energy-density aqueous symmetric supercapacitors. *Chinese Chemical Letters, 31*(6), 1620-1624. doi:https://doi.org/10.1016/j.cclet.2019.09.045

Özarslan, S., Atelge, M. R., Kaya, M., & Ünalan, S. (2021). Production of dual functional carbon material from biomass treated with NaOH for supercapacitor and catalyst. *Energy Storage, 3*(5), e257. doi:https://doi.org/10.1002/est2.257

Pal, B., Yasin, A., Kaur, R., Tebyetekerwa, M., Zabihi, F., Yang, S., . . . Jose, R. (2021). Understanding electrochemical capacitors with in-situ techniques. *Renewable and*

Sustainable Energy Reviews, 149, 111418. doi:https://doi.org/10.1016/j.rser.2021.111418

Pandey, S., Karakoti, M., Surana, K., Dhapola, P. S., SanthiBhushan, B., Ganguly, S., . . . Sahoo, N. G. (2021). Graphene nanosheets derived from plastic waste for the application of DSSCs and supercapacitors. *Scientific Reports, 11*(1), 3916. doi:10.1038/s41598-021-83483-8

Peters, J. F., Baumann, M., Zimmermann, B., Braun, J., & Weil, M. (2017). The environmental impact of Li-Ion batteries and the role of key parameters – A review. *Renewable and Sustainable Energy Reviews, 67*, 491-506. doi:https://doi.org/10.1016/j.rser.2016.08.039

Petzl, M., Kasper, M., & Danzer, M. A. (2015). Lithium plating in a commercial lithium-ion battery – A low-temperature aging study. *Journal of Power Sources, 275*, 799-807. doi:https://doi.org/10.1016/j.jpowsour.2014.11.065

Pongprayoon, P., & Chaimanatsakun, A. (2019). Revealing the Effects of Pore Size and Geometry on the Mechanical Properties of Graphene Nanopore Using the Atomistic Finite Element Method. *Acta Mechanica Solida Sinica, 32*(1), 81-92. doi:10.1007/s10338-018-0061-3

Ponrouch, A., Bitenc, J., Dominko, R., Lindahl, N., Johansson, P., & Palacin, M. R. (2019). Multivalent rechargeable batteries. *Energy Storage Materials, 20*, 253-262. doi:https://doi.org/10.1016/j.ensm.2019.04.012

Poonam, Sharma, K., Arora, A., & Tripathi, S. K. (2019). Review of supercapacitors: Materials and devices. *Journal of Energy Storage, 21*, 801-825. doi:https://doi.org/10.1016/j.est.2019.01.010

Portet, C., Taberna, P. L., Simon, P., & Laberty-Robert, C. (2004). Modification of Al current collector surface by sol–gel deposit for carbon–carbon supercapacitor applications. *Electrochimica Acta, 49*(6), 905-912. doi:https://doi.org/10.1016/j.electacta.2003.09.043

Premathilake, D., Outlaw, R. A., Parler, S. G., Butler, S. M., & Miller, J. R. (2017). Electric double layer capacitors for ac filtering made from vertically oriented graphene nanosheets on aluminum. *Carbon, 111*, 231-237. doi:https://doi.org/10.1016/j.carbon.2016.09.080

Pumera, M. (2010). Graphene-based nanomaterials and their electrochemistry. *Chemical Society Reviews, 39*(11), 4146-4157. doi:10.1039/C002690P

Qian, L., Guo, F., Jia, X., Zhan, Y., Zhou, H., Jiang, X., & Tao, C. (2020). Recent development in the synthesis of agricultural and forestry biomass-derived porous carbons for supercapacitor applications: a review. *Ionics, 26*(8), 3705-3723. doi:10.1007/s11581-020-03626-1

Qian, W., Sun, F., Xu, Y., Qiu, L., Liu, C., Wang, S., & Yan, F. (2014). Human hair-derived carbon flakes for electrochemical supercapacitors. *Energy & Environmental Science, 7*(1), 379-386.

Rahman, A. u., Noreen, H., Nawaz, Z., Iqbal, J., Rahman, G., & Yaseen, M. (2021). Synthesis of graphene nanoplatelets/polythiophene as a high performance supercapacitor electrode material. *New Journal of Chemistry, 45*(35), 16187-16195. doi:10.1039/D1NJ02865K

Rajabathar, J. R., Sivachidambaram, M., Vijaya, J. J., Al-lohedan, H. A., & Aldhayan, D. M. D. (2020). Flexible Type Symmetric Supercapacitor Electrode Fabrication Using Phosphoric Acid-Activated Carbon Nanomaterials Derived from Cow Dung for Renewable Energy Applications. *ACS Omega, 5*(25), 15028-15038. doi:10.1021/acsomega.0c00848

Rajagopal, S., Pulapparambil Vallikkattil, R., Mohamed Ibrahim, M., & Velev, D. G. (2022). Electrode Materials for Supercapacitors in Hybrid Electric Vehicles: Challenges and Current Progress. *Condensed Matter, 7*(1), 6. Retrieved from https://www.mdpi.com/2410-3896/7/1/6

Rani, J., Thangavel, R., Kim, M., Lee, Y. S., & Jang, J.-H. (2020). Ultra-high energy density hybrid supercapacitors using MnO2/reduced graphene oxide hybrid nanoscrolls. *Nanomaterials, 10*(10), 2049.

Rashidi, N. A., & Yusup, S. (2017). A review on recent technological advancement in the activated carbon production from oil palm wastes. *Chemical Engineering Journal, 314*(Supplement C), 277-290. doi:https://doi.org/10.1016/j.cej.2016.11.059

Raymundo-Piñero, E., Leroux, F., & Béguin, F. (2006). A High-Performance Carbon for Supercapacitors Obtained by Carbonization of a Seaweed Biopolymer. *Advanced Materials, 18*(14), 1877-1882. doi:https://doi.org/10.1002/adma.200501905

Reddy, M., Subba Rao, G., & Chowdari, B. (2013). Metal oxides and oxysalts as anode materials for Li ion batteries. *Chemical Reviews, 113*(7), 5364-5457.

Ren, M., Jia, Z., Tian, Z., Lopez, D., Cai, J., Titirici, M.-M., & Jorge, A. B. (2018). High Performance N-Doped Carbon Electrodes Obtained via Hydrothermal Carbonization of Macroalgae for Supercapacitor Applications. *ChemElectroChem, 5*(18), 2686-2693. doi:https://doi.org/10.1002/celc.201800603

Saikia, P., Dutta, K., Guha, A. K., Dolui, S. K., Barman, P., & Borthakur, L. J. (2021). High- performance aqueous electrolyte based supercapacitor of carboxylic acid functionalized carbon-nanotubes and graphene nano composite. *Materials Chemistry and Physics, 258*, 123786. doi:https://doi.org/10.1016/j.matchemphys.2020.123786

Saini, S., Chand, P., & Joshi, A. (2021). Biomass derived carbon for supercapacitor applications: Review. *Journal of Energy Storage, 39*, 102646. doi:https://doi.org/10.1016/j.est.2021.102646

Sajjadi, B., Chen, W.-Y., & Egiebor, N. O. (2019). A comprehensive review on physical activation of biochar for energy and environmental applications. *Reviews in Chemical Engineering, 35*(6), 735-776.

Sajjadi, B., Zubatiuk, T., Leszczynska, D., Leszczynski, J., & Chen, W. Y. (2019). Chemical activation of biochar for energy and environmental applications: a comprehensive review. *Reviews in Chemical Engineering, 35*(7), 777-815.

Saka, C. (2012). BET, TG–DTG, FT-IR, SEM, iodine number analysis and preparation of activated carbon from acorn shell by chemical activation with ZnCl2. *Journal of Analytical and Applied Pyrolysis, 95*, 21-24.

Saka, C., & Balbay, A. (2021). Oxygen and nitrogen-functionalized porous carbon particles derived from hazelnut shells for the efficient catalytic hydrogen production reaction. *Biomass and Bioenergy, 149*, 106072. doi:https://doi.org/10.1016/j.biombioe.2021.106072

Saleem, A. M., Desmaris, V., & Enoksson, P. (2016). Performance Enhancement of Carbon Nanomaterials for Supercapacitors. *Journal of Nanomaterials, 2016*, 1537269. doi:10.1155/2016/1537269

Saleem, M., Desmaris, V., & Enoksson, P. (2016). Performance Enhancement of Carbon Nanomaterials for Supercapacitors. *Journal of Nanomaterials, 2016*, 1-17. doi:10.1155/2016/1537269

Salitra, G., Soffer, A., Eliad, L., Cohen, Y., & Aurbach, D. (2000). Carbon Electrodes for Double-Layer Capacitors I. Relations Between Ion and Pore Dimensions. *Journal of The Electrochemical Society, 147*(7), 2486. doi:10.1149/1.1393557

Sangtong, N., Chaisuwan, T., Wongkasemjit, S., Ishida, H., Redpradit, W., Seneesrisakul, K., & Thubsuang, U. (2021). Ultrahigh-surface-area activated biocarbon based on biomass residue as a supercapacitor electrode material: Tuning pore structure using alkalis with different atom sizes. *Microporous and Mesoporous Materials, 326*, 111383. doi:https://doi.org/10.1016/j.micromeso.2021.111383

Saverettiar, G., Li, D., Gross, A., & Ho, G. (2020). Hydrothermal Carbonization of Cattle Paunch Waste: Process Conditions and Product Characteristics. *Journal of Environmental Chemical Engineering, 8*(6), 104487. doi:https://doi.org/10.1016/j.jece.2020.104487

Schipper, F., Nayak, P. K., Erickson, E. M., Amalraj, S. F., Srur-Lavi, O., Penki, T. R., . . . Aurbach, D. (2017). Study of Cathode Materials for Lithium-Ion Batteries: Recent Progress and New Challenges. *Inorganics, 5*(2), 32. Retrieved from https://www.mdpi.com/2304-6740/5/2/32

Selvaraj, A. R., Muthusamy, A., Inho, C., Kim, H.-J., Senthil, K., & Prabakar, K. (2021). Ultrahigh surface area biomass derived 3D hierarchical porous carbon nanosheet electrodes for high energy density supercapacitors. *Carbon, 174*, 463-474. doi:https://doi.org/10.1016/j.carbon.2020.12.052

Selvaraj, T., Perumal, V., Khor, S. F., Anthony, L. S., Gopinath, S. C. B., & Muti Mohamed, N. (2020). The recent development of polysaccharides biomaterials and their performance for supercapacitor applications. *Materials Research Bulletin, 126*, 110839. doi:https://doi.org/10.1016/j.materresbull.2020.110839

Sennu, P., Aravindan, V., & Lee, Y.-S. (2016). High energy asymmetric supercapacitor with 1D@2D structured NiCo2O4@Co3O4 and jackfruit derived high surface area porous carbon. *Journal of Power Sources, 306*, 248-257. doi:https://doi.org/10.1016/j.jpowsour.2015.12.029

Seredych, M., & Bandosz, T. J. (2007). Removal of ammonia by graphite oxide via its intercalation and reactive adsorption. *Carbon (New York, NY), 45*(10), 2130-2132.

Sevilla, M., & Mokaya, R. (2014). Energy storage applications of activated carbons: supercapacitors and hydrogen storage. *Energy & Environmental Science, 7*(4), 1250-1280. doi:10.1039/C3EE43525C

Shaker, M., Ghazvini, A. A. S., Cao, W., Riahifar, R., & Ge, Q. (2021). Biomass-derived porous carbons as supercapacitor electrodes–A review. *New Carbon Materials, 36*(3), 546-572.

Shanmuga Priya, M., Divya, P., & Rajalakshmi, R. (2020). A review status on characterization and electrochemical behaviour of biomass derived carbon materials for energy storage supercapacitors. *Sustainable Chemistry and Pharmacy, 16*, 100243. doi:https://doi.org/10.1016/j.scp.2020.100243

Shao, Y., El-Kady, M. F., Sun, J., Li, Y., Zhang, Q., Zhu, M., . . . Kaner, R. B. (2018). Design and Mechanisms of Asymmetric Supercapacitors. *Chemical Reviews, 118*(18), 9233-9280. doi:10.1021/acs.chemrev.8b00252

Sharma, S., Sudhakara, P., Omran, A. A. B., Singh, J., & Ilyas, R. A. (2021). Recent Trends and Developments in Conducting Polymer Nanocomposites for Multifunctional Applications. *Polymers, 13*(17), 2898. Retrieved from https://www.mdpi.com/2073-4360/13/17/2898

Sharma, V., Singh, I., & Chandra, A. (2018). Hollow nanostructures of metal oxides as next generation electrode materials for supercapacitors. *Scientific Reports, 8*(1), 1307. doi:10.1038/s41598-018-19815-y

Shen, W., Li, Z., & Liu, Y. (2008). Surface chemical functional groups modification of porous carbon. *Recent Patents on Chemical Engineering, 1*(1), 27-40.

Shen, X., Tian, Z., Fan, R., Shao, L., Zhang, D., Cao, G., . . . Bai, Y. (2018). Research progress on silicon/carbon composite anode materials for lithium-ion battery. *Journal of Energy Chemistry, 27*(4), 1067-1090. doi:https://doi.org/10.1016/j.jechem.2017.12.012

Shi, J., Cui, H., Xu, J., Yan, N., & Liu, Y. (2020). Design and fabrication of hierarchically porous carbon frameworks with Fe2O3 cubes as hard template for CO2 adsorption. *Chemical Engineering Journal, 389*, 124459. doi:https://doi.org/10.1016/j.cej.2020.124459

Shirakawa, H., Louis, E. J., MacDiarmid, A. G., Chiang, C. K., & Heeger, A. J. (1977). Synthesis of electrically conducting organic polymers: halogen derivatives of polyacetylene, (CH). *Journal of the Chemical Society, Chemical Communications*(16), 578-580. doi:10.1039/C39770000578

Shobha, Bhaskaran, Singh, M., Negi, C. M. S., & Gupta, S. K. (2021). Improved electrochemical performance of nickel cobaltite/ multi-walled carbon nanotube composite as a hybrid electrode for supercapacitors. *Journal of Physics and Chemistry of Solids, 154*, 110107. doi:https://doi.org/10.1016/j.jpcs.2021.110107

Shu Hui, T., & Ahmad Zaini, M. A. (2015). Potassium hydroxide activation of activated carbon: A commentary. *Carbon letters, 16*, 275-280. doi:10.5714/CL.2015.16.4.275

Si, Y., & Samulski, E. T. (2008). Exfoliated graphene separated by platinum nanoparticles. *Chemistry of Materials, 20*(21), 6792-6797.

Simon, P., & Gogotsi, Y. (2008). Materials for electrochemical capacitors. *Nat Mater, 7*(11), 845-854. doi:10.1038/nmat2297

Sing, K. S. (1985). Reporting physisorption data for gas/solid systems with special reference to the determination of surface area and porosity (Recommendations 1984). *Pure and applied chemistry, 57*(4), 603-619.

Singh, G., Lakhi, K., Sil, S., Bhosale, S., Kim, I., Albahily, K., & Vinu, A. (2019). Biomass derived porous carbon for CO sub (2) capture.

Singu, B. S., Goda, E. S., & Yoon, K. R. (2021). Carbon Nanotube–Manganese oxide nanorods hybrid composites for high-performance supercapacitor materials. *Journal of Industrial and Engineering Chemistry, 97*, 239-249. doi:https://doi.org/10.1016/j.jiec.2021.02.002

Sinha, P., Banerjee, S., & Kar, K. (2020). Characteristics of Activated Carbon. In (pp. 125-154).

Song, Q. S., Li, Y. Y., & Chan, S. L. I. (2005). Physical and electrochemical characteristics of nanostructured nickel hydroxide powder. *Journal of Applied Electrochemistry, 35*(2), 157-162. doi:10.1007/s10800-004-6301-x

Song, Z., Li, W., Bao, Y., Sun, Z., Gao, L., Nawaz, M. H., . . . Niu, L. (2018). A new route to tailor high mass loading all-solid-state supercapacitor with ultra-high volumetric energy density. *Carbon, 136*, 46-53. doi:https://doi.org/10.1016/j.carbon.2018.04.036

Sridhar, M. K., & AdeOluwa, O. O. (2009). Palm oil industry residues. In *Biotechnology for agro-industrial residues utilisation* (pp. 341-355): Springer.

Stankovich, S., Dikin, D. A., Dommett, G. H. B., Kohlhaas, K. M., Zimney, E. J., Stach, E. A., . . . Ruoff, R. S. (2006). Graphene-based composite materials. *Nature, 442*(7100), 282-286. doi:10.1038/nature04969

Subramanian, N., & Viswanathan, B. (2015). Nitrogen- and oxygen-containing activated carbons from sucrose for electrochemical supercapacitor applications. *RSC Advances, 5*(77), 63000-63011. doi:10.1039/C5RA06661A

Sudha, V., & Sangaranarayanan, M. V. (2002). Underpotential Deposition of Metals: Structural and Thermodynamic Considerations. *The Journal of Physical Chemistry B, 106*(10), 2699-2707. doi:10.1021/jp013544b

Sun, G., Song, W., Liu, X., Long, D., Qiao, W., & Ling, L. (2011). Capacitive matching of pore size and ion size in the negative and positive electrodes for supercapacitors. *Electrochimica Acta - ELECTROCHIM ACTA, 56*, 9248-9256. doi:10.1016/j.electacta.2011.07.139

Sun, X., Cheng, P., Wang, H., Xu, H., Dang, L., Liu, Z., & Lei, Z. (2015). Activation of graphene aerogel with phosphoric acid for enhanced electrocapacitive performance. *Carbon, 92*, 1-10. doi:https://doi.org/10.1016/j.carbon.2015.02.052

Sundalian, M., Larissa, D., & Suprijana, O. (2021). Contents and Utilization of Palm Oil Fruit Waste. *Biointerface Research in Applied Chemistry, 11*, 10148-10160. doi:10.33263/BRIAC113.1014810160

Sundriyal, S., Shrivastav, V., Pham, H. D., Mishra, S., Deep, A., & Dubal, D. P. (2021). Advances in bio-waste derived activated carbon for supercapacitors: Trends, challenges and prospective. *Resources, Conservation and Recycling, 169*, 105548. doi:https://doi.org/10.1016/j.resconrec.2021.105548

Sunil, V., Pal, B., Izwan Misnon, I., & Jose, R. (2021). Characterization of supercapacitive charge storage device using electrochemical impedance spectroscopy. *Materials Today: Proceedings, 46*, 1588-1594. doi:https://doi.org/10.1016/j.matpr.2020.07.248

Syarif, N., Ivandini, T. A., & Wibowo, W. (2012). Direct synthesis carbon/Metal oxide composites for electrochemical capacitors electrode. *Trans J Eng Manag Appl Sci Technol, 3*, 21-34.

Taer, E., Febriyanti, F., Mustika, W. S., Taslim, R., Agustino, A., & Apriwandi, A. (2021). Enhancing the performance of supercapacitor electrode from chemical activation of carbon nanofibers derived Areca catechu husk via one-stage integrated pyrolysis. *Carbon letters, 31*(4), 601-612. doi:10.1007/s42823-020-00191-5

Taer, E., Melisa, M., Agustino, A., Taslim, R., Sinta Mustika, W., & Apriwandi, A. (2021). Biomass-based activated carbon monolith from Tectona grandis leaf as supercapacitor electrode materials. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1-12.

Tafete, G. A., Abera, M. K., & Thothadri, G. (2022). Review on nanocellulose-based materials for supercapacitors applications. *Journal of Energy Storage, 48*, 103938. doi:https://doi.org/10.1016/j.est.2021.103938

Tahalyani, J., Akhtar, M. J., Cherusseri, J., & Kar, K. K. (2020). Characteristics of capacitor: fundamental aspects. In *Handbook of Nanocomposite Supercapacitor Materials I* (pp. 1-51): Springer.

Tan, Y. B., & Lee, J.-M. (2013). Graphene for supercapacitor applications. *Journal of Materials Chemistry A, 1*(47), 14814-14843. doi:10.1039/C3TA12193C

Technology, G. U. o. (2020). New findings pave the way to environmentally friendly supercapacitors, https://www.sciencedaily.com/releases/2020/10/201007093622.htm [Press release]

Telgote, A. R. P., Sarish Sudhakarao. (2020). Current World Environment.

Teo, E. Y. L., Muniandy, L., Ng, E.-P., Adam, F., Mohamed, A. R., Jose, R., & Chong, K. F. (2016). High surface area activated carbon from rice husk as a high performance supercapacitor electrode. *Electrochimica Acta, 192*, 110-119. doi:https://doi.org/10.1016/j.electacta.2016.01.140

Tian, D., Xu, Z., Zhang, D., Zhou, Y., & Sun, Z. (2020). Multifaceted roles of FeCl2 on pore formation of polyester fabric wastes-based activated carbon. *Colloids and Surfaces A: Physicochemical and Engineering Aspects, 598*, 124756. doi:https://doi.org/10.1016/j.colsurfa.2020.124756

Trasatti, S. (1971). Work function, electronegativity, and electrochemical behaviour of metals: II. Potentials of zero charge and "electrochemical" work functions. *Journal of Electroanalytical Chemistry and Interfacial Electrochemistry, 33*(2), 351-378. doi:https://doi.org/10.1016/S0022-0728(71)80123-7

Ullah, K., Shah, N., Wadood, R., Khan, B. M., & Oh, W. C. (2023). Recent trends in graphene based transition metal oxides as anode materials for rechargeable lithium-ion batteries. *Nano Trends, 1*, 100004. doi:https://doi.org/10.1016/j.nwnano.2023.100004

Usha Rani, M., Nanaji, K., Rao, T. N., & Deshpande, A. S. (2020). Corn husk derived activated carbon with enhanced electrochemical performance for high-voltage supercapacitors. *Journal of Power Sources, 471*, 228387. doi:https://doi.org/10.1016/j.jpowsour.2020.228387

Vermisoglou, E. C., Giannouri, M., Todorova, N., Giannakopoulou, T., Lekakou, C., & Trapalis, C. (2016). Recycling of typical supercapacitor materials. *Waste Management & Research, 34*(4), 337-344.

Vijayan, B. L., Krishnan, S. G., Zain, N. K. M., Harilal, M., Yar, A., Misnon, I. I., . . . Jose, R. (2017). Large scale synthesis of binary composite nanowires in the Mn2O3-SnO2 system with improved charge storage capabilities. *Chemical Engineering Journal, 327*, 962-972.

Vijayan, B. L., Misnon, I. I., Anil Kumar, G. M., Miyajima, K., Reddy, M. V., Zaghib, K., . . . Jose, R. (2020). Facile fabrication of thin metal oxide films on porous carbon for high density charge storage. *Journal of Colloid and Interface Science, 562*, 567-577. doi:https://doi.org/10.1016/j.jcis.2019.11.077

Vijayan, B. L., Mohd Zain, N. K., Misnon, I. I., Reddy, M. V., Adams, S., Yang, C.-C., . . . Jose, R. (2020). Void Space Control in Porous Carbon for High-Density Supercapacitive Charge Storage. *Energy & Fuels, 34*(4), 5072-5083. doi:10.1021/acs.energyfuels.0c00737

Wang, A., Sun, K., Li, J., Xu, W., & Jiang, J. (2019). Nitrogen and oxygen dual-doped activated carbon as electrode material for high performance supercapacitors prepared by direct carbonization of amaranthus. *Materials Chemistry and Physics, 231*, 311-321. doi:https://doi.org/10.1016/j.matchemphys.2019.04.046

Wang, B., Ruan, T., Chen, Y., Jin, F., Peng, L., Zhou, Y., . . . Dou, S. (2020). Graphene-based composites for electrochemical energy storage. *Energy Storage Materials, 24*, 22-51. doi:https://doi.org/10.1016/j.ensm.2019.08.004

Wang, C., & Liu, T. (2017). Nori-based N, O, S, Cl co-doped carbon materials by chemical activation of ZnCl2 for supercapacitor. *Journal of Alloys and Compounds, 696*, 42-50. doi:https://doi.org/10.1016/j.jallcom.2016.11.206

Wang, F., Xiao, S., Hou, Y., Hu, C., Liu, L., & Wu, Y. (2013). Electrode materials for aqueous asymmetric supercapacitors. *RSC Advances, 3*(32), 13059-13084. doi:10.1039/C3RA23466E

Wang, J.-W., Chen, Y., & Chen, B.-Z. (2015). A Synthesis Method of MnO₂/Activated Carbon Composite for Electrochemical Supercapacitors. *Journal of The Electrochemical Society, 162*(8), A1654-A1661. doi:10.1149/2.0031509jes

Wang, J., & Kaskel, S. (2012). KOH activation of carbon-based materials for energy storage. *Journal of Materials Chemistry, 22*(45), 23710-23725.

Wang, J., Yamada, Y., Sodeyama, K., Watanabe, E., Takada, K., Tateyama, Y., & Yamada, A. (2018). Fire-extinguishing organic electrolytes for safe batteries. *Nature Energy, 3*(1), 22-29. doi:10.1038/s41560-017-0033-8

Wang, K., Zhao, N., Lei, S., Yan, R., Tian, X., Wang, J., . . . Liu, L. (2015). Promising biomass-based activated carbons derived from willow catkins for high performance supercapacitors. *Electrochimica Acta, 166*, 1-11. doi:https://doi.org/10.1016/j.electacta.2015.03.048

Wang, R., Sui, Y., Huang, S., Pu, Y., & Cao, P. (2018). High-performance flexible all-solid-state asymmetric supercapacitors from nanostructured electrodes prepared by oxidation-assisted dealloying protocol. *Chemical Engineering Journal, 331*, 527-535. doi:https://doi.org/10.1016/j.cej.2017.09.004

Wang, Y.-F., Liu, D.-L., Han, J.-J., & Guo, A.-R. (2022). Detection of formaldehyde by cyclic voltammetry using a PANI/GO composite film–modified electrode. *Ionics, 28*(5), 2457-2468.

Wang, Y., Chen, B., Zhang, Y., Fu, L., Zhu, Y., Zhang, L., & Wu, Y. (2016). ZIF-8@MWCNT-derived carbon composite as electrode of high performance for supercapacitor. *Electrochimica Acta, 213*, 260-269. doi:https://doi.org/10.1016/j.electacta.2016.07.019

Wang, Y., Song, Y., & Xia, Y. (2016). Electrochemical capacitors: mechanism, materials, systems, characterization and applications. *Chem Soc Rev, 45*(21), 5925-5950. doi:10.1039/c5cs00580a

Wei, J., Nagarajan, N., & Zhitomirsky, I. (2007). Manganese oxide films for electrochemical supercapacitors. *Journal of Materials Processing Technology, 186*(1), 356-361. doi:https://doi.org/10.1016/j.jmatprotec.2007.01.003

Wei, X., Wan, S., & Gao, S. (2016). Self-assembly-template engineering nitrogen-doped carbon aerogels for high-rate supercapacitors. *Nano Energy, 28*, 206-215.

Wei, Y. (2014). Activated Carbon Microtubes Prepared from Plant Biomass (Poplar Catkins) and Their Application for Supercapacitors. *Chemistry Letters, 43*(2), 216-218. doi:10.1246/cl.130837

Wilberforce, T., Ijaodola, O., Ogungbemi, E., Khatib, F. N., Leslie, T., El-Hassan, Z., . . . Olabi, A. G. (2019). Technical evaluation of proton exchange membrane (PEM) fuel cell performance – A review of the effects of bipolar plates coating. *Renewable and Sustainable Energy Reviews, 113*, 109286. doi:https://doi.org/10.1016/j.rser.2019.109286

Worsley, E. A., Margadonna, S., & Bertoncello, P. (2022). Application of Graphene Nanoplatelets in Supercapacitor Devices: A Review of Recent Developments. *Nanomaterials (Basel), 12*(20). doi:10.3390/nano12203600

Wu, C., Yang, S., Cai, J., Zhang, Q., Zhu, Y., & Zhang, K. (2016). Activated microporous carbon derived from almond shells for high energy density asymmetric supercapacitors. *ACS applied materials & interfaces, 8*(24), 15288-15296.

Wu, N.-L., Kuo, S.-L., & Lee, M.-H. (2002). Preparation and optimization of RuO2-impregnated SnO2 xerogel supercapacitor. *Journal of Power Sources, 104*(1), 62-65. doi:https://doi.org/10.1016/S0378-7753(01)00873-4

Wu, Q., Gao, M., Zhang, G., Zhang, Y., Liu, S., Xie, C., . . . Yu, S. (2019). Preparation and application performance study of biomass-based carbon materials with various morphologies by a hydrothermal/soft template method. *Nanotechnology, 30*(18), 185702.

Xia, J., Chen, F., Li, J., & Tao, N. (2009). Measurement of the quantum capacitance of graphene. *Nature Nanotechnology, 4*(8), 505-509. doi:10.1038/nnano.2009.177

Xiang, X., Liu, E., Huang, Z., Shen, H., Tian, Y., Xiao, C., . . . Mao, Z. (2011). Preparation of activated carbon from polyaniline by zinc chloride activation as supercapacitor electrodes. *Journal of Solid State Electrochemistry, 15*(11), 2667-2674. doi:10.1007/s10008-010-1258-7

Xu, C., Wei, C., Li, B., Kang, F., & Guan, Z. (2011). Charge storage mechanism of manganese dioxide for capacitor application: Effect of the mild electrolytes containing alkaline and alkaline-earth metal cations. *Journal of Power Sources, 196*(18), 7854-7859.

Xu, H., Zhang, Y., Wang, L., Chen, Y., & Gao, S. (2021). Hierarchical porous biomass-derived carbon framework with ultrahigh surface area for outstanding capacitance supercapacitor. *Renewable Energy, 179*, 1826-1835. doi:https://doi.org/10.1016/j.renene.2021.08.008

Xu, L., Jia, M., Li, Y., Jin, X., & Zhang, F. (2017). High-performance MnO2-deposited graphene/activated carbon film electrodes for flexible solid-state supercapacitor. *Scientific Reports, 7*(1), 12857. doi:10.1038/s41598-017-11267-0

Xu, P., Tong, J., Zhang, L., Yang, Y., Chen, X., Wang, J., & Zhang, S. (2022). Dung beetle forewing-derived nitrogen and oxygen self-doped porous carbon for high performance solid-state supercapacitors. *Journal of Alloys and Compounds, 892*, 162129. doi:https://doi.org/10.1016/j.jallcom.2021.162129

Xu, Y.-w., Wu, X.-l., Zhong, X., Zhao, D., Fu, J., Jiang, J., . . . Li, X. (2020). Development of solid oxide fuel cell and battery hybrid power generation system. *International Journal of Hydrogen Energy, 45*(15), 8899-8914. doi:https://doi.org/10.1016/j.ijhydene.2020.01.032

Xu, Y., Lin, Z., Zhong, X., Huang, X., Weiss, N. O., Huang, Y., & Duan, X. (2014). Holey graphene frameworks for highly efficient capacitive energy storage. *Nature Communications, 5*(1), 4554. doi:10.1038/ncomms5554

Yagmur, E., Gokce, Y., Tekin, S., Semerci, N. I., & Aktas, Z. (2020). Characteristics and comparison of activated carbons prepared from oleaster (Elaeagnus angustifolia L.) fruit using KOH and ZnCl2. *Fuel, 267*, 117232. doi:https://doi.org/10.1016/j.fuel.2020.117232

Yang, H., Yan, R., Chen, H., Zheng, C., Lee, D. H., & Liang, D. T. (2006). In-Depth Investigation of Biomass Pyrolysis Based on Three Major Components: Hemicellulose, Cellulose and Lignin. *Energy & Fuels, 20*(1), 388-393. doi:10.1021/ef0580117

Yang, I., Jung, M., Kim, M.-S., Choi, D., & Jung, J. C. (2021). Physical and chemical activation mechanisms of carbon materials based on the microdomain model. *Journal of Materials Chemistry A, 9*(15), 9815-9825. doi:10.1039/D1TA00765C

Yang, I., Kim, S.-G., Kwon, S. H., Lee, J. H., Kim, M.-S., & Jung, J. C. (2016). Pore size-controlled carbon aerogels for EDLC electrodes in organic electrolytes. *Current Applied Physics, 16*(6), 665-672. doi:https://doi.org/10.1016/j.cap.2016.03.019

Yang, V., Arumugam Senthil, R., Pan, J., Rajesh Kumar, T., Sun, Y., & Liu, X. (2020). Hierarchical porous carbon derived from jujube fruits as sustainable and ultrahigh capacitance material for advanced supercapacitors. *Journal of Colloid and Interface Science, 579*, 347-356. doi:https://doi.org/10.1016/j.jcis.2020.06.080

Yassine, M., & Fabris, D. (2017). Performance of commercially available supercapacitors. *Energies, 10*(9), 1340.

Yu, M., Song, Z., Zhang, C., & He, X. (2017). One-step synthesis of mesoporous carbons from mixed resources by microwave-assisted phosphoric acid activation for supercapacitors. *Materials Technology, 32*(11), 701-705. doi:10.1080/10667857.2017.1344370

Yuan, J., Tang, S., Zhu, Z., Qin, X., Qu, R., Deng, Y., . . . Haarberg, G. M. (2017). Facile synthesis of high-performance Ni(OH)2/expanded graphite electrodes for asymmetric supercapacitors. *Journal of Materials Science: Materials in Electronics, 28*(23), 18022-18030. doi:10.1007/s10854-017-7745-1

Yuan, Y. F., Pei, Y. B., Guo, S. Y., Fang, J., & Yang, J. L. (2012). Sparse MnO2 nanowires clusters for high-performance supercapacitors. *Materials Letters, 73*, 194-197. doi:https://doi.org/10.1016/j.matlet.2012.01.046

Yue, Z., Jiang, W., Wang, L., Gardner, S., & Pittman Jr, C. (1999). Surface characterization of electrochemically oxidized carbon fibers. *Carbon, 37*(11), 1785-1796.

Zakir, M., Budi, P., Raya, I., Karim, A., Wulandari, R., & Sobrido, A. B. J. (2018). Determination of specific capacitance of modified candlenut shell based carbon as electrode material for supercapacitor. *Journal of Physics: Conference Series, 979*, 012024. doi:10.1088/1742-6596/979/1/012024

Zhang, J., Chen, H., Bai, J., Xu, M., Luo, C., Yang, L., . . . Yang, H. (2021). N-doped hierarchically porous carbon derived from grape marcs for high-performance supercapacitors. *Journal of Alloys and Compounds, 854*, 157207. doi:https://doi.org/10.1016/j.jallcom.2020.157207

Zhang, K., Zhang, L. L., Zhao, X. S., & Wu, J. (2010). Graphene/Polyaniline Nanofiber Composites as Supercapacitor Electrodes. *Chemistry of Materials, 22*(4), 1392-1401. doi:10.1021/cm902876u

Zhang, L. L., & Zhao, X. S. (2009). Carbon-based materials as supercapacitor electrodes. *Chemical Society Reviews, 38*(9), 2520-2531. doi:10.1039/B813846J

Zhang, S., & Pan, N. (2015). Supercapacitors Performance Evaluation. *Advanced Energy Materials, 5*(6), 1401401. doi:https://doi.org/10.1002/aenm.201401401

Zhang, Y., & Park, S.-J. (2017). Incorporation of RuO2 into charcoal-derived carbon with controllable microporosity by CO2 activation for high-performance supercapacitor. *Carbon, 122*, 287-297.

Zheng, B., Lu, C., Gu, G., Makarovski, A., Finkelstein, G., & Liu, J. (2002). Efficient CVD Growth of Single-Walled Carbon Nanotubes on Surfaces Using Carbon Monoxide Precursor. *Nano Letters, 2*(8), 895-898. doi:10.1021/nl025634d

Zheng, S., Zhang, J., Deng, H., Du, Y., & Shi, X. (2021). Chitin derived nitrogen-doped porous carbons with ultrahigh specific surface area and tailored hierarchical porosity for high performance supercapacitors. *Journal of Bioresources and Bioproducts, 6*(2), 142-151. doi:https://doi.org/10.1016/j.jobab.2021.02.002

Zheng, Y., Lian, Y., Wang, D., Ban, C., Zhao, J., & Zhang, H. (2020). 3D fungi carbon by less-alkali activation for supercapacitors. *Vacuum, 181*, 109746. doi:https://doi.org/10.1016/j.vacuum.2020.109746

Zhong, C., Deng, Y., Hu, W., Sun, D., Han, X., Qiao, J., & Zhang, J. (2016). *Electrolytes for electrochemical supercapacitors*: CRC press.

Zhou, J., Lian, J., Hou, L., Zhang, J., Gou, H., Xia, M., . . . Gao, F. (2015). Ultrahigh volumetric capacitance and cyclic stability of fluorine and nitrogen co-doped carbon microspheres. *Nature Communications, 6*(1), 8503. doi:10.1038/ncomms9503

Zhou, X., Chen, H., Shu, D., He, C., & Nan, J. (2009). Study on the electrochemical behavior of vanadium nitride as a promising supercapacitor material. *Journal of Physics and Chemistry of Solids, 70*(2), 495-500.

Zhu, K., Wang, Y., Tang, J. A., Guo, S., Gao, Z., Wei, Y., . . . Gao, Y. (2017). A high-performance supercapacitor based on activated carbon fibers with an optimized pore structure and oxygen-containing functional groups. *Materials Chemistry Frontiers, 1*(5), 958-966. doi:10.1039/C6QM00196C

Zhu, S., Ni, J., & Li, Y. (2020). Carbon nanotube-based electrodes for flexible supercapacitors. *Nano Research, 13*(7), 1825-1841. doi:10.1007/s12274-020-2729-5

Zilli, D., Bonelli, P. R., & Cukierman, A. L. (2006). Effect of alignment on adsorption characteristics of self-oriented multi-walled carbon nanotube arrays. *Nanotechnology, 17*(20), 5136-5141. doi:10.1088/0957-4484/17/20/016

Zuo, D., Tian, G., Li, X., Chen, D., & Shu, K. (2017). Recent progress in surface coating of cathode materials for lithium ion secondary batteries. *Journal of Alloys and Compounds, 706*, 24-40. doi:https://doi.org/10.1016/j.jallcom.2017.02.230