

References

- [1] C. Bittencourt and G. Van Tendeloo, “Carbon Nanoforms,” *Handb. Nanoscopy*, vol. 2, pp. 995–1070, May 2012, doi: 10.1002/9783527641864.CH28.
- [2] N. Slepíčková Kasálková, P. Slepíčka, and V. Švorčík, “Carbon Nanostructures, Nanolayers, and Their Composites,” *Nanomaterials*, vol. 11, no. 9, Sep. 2021, doi: 10.3390/NANO11092368.
- [3] B. He, M. Feng, X. Chen, and J. Sun, “Multidimensional (0D-3D) functional nanocarbon: Promising material to strengthen the photocatalytic activity of graphitic carbon nitride,” *Green Energy Environ.*, vol. 6, no. 6, pp. 823–845, Dec. 2021, doi: 10.1016/J.GEE.2020.07.011.
- [4] H. W. Kroto, J. R. Heath, S. C. O’Brien, R. F. Curl, and R. E. Smalley, “C₆₀: Buckminsterfullerene,” *Nature*, vol. 318, no. 6042, pp. 162–163, 1985, doi: 10.1038/318162a0.
- [5] “Discovery of Fullerenes National Historic Chemical Landmark - American Chemical Society.” [Online]. Available: <https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/fullerenes.html>. [Accessed: 24-Aug-2022].
- [6] S. Goodarzi, T. Da Ros, J. Conde, F. Sefat, and M. Mozafari, “Fullerene: biomedical engineers get to revisit an old friend,” *Mater. Today*, vol. 20, no. 8, pp. 460–480, Oct. 2017, doi: 10.1016/J.MATTOD.2017.03.017.
- [7] P. Weis, F. Hennrich, R. Fischer, E. K. Schneider, M. Neumaier, and M. M. Kappes, “Probing the structure of giant fullerenes by high resolution trapped ion mobility spectrometry †,” *Phys. Chem. Chem. Phys.*, vol. 21, p. 18877, 2019, doi: 10.1039/c9cp03326b.
- [8] “Nobel Prize ® and the Nobel Prize ® medal design mark are registered trademarks of the Nobel Foundation Scientific Background on the Nobel Prize in Physics 2010 G R A P H E N E compiled by the Class for Physics of the Royal Swedish Academy of Sciences,” 2010.
- [9] A. K. Geim and K. S. Novoselov, “The rise of graphene,” *Nat. Mater.*, vol. 6, no. 3, pp. 183–191, Mar. 2007, doi: 10.1038/nmat1849.
- [10] S. K. Tiwari, S. Sahoo, N. Wang, and A. Huczko, “Graphene research and their outputs: Status and prospect,” *J. Sci. Adv. Mater. Devices*, vol. 5, no. 1, pp. 10–29, Mar. 2020, doi: 10.1016/J.JSAMD.2020.01.006.
- [11] F. Farjadian *et al.*, “Recent Developments in Graphene and Graphene Oxide: Properties, Synthesis, and Modifications: A Review,” *ChemistrySelect*, vol. 5, no. 33, pp. 10200–10219, Sep. 2020, doi: 10.1002/SLCT.202002501.

- [12] C. N. R. Rao, H. S. S. R. Matte, and K. S. Subrahmanyam, "Synthesis and selected properties of graphene and graphene mimics," *Acc. Chem. Res.*, vol. 46, no. 1, pp. 149–159, Jan. 2013, doi: 10.1021/AR300033M.
- [13] S. Iijima, "Helical microtubules of graphitic carbon," *Nat.* 1991 3546348, vol. 354, no. 6348, pp. 56–58, 1991, doi: 10.1038/354056a0.
- [14] A. Aqel, K. M. M. A. El-Nour, R. A. A. Ammar, and A. Al-Warthan, "Carbon nanotubes, science and technology part (I) structure, synthesis and characterisation," *Arab. J. Chem.*, vol. 5, no. 1, pp. 1–23, Jan. 2012, doi: 10.1016/J.ARABJC.2010.08.022.
- [15] A. K. Jagadeesan, K. Thangavelu, and V. Dhananjeyan, "Carbon Nanotubes: Synthesis, Properties and Applications," *21st Century Surf. Sci. - a Handb.*, Jul. 2020, doi: 10.5772/INTECHOPEN.92995.
- [16] N. Anzar, R. Hasan, M. Tyagi, N. Yadav, and J. Narang, "Carbon nanotube - A review on Synthesis, Properties and plethora of applications in the field of biomedical science," *Sensors Int.*, vol. 1, p. 100003, Jan. 2020, doi: 10.1016/J.SINTL.2020.100003.
- [17] W. Khan, R. Sharma, and P. Saini, "Carbon Nanotube-Based Polymer Composites: Synthesis, Properties and Applications," *Carbon Nanotub. - Curr. Prog. their Polym. Compos.*, Jul. 2016, doi: 10.5772/62497.
- [18] L. Boumia, M. Zidour, A. Benzair, and A. Tounsi, "A Timoshenko beam model for vibration analysis of chiral single-walled carbon nanotubes," *Phys. E Low-Dimensional Syst. Nanostructures*, vol. 59, pp. 186–191, May 2014, doi: 10.1016/J.PHYSE.2014.01.020.
- [19] T. W. Odom, J.-L. Huang, and C. M. Lieber, "STM studies of single-walled carbon nanotubes," *J. Phys. Condens. Matter*, vol. 14, pp. 145–167, 2002.
- [20] S. Y. Madani, A. Tan, M. Dwek, and A. M. Seifalian, "Functionalization of single-walled carbon nanotubes and their binding to cancer cells," *Int. J. Nanomedicine*, vol. 7, pp. 905–914, 2012, doi: 10.2147/IJN.S25035.
- [21] R. Dubey, D. Dutta, A. Sarkar, and P. Chattopadhyay, "Functionalized carbon nanotubes: synthesis, properties and applications in water purification, drug delivery, and material and biomedical sciences," 2021, doi: 10.1039/d1na00293g.
- [22] J. Chen *et al.*, "Solution properties of single-walled carbon nanotubes," *Science*, vol. 282, no. 5386, pp. 95–98, Oct. 1998, doi: 10.1126/SCIENCE.282.5386.95.
- [23] X. Xu *et al.*, "Electrophoretic analysis and purification of fluorescent single-walled carbon nanotube fragments," *J. Am. Chem. Soc.*, vol. 126, no. 40, pp. 12736–12737, Oct. 2004, doi: 10.1021/JA040082H/SUPPL_FILE/JA040082H_S.PDF.
- [24] S. Ross, R. S. Wu, S. C. Wei, G. M. Ross, and H. T. Chang, "The analytical and biomedical applications of carbon dots and their future theranostic potential: A review,"

J. Food Drug Anal., vol. 28, no. 4, p. 677, 2020, doi: 10.38212/2224-6614.1154.

- [25] H. Yu, Y. Feng, X. Wang, P. Dong, and J. Huang, “A Mini Review on Carbon Quantum Dots: Preparation, Properties, and Electrocatalytic Application,” *Front. Chem.*, vol. 7, p. 671, 2019, doi: 10.3389/fchem.2019.00671.
- [26] R. Hardman, “A toxicologic review of quantum dots: Toxicity depends on physicochemical and environmental factors,” *Environ. Health Perspect.*, vol. 114, no. 2, pp. 165–172, Feb. 2006, doi: 10.1289/EHP.8284.
- [27] J. Liu, R. Li, and B. Yang, “Carbon Dots: A New Type of Carbon-Based Nanomaterial with Wide Applications,” *ACS Cent. Sci.*, vol. 6, no. 12, p. 2179, Dec. 2020, doi: 10.1021/ACSCENTSCI.0C01306.
- [28] R. Wang, K.-Q. Lu, Z.-R. Tang, and Y.-J. Xu, “Recent progress in carbon quantum dots: synthesis, properties and applications in photocatalysis,” 2017, doi: 10.1039/c6ta08660h.
- [29] L. Malfatti, D. Carboni, and P. Innocenzi, “Graphene and Carbon Dots in Mesoporous Materials,” *Handb. Sol-Gel Sci. Technol.*, pp. 1–30, 2016, doi: 10.1007/978-3-319-19454-7_150-1.
- [30] R. Atchudan, T. N. Jebakumar Immanuel Edison, M. Shanmugam, S. Perumal, T. Somanathan, and Y. R. Lee, “Sustainable synthesis of carbon quantum dots from banana peel waste using hydrothermal process for in vivo bioimaging,” *Phys. E Low-dimensional Syst. Nanostructures*, vol. 126, p. 114417, Feb. 2021, doi: 10.1016/J.PHYSE.2020.114417.
- [31] H. Ding, X. H. Li, X. B. Chen, J. S. Wei, X. B. Li, and H. M. Xiong, “Surface states of carbon dots and their influences on luminescence,” *J. Appl. Phys.*, vol. 127, no. 23, p. 231101, Jun. 2020, doi: 10.1063/1.5143819.
- [32] S. Borna, R. E. Sabzi, and S. Pirsā, “Synthesis of carbon quantum dots from apple juice and graphite: investigation of fluorescence and structural properties and use as an electrochemical sensor for measuring Letrozole,” *J. Mater. Sci. Mater. Electron.*, vol. 32, no. 8, pp. 10866–10879, Apr. 2021, doi: 10.1007/S10854-021-05745-5/TABLES/3.
- [33] A. Dager, T. Uchida, T. Maekawa, and M. Tachibana, “Synthesis and characterization of Mono-disperse Carbon Quantum Dots from Fennel Seeds: Photoluminescence analysis using Machine Learning,” *Sci. Reports 2019 91*, vol. 9, no. 1, pp. 1–12, Sep. 2019, doi: 10.1038/s41598-019-50397-5.
- [34] H. Li, Z. Kang, Y. Liu, and S. T. Lee, “Carbon nanodots: synthesis, properties and applications,” *J. Mater. Chem.*, vol. 22, no. 46, pp. 24230–24253, Nov. 2012, doi: 10.1039/C2JM34690G.
- [35] P. Zuo, X. Lu, Z. Sun, Y. Guo, and H. He, “A review on syntheses, properties, characterization and bioanalytical applications of fluorescent carbon dots,” *Microchim.*

Acta, vol. 183, no. 2, pp. 519–542, Feb. 2016, doi: 10.1007/S00604-015-1705-3.

- [36] S. Yao, Y. Hu, and G. Li, “A one-step sonoelectrochemical preparation method of pure blue fluorescent carbon nanoparticles under a high intensity electric field,” 2014, doi: 10.1016/j.carbon.2013.08.044.
- [37] S. Tajik *et al.*, “Carbon and graphene quantum dots: a review on syntheses, characterization, biological and sensing applications for neurotransmitter determination,” *RSC Adv.*, vol. 10, no. 26, pp. 15406–15429, Apr. 2020, doi: 10.1039/D0RA00799D.
- [38] A. Sharma and J. Das, “Small molecules derived carbon dots: synthesis and applications in sensing, catalysis, imaging, and biomedicine,” *J. Nanobiotechnology 2019 171*, vol. 17, no. 1, pp. 1–24, Aug. 2019, doi: 10.1186/S12951-019-0525-8.
- [39] M. Bayazeed Alam *et al.*, “Deciphering interaction between chlorophyll functionalized carbon quantum dots with arsenic and mercury toxic metals in water as highly sensitive dual-probe sensor,” *J. Photochem. Photobiol. A Chem.*, vol. 431, p. 114059, Oct. 2022, doi: 10.1016/J.JPHOTOCHEM.2022.114059.
- [40] H. Soni and P. S. Pamidimukkala, “Green synthesis of N, S co-doped carbon quantum dots from triflic acid treated palm shell waste and their application in nitrophenol sensing,” *Mater. Res. Bull.*, vol. 108, pp. 250–254, Dec. 2018, doi: 10.1016/J.MATERRESBULL.2018.08.033.
- [41] Q. Liang, W. Ma, Y. Shi, Z. Li, and X. Yang, “Easy synthesis of highly fluorescent carbon quantum dots from gelatin and their luminescent properties and applications,” *Carbon N. Y.*, vol. 60, pp. 421–428, Aug. 2013, doi: 10.1016/J.CARBON.2013.04.055.
- [42] N. Arumugam and J. Kim, “Synthesis of carbon quantum dots from Broccoli and their ability to detect silver ions,” *Mater. Lett.*, vol. 219, pp. 37–40, May 2018, doi: 10.1016/J.MATLET.2018.02.043.
- [43] M. He, J. Zhang, H. Wang, Y. Kong, Y. Xiao, and W. Xu, “Material and Optical Properties of Fluorescent Carbon Quantum Dots Fabricated from Lemon Juice via Hydrothermal Reaction,” *Nanoscale Res. Lett.*, vol. 13, no. 1, pp. 1–7, Jun. 2018, doi: 10.1186/S11671-018-2581-7/FIGURES/5.
- [44] M. Athika, A. Prasath, E. Duraisamy, V. Sankar Devi, A. Selva Sharma, and P. Elumalai, “Carbon-quantum dots derived from denatured milk for efficient chromium-ion sensing and supercapacitor applications,” *Mater. Lett.*, vol. 241, pp. 156–159, Apr. 2019, doi: 10.1016/J.MATLET.2019.01.064.
- [45] A. Sachdev and P. Gopinath, “Green synthesis of multifunctional carbon dots from coriander leaves and their potential application as antioxidants, sensors and bioimaging agents,” *Analyst*, vol. 140, no. 12, pp. 4260–4269, Jun. 2015, doi: 10.1039/C5AN00454C.

- [46] A. Nair, J. T. Haponiuk, S. Thomas, and S. Gopi, "Natural carbon-based quantum dots and their applications in drug delivery: A review," *Biomed. Pharmacother.*, vol. 132, p. 110834, Dec. 2020, doi: 10.1016/J.BIOPHA.2020.110834.
- [47] J. Zhou, Z. Sheng, H. Han, M. Zou, and C. Li, "Facile synthesis of fluorescent carbon dots using watermelon peel as a carbon source," *Mater. Lett.*, vol. 66, no. 1, pp. 222–224, Jan. 2012, doi: 10.1016/J.MATLET.2011.08.081.
- [48] D. Bano, V. Kumar, V. K. Singh, and S. H. Hasan, "Green synthesis of fluorescent carbon quantum dots for the detection of mercury(ii) and glutathione," *New J. Chem.*, vol. 42, no. 8, pp. 5814–5821, 2018, doi: 10.1039/c8nj00432c.
- [49] S. Ghosh, K. Ghosal, S. A. Mohammad, and K. Sarkar, "Dendrimer functionalized carbon quantum dot for selective detection of breast cancer and gene therapy," *Chem. Eng. J.*, vol. 373, pp. 468–484, Oct. 2019, doi: 10.1016/J.CEJ.2019.05.023.
- [50] R. Riaz *et al.*, "Dye-sensitized solar cell (DSSC) coated with energy down shift layer of nitrogen-doped carbon quantum dots (N-CQDs) for enhanced current density and stability," *Appl. Surf. Sci.*, vol. 483, pp. 425–431, Jul. 2019, doi: 10.1016/J.APSUSC.2019.03.236.
- [51] M. Sabet and K. Mahdavi, "Green synthesis of high photoluminescence nitrogen-doped carbon quantum dots from grass via a simple hydrothermal method for removing organic and inorganic water pollutions," *Appl. Surf. Sci.*, vol. 463, pp. 283–291, Jan. 2019, doi: 10.1016/J.APSUSC.2018.08.223.
- [52] S. A. A. Vandarkuzhali *et al.*, "Pineapple Peel-Derived Carbon Dots: Applications as Sensor, Molecular Keypad Lock, and Memory Device," *ACS Omega*, vol. 3, no. 10, pp. 12584–12592, Oct. 2018, doi: 10.1021/ACSOMEGA.8B01146/ASSET/IMAGES/LARGE/AO-2018-01146E_0010.JPEG.
- [53] S. D. Torres Landa, N. K. Reddy Bogireddy, I. Kaur, V. Batra, and V. Agarwal, "Heavy metal ion detection using green precursor derived carbon dots," *iScience*, vol. 25, no. 2, Feb. 2022, doi: 10.1016/J.ISCI.2022.103816.
- [54] M. Pan, X. Xie, K. Liu, J. Yang, L. Hong, and S. Wang, "Fluorescent Carbon Quantum Dots—Synthesis, Functionalization and Sensing Application in Food Analysis," *Nanomater. 2020, Vol. 10, Page 930*, vol. 10, no. 5, p. 930, May 2020, doi: 10.3390/NANO10050930.
- [55] R. Tabaraki and N. Sadeghinejad, "Microwave assisted synthesis of doped carbon dots and their application as green and simple turn off–on fluorescent sensor for mercury (II) and iodide in environmental samples," *Ecotoxicol. Environ. Saf.*, vol. 153, pp. 101–106, May 2018, doi: 10.1016/J.ECOENV.2018.01.059.
- [56] V. L. John, Y. Nair, and T. P. Vinod, "Doping and Surface Modification of Carbon Quantum Dots for Enhanced Functionalities and Related Applications," *Part. Part. Syst.*

Charact., vol. 38, no. 11, p. 2100170, Nov. 2021, doi: 10.1002/PPSC.202100170.

- [57] J. Tang *et al.*, “Influence of Group Modification at the Edges of Carbon Quantum Dots on Fluorescent Emission,” *Nanoscale Res. Lett.*, vol. 14, no. 1, pp. 1–10, Dec. 2019, doi: 10.1186/S11671-019-3079-7/FIGURES/4.
- [58] C. Qi, H. Wang, A. Yang, X. Wang, and J. Xu, “Facile Fabrication of Highly Fluorescent N-Doped Carbon Quantum Dots Using an Ultrasonic-Assisted Hydrothermal Method: Optical Properties and Cell Imaging,” *ACS Omega*, vol. 6, no. 48, p. 32904, Dec. 2021, doi: 10.1021/ACSOMEGA.1C04903.
- [59] J. Zhan, R. Peng, S. Wei, J. Chen, X. Peng, and B. Xiao, “Ethanol-Precipitation-Assisted Highly Efficient Synthesis of Nitrogen-Doped Carbon Quantum Dots from Chitosan,” 2019, doi: 10.1021/acsomega.9b03318.
- [60] a K.-Q. L. Z.-R. T. and Y.-J. X. Ru Wang, “Recent progress in carbon quantum dots: synthesis, properties and applications in photocatalysis,” *J. Mater. Chem. A*, pp. 3717–3734, 2017.
- [61] Y. Li, D. J. Young, and X. J. Loh, “Fluorescent gels: a review of synthesis, properties, applications and challenges,” *Mater. Chem. Front.*, vol. 3, no. 8, pp. 1489–1502, Jul. 2019, doi: 10.1039/C9QM00127A.
- [62] Y. Sun *et al.*, “Ultralong lifetime and efficient room temperature phosphorescent carbon dots through multi-confinement structure design,” *Nat. Commun. 2020 111*, vol. 11, no. 1, pp. 1–11, Nov. 2020, doi: 10.1038/s41467-020-19422-4.
- [63] M. J. Molaei, “Carbon quantum dots and their biomedical and therapeutic applications: a review,” *RSC Adv.*, vol. 9, no. 12, pp. 6460–6481, Feb. 2019, doi: 10.1039/C8RA08088G.
- [64] N. V Tepliakov *et al.*, “sp²–sp³-Hybridized Atomic Domains Determine Optical Features of Carbon Dots,” 2019, doi: 10.1021/acsnano.9b05444.
- [65] K. Bramhaiah and S. Bhattacharyya, “Challenges and future prospects of graphene-based hybrids for solar fuel generation: moving towards next generation photocatalysts,” *Mater. Adv.*, vol. 3, no. 1, pp. 142–172, Jan. 2022, doi: 10.1039/D1MA00748C.
- [66] Y. P. Sun *et al.*, “Quantum-sized carbon dots for bright and colorful photoluminescence,” *J. Am. Chem. Soc.*, vol. 128, no. 24, pp. 7756–7757, Jun. 2006, doi: 10.1021/JA062677D/SUPPL_FILE/JA062677DSI20060417_112943.PDF.
- [67] Y. Xu, M. Wu, X. Z. Feng, X. B. Yin, X. W. He, and Y. K. Zhang, “Reduced Carbon Dots versus Oxidized Carbon Dots: Photo- and Electrochemiluminescence Investigations for Selected Applications,” *Chem. – A Eur. J.*, vol. 19, no. 20, pp. 6282–6288, May 2013, doi: 10.1002/CHEM.201204372.

- [68] Y. Wang and A. Hu, "Carbon quantum dots: synthesis, properties and applications," *J. Mater. Chem. C*, vol. 2, no. 34, pp. 6921–6939, Aug. 2014, doi: 10.1039/C4TC00988F.
- [69] H. W. Chu, B. Unnikrishnan, A. Anand, Y. W. Lin, and C. C. Huang, "Carbon quantum dots for the detection of antibiotics and pesticides," *J. Food Drug Anal.*, vol. 28, no. 4, p. 539, 2020, doi: 10.38212/2224-6614.1269.
- [70] X. Yang *et al.*, "Red-emissive carbon dots for 'switch-on' dual function sensing platform rapid detection of ferric ions and l-cysteine in living cells," *ACS Omega*, vol. 4, no. 7, pp. 12575–12583, Jul. 2019, doi: 10.1021/ACSOMEGA.9B01019/ASSET/IMAGES/LARGE/AO-2019-010198_0007.JPEG.
- [71] T. Zhou, J. Ashley, X. Feng, and Y. Sun, "Detection of hemoglobin using hybrid molecularly imprinted polymers/carbon quantum dots-based nanobiosensor prepared from surfactant-free Pickering emulsion," *Talanta*, vol. 190, pp. 443–449, Dec. 2018, doi: 10.1016/J.TALANTA.2018.08.030.
- [72] D. Gu, S. Shang, Q. Yu, and J. Shen, "Green synthesis of nitrogen-doped carbon dots from lotus root for Hg(II) ions detection and cell imaging," *Appl. Surf. Sci.*, vol. 390, pp. 38–42, Dec. 2016, doi: 10.1016/J.APSUSC.2016.08.012.
- [73] H. Huang *et al.*, "One-pot green synthesis of nitrogen-doped carbon nanoparticles as fluorescent probes for mercury ions," *RSC Adv.*, vol. 3, no. 44, pp. 21691–21696, Oct. 2013, doi: 10.1039/C3RA43452D.
- [74] Z. Liu *et al.*, "Ratiometric fluorescent sensing of Pb²⁺ and Hg²⁺ with two types of carbon dot nanohybrids synthesized from the same biomass," *Sensors Actuators, B Chem.*, vol. 296, Oct. 2019, doi: 10.1016/J.SNB.2019.126698.
- [75] K. Raji, V. Ramanan, and P. Ramamurthy, "Facile and green synthesis of highly fluorescent nitrogen-doped carbon dots from jackfruit seeds and its applications towards the fluorimetric detection of Au³⁺ ions in aqueous medium and in in vitro multicolor cell imaging," *New J. Chem.*, vol. 43, no. 29, pp. 11710–11719, Jul. 2019, doi: 10.1039/C9NJ02590A.
- [76] N. Wang, Y. Wang, T. Guo, T. Yang, M. Chen, and J. Wang, "Green preparation of carbon dots with papaya as carbon source for effective fluorescent sensing of Iron (III) and Escherichia coli," *Biosens. Bioelectron.*, vol. 85, pp. 68–75, Nov. 2016, doi: 10.1016/J.BIOS.2016.04.089.
- [77] H. Wang *et al.*, "Carbon dots promote the growth and photosynthesis of mung bean sprouts," *Carbon N. Y.*, vol. 136, pp. 94–102, Sep. 2018, doi: 10.1016/J.CARBON.2018.04.051.
- [78] S. Bhatt, M. Bhatt, A. Kumar, G. Vyas, T. Gajaria, and P. Paul, "Green route for synthesis of multifunctional fluorescent carbon dots from Tulsi leaves and its application as Cr(VI) sensors, bio-imaging and patterning agents," *Colloids Surfaces B*

- Biointerfaces*, vol. 167, pp. 126–133, Jul. 2018, doi: 10.1016/J.COLSURFB.2018.04.008.
- [79] P. Kumar, S. Dua, R. Kaur, M. Kumar, and G. Bhatt, “A review on advancements in carbon quantum dots and their application in photovoltaics,” *RSC Adv.*, vol. 12, no. 8, pp. 4714–4759, Feb. 2022, doi: 10.1039/D1RA08452F.
- [80] T. Yuan *et al.*, “Carbon quantum dots: an emerging material for optoelectronic applications,” *J. Mater. Chem. C*, vol. 7, p. 6820, 2019, doi: 10.1039/c9tc01730e.
- [81] B. Zhao and Z. Tan, “Fluorescent Carbon Dots: Fantastic Electroluminescent Materials for Light-Emitting Diodes,” *Adv. Sci.*, vol. 8, no. 7, p. 2001977, Apr. 2021, doi: 10.1002/ADVS.202001977.
- [82] F. Yuan *et al.*, “Bright Multicolor Bandgap Fluorescent Carbon Quantum Dots for Electroluminescent Light-Emitting Diodes,” *Adv. Mater.*, vol. 29, no. 3, p. 1604436, Jan. 2017, doi: 10.1002/ADMA.201604436.
- [83] S. Paulo, G. Stoica, W. Cambarau, E. Martinez-Ferrero, and E. Palomares, “Carbon quantum dots as new hole transport material for perovskite solar cells,” *Synth. Met.*, vol. 222, pp. 17–22, Dec. 2016, doi: 10.1016/J.SYNTHMET.2016.04.025.
- [84] F. A. Permatasari, M. A. Irham, S. Z. Bisri, and F. Iskandar, “Carbon-Based Quantum Dots for Supercapacitors: Recent Advances and Future Challenges,” *Nanomater. 2021, Vol. 11, Page 91*, vol. 11, no. 1, p. 91, Jan. 2021, doi: 10.3390/NANO11010091.
- [85] S. T. Yang *et al.*, “Carbon dots for optical imaging in vivo,” *J. Am. Chem. Soc.*, vol. 131, no. 32, pp. 11308–11309, Aug. 2009, doi: 10.1021/JA904843X/SUPPL_FILE/JA904843X_SI_001.PDF.
- [86] A. S. Dezfuli, E. Kohan, S. Tehrani Fateh, N. Alimirzaei, H. Arzaghi, and M. R. Hamblin, “Organic dots (O-dots) for theranostic applications: preparation and surface engineering,” *RSC Adv.*, vol. 11, no. 4, pp. 2253–2291, Jan. 2021, doi: 10.1039/D0RA08041A.
- [87] S. T. Yang *et al.*, “Carbon Dots as Nontoxic and High-Performance Fluorescence Imaging Agents,” *J. Phys. Chem. C. Nanomater. Interfaces*, vol. 113, no. 42, p. 18110, Sep. 2009, doi: 10.1021/JP9085969.
- [88] D. Kobat *et al.*, “Deep tissue multiphoton microscopy using longer wavelength excitation,” *Opt. Express, Vol. 17, Issue 16, pp. 13354-13364*, vol. 17, no. 16, pp. 13354–13364, Aug. 2009, doi: 10.1364/OE.17.013354.
- [89] S. F. Ou *et al.*, “N-Doped Carbon Quantum Dots as Fluorescent Bioimaging Agents,” *Cryst. 2021, Vol. 11, Page 789*, vol. 11, no. 7, p. 789, Jul. 2021, doi: 10.3390/CRYST11070789.
- [90] S. Karthik, B. Saha, S. Kumar Ghosh, and N. D. Pradeep Singh, “Photoresponsive

- quinoline tethered fluorescent carbon dots for regulated anticancer drug delivery † ChemComm,” *Chem. Commun.*, vol. 49, pp. 10471–10473, 2013, doi: 10.1039/c3cc46078a.
- [91] M. S. Khan, S. Pandey, A. Talib, M. L. Bhaisare, and H. F. Wu, “Controlled delivery of dopamine hydrochloride using surface modified carbon dots for neuro diseases,” *Colloids Surf. B. Biointerfaces*, vol. 134, pp. 140–146, Oct. 2015, doi: 10.1016/J.COLSURFB.2015.06.006.
- [92] Q. Wang *et al.*, “Hollow luminescent carbon dots for drug delivery,” *Carbon N. Y.*, vol. Complete, no. 59, pp. 192–199, Aug. 2013, doi: 10.1016/J.CARBON.2013.03.009.
- [93] J. Yang *et al.*, “Ultrasmall and photostable nanotheranostic agents based on carbon quantum dots passivated with polyamine-containing organosilane molecules,” *Nanoscale*, vol. 9, no. 40, pp. 15441–15452, Oct. 2017, doi: 10.1039/C7NR05613C.
- [94] G. Murali *et al.*, “Hematoporphyrin Photosensitizer-Linked Carbon Quantum Dots for Photodynamic Therapy of Cancer Cells,” *ACS Appl. Nano Mater.*, vol. 5, no. 3, pp. 4376–4385, Mar. 2022, doi: 10.1021/ACSANM.2C00443/ASSET/IMAGES/LARGE/AN2C00443_0009.JPEG.
- [95] C. L. Shen *et al.*, “Recent progress of carbon dots in targeted bioimaging and cancer therapy,” *Theranostics*, vol. 12, no. 6, pp. 2860–2893, 2022, doi: 10.7150/THNO.70721.
- [96] N. Azam, M. Najabat Ali, and T. Javaid Khan, “Carbon Quantum Dots for Biomedical Applications: Review and Analysis,” *Front. Mater.*, vol. 8, p. 272, Aug. 2021, doi: 10.3389/FMATS.2021.700403/BIBTEX.
- [97] S. Lu *et al.*, “Facile and ultrasensitive fluorescence sensor platform for tumor invasive biomarker β -glucuronidase detection and inhibitor evaluation with carbon quantum dots based on inner-filter effect,” *Biosens. Bioelectron.*, vol. 85, pp. 358–362, Nov. 2016, doi: 10.1016/J.BIOS.2016.05.021.
- [98] C. Biao Kong *et al.*, “Carbon Dot-Based Inorganic–Organic Nanosystem for Two-Photon Imaging and Biosensing of pH Variation in Living Cells and Tissues,” *Adv. Mater.*, vol. 24, no. 43, pp. 5844–5848, Nov. 2012, doi: 10.1002/ADMA.201202599.
- [99] B. Bin Chen, M. L. Liu, and C. Z. Huang, “Carbon dot-based composites for catalytic applications,” *Green Chem.*, vol. 22, no. 13, pp. 4034–4054, Jul. 2020, doi: 10.1039/D0GC01014F.
- [100] J. Yang *et al.*, “Research on Chemical Composition and Ensiling Characteristics of Banana Stems and Leaves,” *Adv. Mater. Res.*, vol. 347–353, pp. 1647–1651, 2012, doi: 10.4028/WWW.SCIENTIFIC.NET/AMR.347-353.1647.
- [101] É. Molnár, ! Dóra Rippel-Pethő, and R. Bocsi, “Solid-liquid Extraction of Chlorophyll from Microalgae from Photoautotroph Open-air Cultivation,” *Hungarian J. Ind. Chem.*,

- vol. 41, no. 2, pp. 119–122, 2013, doi: 10.1515/511.
- [102] N. Fairley *et al.*, “Systematic and collaborative approach to problem solving using X-ray photoelectron spectroscopy,” *Appl. Surf. Sci. Adv.*, vol. 5, no. May, p. 100112, 2021, doi: 10.1016/j.apsadv.2021.100112.
- [103] A. Prakash and M. Katiyar, “Correlation between electroluminescence, charge transport and photophysical properties of polymer blends,” *Synth. Met.*, vol. 223, pp. 184–191, Jan. 2017, doi: 10.1016/J.SYNTHMET.2016.11.019.
- [104] “Revision C.01 | Gaussian.com.” [Online]. Available: https://gaussian.com/g09_c01/. [Accessed: 18-Dec-2021].
- [105] B. P. Pritchard, D. Altarawy, B. Didier, T. D. Gibson, and T. L. Windus, “New Basis Set Exchange: An Open, Up-to-Date Resource for the Molecular Sciences Community,” *J. Chem. Inf. Model.*, vol. 59, no. 11, pp. 4814–4820, 2019, doi: 10.1021/acs.jcim.9b00725.
- [106] G. Khandelwal *et al.*, “All edible materials derived biocompatible and biodegradable triboelectric nanogenerator,” *Nano Energy*, vol. 65, p. 104016, Nov. 2019, doi: 10.1016/J.NANOEN.2019.104016.
- [107] S. Qin, Z. Zhang, J. Li, and L. Zang, “FRZB knockdown upregulates β -catenin activity and enhances cell aggressiveness in gastric cancer,” *Oncol. Rep.*, vol. 31, no. 5, pp. 2351–2357, May 2014, doi: 10.3892/OR.2014.3109/HTML.
- [108] S. Mishra *et al.*, “Curcuma raktakanda Induces Apoptosis and Suppresses Migration in Cancer Cells: Role of Reactive Oxygen Species,” *Biomolecules*, vol. 9, no. 4, Apr. 2019, doi: 10.3390/BIOM9040159.
- [109] V. Rai *et al.*, “Epoxyazadiradione exhibit activities in head and neck squamous cell carcinoma by targeting multiple pathways.,” *Apoptosis*, vol. 25, no. 9–10, pp. 763–782, Sep. 2020, doi: 10.1007/S10495-020-01633-1.
- [110] S.-B. Shin *et al.*, “Properties of polymer light-emitting diodes coated on surface-treated ITO/glass substrates,” *J. Appl. Polym. Sci.*, vol. 110, no. 6, pp. 3678–3682, Dec. 2008, doi: 10.1002/app.28910.
- [111] A. Kalita, S. Hussain, A. H. Malik, N. V. V. Subbarao, and P. K. Iyer, “Vapor phase sensing of ammonia at the sub-ppm level using a perylene diimide thin film device,” *J. Mater. Chem. C*, vol. 3, no. 41, pp. 10767–10774, 2015, doi: 10.1039/c5tc02521d.
- [112] A. R. Murad, A. Iraqi, S. B. Aziz, S. N. Abdullah, and M. A. Brza, “Conducting polymers for optoelectronic devices and organic solar cells: A review,” *Polymers (Basel)*, vol. 12, no. 11, pp. 1–47, 2020, doi: 10.3390/polym12112627.
- [113] M. Ullah Chaudhry *et al.*, “Organic Light-Emitting Transistors: Advances and Perspectives,” *Adv. Funct. Mater.*, vol. 30, no. 20, p. 1905282, May 2020, doi:

10.1002/ADFM.201905282.

- [114] Y.-L. Wu *et al.*, “A Highly Responsive Organic Image Sensor Based on a Two-Terminal Organic Photodetector with Photomultiplication,” *Adv. Mater.*, vol. 31, no. 43, p. 1903687, Oct. 2019, doi: 10.1002/ADMA.201903687.
- [115] T. Pan, S. Liu, L. Zhang, and W. Xie, “Flexible organic optoelectronic devices on paper,” *iScience*, vol. 25, no. 2, p. 103782, Feb. 2022, doi: 10.1016/J.ISCI.2022.103782.
- [116] A. Islam, M. Rabbani, M. H. Bappy, M. A. R. Miah, and N. Sakib, “A review on fabrication process of organic light emitting diodes,” *2013 Int. Conf. Informatics, Electron. Vision, ICIEV 2013*, no. August 2015, 2013, doi: 10.1109/ICIEV.2013.6572656.
- [117] D. Nayak and R. B. Choudhary, “Conducting Polymer-Based Emissive Layer on Efficiency of OLEDs,” *Light. Diodes Photodetectors - Adv. Futur. Dir. [Working Title]*, Jun. 2021, doi: 10.5772/INTECHOPEN.98652.
- [118] H. W. Chen, J. H. Lee, B. Y. Lin, S. Chen, and S. T. Wu, “Liquid crystal display and organic light-emitting diode display: present status and future perspectives,” *Light Sci. Appl. 2018 73*, vol. 7, no. 3, pp. 17168–17168, Dec. 2017, doi: 10.1038/lsa.2017.168.
- [119] G. Hong *et al.*, “A Brief History of OLEDs—Emitter Development and Industry Milestones,” *Adv. Mater.*, vol. 33, no. 9, p. 2005630, Mar. 2021, doi: 10.1002/ADMA.202005630.
- [120] H. Musavi and M. R. Fadavieslam, “Improving organic light-emitting diode performance with ZnO nanoparticles,” *J. Mater. Sci. Mater. Electron.*, vol. 28, no. 11, pp. 7797–7801, 2017, doi: 10.1007/s10854-017-6475-8.
- [121] Z. Wu *et al.*, “Efficient and low-voltage vertical organic permeable base light-emitting transistors,” *Nat. Mater. 2021 207*, vol. 20, no. 7, pp. 1007–1014, Mar. 2021, doi: 10.1038/s41563-021-00937-0.
- [122] R. Capelli, S. Toffanin, G. Generali, H. Usta, A. Facchetti, and M. Muccini, “Organic light-emitting transistors with an efficiency that outperforms the equivalent light-emitting diodes,” *Nat. Mater.*, vol. 9, no. 6, pp. 496–503, 2010, doi: 10.1038/nmat2751.
- [123] Z. Xu, S. H. Li, L. Ma, G. Li, and Y. Yang, “Vertical organic light emitting transistor,” *Appl. Phys. Lett.*, vol. 91, no. 9, pp. 1–4, 2007, doi: 10.1063/1.2778751.
- [124] H. Yu, Z. Dong, J. Guo, D. Kim, and F. So, “Vertical Organic Field-Effect Transistors for Integrated Optoelectronic Applications,” *ACS Appl. Mater. Interfaces*, vol. 8, no. 16, pp. 10430–10435, 2016, doi: 10.1021/acsami.6b00182.
- [125] Q. Huang, J. Cui, J. G. C. Veinot, H. Yan, and T. J. Marks, “Realization of high-efficiency/high-luminance small-molecule organic light-emitting diodes: Synergistic effects of siloxane anode functionalization/hole-injection layers, and hole/exciton-

- blocking/electron-transport layers,” *Appl. Phys. Lett.*, vol. 82, no. 3, pp. 331–333, Jan. 2003, doi: 10.1063/1.1536268.
- [126] M. Y. Wong, E. Zysman-Colman, M. Y. Wong, and E. Zysman-Colman, “Purely Organic Thermally Activated Delayed Fluorescence Materials for Organic Light-Emitting Diodes,” *Adv. Mater.*, vol. 29, no. 22, p. 1605444, Jun. 2017, doi: 10.1002/ADMA.201605444.
- [127] S. Pitchaiya *et al.*, “A review on the classification of organic/inorganic/carbonaceous hole transporting materials for perovskite solar cell application,” *Arab. J. Chem.*, vol. 13, no. 1, pp. 2526–2557, Jan. 2020, doi: 10.1016/J.ARABJC.2018.06.006.
- [128] Y. Xia, G. Yan, and J. Lin, “Review on tailoring pedot:Pss layer for improved device stability of perovskite solar cells,” *Nanomaterials*, vol. 11, no. 11, pp. 1–16, 2021, doi: 10.3390/nano11113119.
- [129] X. Liang *et al.*, “Colloidal metal oxide nanocrystals as charge transporting layers for solution-processed light-emitting diodes and solar cells,” *Chem. Soc. Rev.*, vol. 46, p. 1730, 2017, doi: 10.1039/c6cs00122j.
- [130] M. B. Alam, K. Yadav, D. Shukla, R. Srivastava, J. Lahiri, and A. S. Parmar, “Carbon Quantum Dot as Electron Transporting Layer in Organic Light Emitting Diode,” *ChemistrySelect*, vol. 4, no. 25, pp. 7450–7454, 2019, doi: 10.1002/slct.201901551.
- [131] Y. T. Li *et al.*, “A review on low-dimensional novel optoelectronic devices based on carbon nanotubes,” *AIP Adv.*, vol. 11, no. 11, 2021, doi: 10.1063/5.0063774.
- [132] M. Bansal, R. Srivastava, C. Lal, M. N. Kamalasanan, and L. S. Tanwar, “Carbon nanotube-based organic light emitting diodes,” *Nanoscale*, vol. 1, no. 3, pp. 317–330, Nov. 2009, doi: 10.1039/B9NR00179D.
- [133] B. Liu *et al.*, “Carbon-nanotube-enabled vertical field effect and light-emitting transistors,” *Adv. Mater.*, vol. 20, no. 19, pp. 3605–3609, 2008, doi: 10.1002/adma.200800601.
- [134] P. Avouris, M. Radosavljević, and S. J. Wind, “Carbon Nanotube Electronics and Optoelectronics,” pp. 227–251, 2005, doi: 10.1007/3-540-28075-8_9.
- [135] V. T. Tiong *et al.*, “Octadecylamine-Functionalized Single-Walled Carbon Nanotubes for Facilitating the Formation of a Monolithic Perovskite Layer and Stable Solar Cells,” *Adv. Funct. Mater.*, vol. 28, no. 10, p. 1705545, Mar. 2018, doi: 10.1002/ADFM.201705545.
- [136] X. Wang *et al.*, “Poly(spirobifluorene)s containing nonconjugated diphenylsulfone moiety: Toward blue emission through a weak charge transfer effect,” *Macromolecules*, vol. 47, no. 9, pp. 2907–2914, May 2014, doi: 10.1021/MA500407M/SUPPL_FILE/MA500407M_SI_001.PDF.

- [137] D. Marsitzky, M. Klapper, and K. Müllen, “End-functionalization of poly(2,7-fluorene): A key step toward novel luminescent rod-coil block copolymers,” *Macromolecules*, vol. 32, no. 25, pp. 8685–8688, 1999, doi: 10.1021/MA991216S/SUPPL_FILE/MA991216S_S.PDF.
- [138] R. Ahmad, U. Soni, R. Srivastava, V. N. Singh, S. Chand, and S. Sapra, “Investigation of the photophysical and electrical characteristics of cuins2 qds/swcnt hybrid nanostructure,” *J. Phys. Chem. C*, vol. 118, no. 21, pp. 11409–11416, 2014, doi: 10.1021/jp411568c.
- [139] J. E. Weaver, M. R. Dasari, A. Datar, S. Talapatra, and P. Kohli, “Investigating photoinduced charge transfer in carbon nanotube-perylene- quantum dot hybrid nanocomposites,” *ACS Nano*, vol. 4, no. 11, pp. 6883–6893, Nov. 2010, doi: 10.1021/NN1020067/SUPPL_FILE/NN1020067_SI_001.PDF.
- [140] J. L. Xu *et al.*, “Efficient and Reversible Electron Doping of Semiconductor-Enriched Single-Walled Carbon Nanotubes by Using Decamethylcobaltocene,” *Sci. Rep.*, vol. 7, no. 1, Dec. 2017, doi: 10.1038/S41598-017-05967-W.
- [141] A. Turak, “On the Role of LiF in Organic Optoelectronics,” *Electron. Mater.*, vol. 2, no. 2, pp. 198–221, 2021, doi: 10.3390/electronicmat2020016.
- [142] R. Verma *et al.*, “A vertically stacked phosphorescent multilayer organic light emitting transistor,” *RSC Adv.*, vol. 6, no. 93, pp. 90873–90877, 2016, doi: 10.1039/c6ra14942a.
- [143] H. Yu, S. Ho, N. Barange, R. Larrabee, and F. So, “Semi-transparent vertical organic light-emitting transistors,” *Org. Electron.*, vol. 55, no. December 2017, pp. 126–132, 2018, doi: 10.1016/j.orgel.2018.01.030.
- [144] S. H. Li, Z. Xu, L. Ma, C. W. Chu, and Y. Yang, “Achieving ambipolar vertical organic transistors via nanoscale interface modification,” *Appl. Phys. Lett.*, vol. 91, no. 8, p. 083507, Aug. 2007, doi: 10.1063/1.2773749.
- [145] S. M. Lee, J. H. Kwon, S. Kwon, and K. C. Choi, “A Review of Flexible OLEDs Toward Highly Durable Unusual Displays,” *undefined*, vol. 64, no. 5, pp. 1922–1931, May 2017, doi: 10.1109/TED.2017.2647964.
- [146] D. Fyfe, “Organic displays come of age,” *Nat. Photonics 2009 38*, vol. 3, no. 8, pp. 453–455, Aug. 2009, doi: 10.1038/nphoton.2009.132.
- [147] D. Luo, Q. Chen, B. Liu, and Y. Qiu, “Emergence of Flexible White Organic Light-Emitting Diodes,” *Polymers (Basel)*, vol. 11, no. 2, 2019, doi: 10.3390/POLYM11020384.
- [148] S. Scholz, D. Kondakov, B. Lüssem, and K. Leo, “Degradation mechanisms and reactions in organic light-emitting devices,” *Chem. Rev.*, vol. 115, no. 16, pp. 8449–8503, Aug. 2015, doi: 10.1021/CR400704V/ASSET/IMAGES/LARGE/CR-2013-00704V_0005.JPEG.

- [149] T. Yasuda, Y. Yamaguchi, D. C. Zou, and T. Tsutsui, "Carrier mobilities in organic electron transport materials determined from space charge limited current," *Japanese J. Appl. Physics, Part 1 Regul. Pap. Short Notes Rev. Pap.*, vol. 41, no. 9, pp. 5626–5629, Sep. 2002, doi: 10.1143/JJAP.41.5626/XML.
- [150] R. G. Kepler *et al.*, "Electron and hole mobility in tris(8-hydroxyquinolinolato-N1,O8) aluminum," *Appl. Phys. Lett.*, vol. 66, no. 26, p. 3618, Jun. 1998, doi: 10.1063/1.113806.
- [151] B. J. Chen, W. Y. Lai, Z. Q. Gao, C. S. Lee, S. T. Lee, and W. A. Gambling, "Electron drift mobility and electroluminescent efficiency of tris(8-hydroxyquinolinolato) aluminum," *Appl. Phys. Lett.*, vol. 75, no. 25, p. 4010, Dec. 1999, doi: 10.1063/1.125521.
- [152] Z. H. Bakr, Q. Wali, A. Fakharuddin, L. Schmidt-Mende, T. M. Brown, and R. Jose, "Advances in hole transport materials engineering for stable and efficient perovskite solar cells," *Nano Energy*, vol. 34, pp. 271–305, Apr. 2017, doi: 10.1016/J.NANOEN.2017.02.025.
- [153] Q. Wei *et al.*, "Small-Molecule Emitters with High Quantum Efficiency: Mechanisms, Structures, and Applications in OLED Devices," *Adv. Opt. Mater.*, vol. 6, no. 20, p. 1800512, Oct. 2018, doi: 10.1002/ADOM.201800512.
- [154] J. M. Caruge, J. E. Halpert, V. Wood, V. Bulović, and M. G. Bawendi, "Colloidal quantum-dot light-emitting diodes with metal-oxide charge transport layers," *Nat. Photonics*, vol. 2, no. 4, pp. 247–250, Apr. 2008, doi: 10.1038/NPHOTON.2008.34.
- [155] V. Wood, M. J. Panzer, J. E. Halpert, J. M. Caruge, M. G. Bawendi, and V. Bulović, "Selection of metal oxide charge transport layers for colloidal quantum dot LEDs," *ACS Nano*, vol. 3, no. 11, pp. 3581–3586, Nov. 2009, doi: 10.1021/NN901074R/ASSET/IMAGES/LARGE/NN-2009-01074R_0003.JPEG.
- [156] M. D. Ho, D. Kim, N. Kim, S. M. Cho, and H. Chae, "Polymer and small molecule mixture for organic hole transport layers in quantum dot light-emitting diodes," *ACS Appl. Mater. Interfaces*, vol. 5, no. 23, pp. 12369–12374, Dec. 2013, doi: 10.1021/AM403173N/ASSET/IMAGES/LARGE/AM-2013-03173N_0007.JPEG.
- [157] A. P. Kulkarni, C. J. Tonzola, A. Babel, and S. A. Jenekhe, "Electron transport materials for organic light-emitting diodes," *Chem. Mater.*, vol. 16, no. 23, pp. 4556–4573, Nov. 2004, doi: 10.1021/CM049473L/ASSET/IMAGES/LARGE/CM049473LF25.JPEG.
- [158] J. Lian *et al.*, "Electron-Transport Materials in Perovskite Solar Cells," *Small Methods*, vol. 2, no. 10, p. 1800082, Oct. 2018, doi: 10.1002/SMTD.201800082.
- [159] X. Li, F. Xie, S. Zhang, J. Hou, and W. C. H. Choy, "MoOx and V2Ox as hole and electron transport layers through functionalized intercalation in normal and inverted organic optoelectronic devices," *Light Sci. Appl. 2015 44*, vol. 4, no. 4, pp. e273–e273, Apr. 2015, doi: 10.1038/lssa.2015.46.

- [160] C. R. Kagan and C. B. Murray, “Charge transport in strongly coupled quantum dot solids,” *Nat. Nanotechnol.* 2015 1012, vol. 10, no. 12, pp. 1013–1026, Nov. 2015, doi: 10.1038/nnano.2015.247.
- [161] M. J. Bowers, J. R. McBride, and S. J. Rosenthal, “White-light emission from magic-sized cadmium selenide nanocrystals,” *J. Am. Chem. Soc.*, vol. 127, no. 44, pp. 15378–15379, Nov. 2005, doi: 10.1021/JA055470D/SUPPL_FILE/JA055470DSI20051004_020032.PDF.
- [162] F. Yuan *et al.*, “Engineering triangular carbon quantum dots with unprecedented narrow bandwidth emission for multicolored LEDs,” *Nat. Commun.* 2018 91, vol. 9, no. 1, pp. 1–11, Jun. 2018, doi: 10.1038/s41467-018-04635-5.
- [163] L. Manna, E. C. Scher, and A. P. Alivisatos, “Synthesis of Soluble and Processable Rod-, Arrow-, Teardrop-, and Tetrapod-Shaped CdSe Nanocrystals,” 2000, doi: 10.1021/JA003055.
- [164] B. Goris, M. A. Van Huis, S. Bals, H. W. Zandbergen, L. Manna, and G. Van Tendeloo, “Thermally Induced Structural and Morphological Changes of CdSe/CdS Octapods,” *Small*, vol. 8, no. 6, pp. 937–942, Mar. 2012, doi: 10.1002/SMLL.201101897.
- [165] X. J. Wu, J. Chen, C. Tan, Y. Zhu, Y. Han, and H. Zhang, “Controlled growth of high-density CdS and CdSe nanorod arrays on selective facets of two-dimensional semiconductor nanoplates,” *Nat. Chem.* 2016 85, vol. 8, no. 5, pp. 470–475, Mar. 2016, doi: 10.1038/nchem.2473.
- [166] L. Polavarapu, S. Mourdikoudis, I. Pastoriza-Santos, and J. Pérez-Juste, “Nanocrystal engineering of noble metals and metal chalcogenides: controlling the morphology, composition and crystallinity,” *undefined*, vol. 17, no. 20, pp. 3727–3762, May 2015, doi: 10.1039/C5CE00112A.
- [167] D. M. Kroupa *et al.*, “Tuning colloidal quantum dot band edge positions through solution-phase surface chemistry modification,” *Nat. Commun.* 2017 81, vol. 8, no. 1, pp. 1–8, May 2017, doi: 10.1038/ncomms15257.
- [168] L. Zhang, Z. C. Ding, T. Tong, and J. Liu, “Tuning the work functions of graphene quantum dot-modified electrodes for polymer solar cell applications,” *Nanoscale*, vol. 9, no. 10, pp. 3524–3529, Mar. 2017, doi: 10.1039/C7NR00136C.
- [169] W. Xing *et al.*, “MoS₂ Quantum Dots with a Tunable Work Function for High-Performance Organic Solar Cells,” *ACS Appl. Mater. Interfaces*, vol. 8, no. 40, pp. 26916–26923, Oct. 2016, doi: 10.1021/ACSAMI.6B06081/ASSET/IMAGES/LARGE/AM-2016-06081Z_0009.JPEG.
- [170] R. Wang, K. Q. Lu, Z. R. Tang, and Y. J. Xu, “Recent progress in carbon quantum dots: synthesis, properties and applications in photocatalysis,” *J. Mater. Chem. A*, vol. 5, no. 8, pp. 3717–3734, Feb. 2017, doi: 10.1039/C6TA08660H.

- [171] S. Y. Lim, W. Shen, and Z. Gao, “Carbon quantum dots and their applications,” *Chem. Soc. Rev.*, vol. 44, no. 1, pp. 362–381, Dec. 2014, doi: 10.1039/C4CS00269E.
- [172] K. J. Mintz, Y. Zhou, and R. M. Leblanc, “Recent development of carbon quantum dots regarding their optical properties, photoluminescence mechanism, and core structure,” *Nanoscale*, vol. 11, no. 11, pp. 4634–4652, Mar. 2019, doi: 10.1039/C8NR10059D.
- [173] A. Hirsch ; 2 *et al.*, “Luminescent colloidal carbon dots: optical properties and effects of doping [Invited],” *Opt. Express*, Vol. 24, Issue 2, pp. A312–A340, vol. 24, no. 2, pp. A312–A340, Jan. 2016, doi: 10.1364/OE.24.00A312.
- [174] T. K. Cheng *et al.*, “Modulation of a semiconductor-to-semimetal transition at 7 THz via coherent lattice vibrations,” *Appl. Phys. Lett.*, vol. 62, no. 16, p. 1901, Jun. 1998, doi: 10.1063/1.109537.
- [175] S. H. Jin, D. H. Kim, G. H. Jun, S. H. Hong, and S. Jeon, “Tuning the photoluminescence of graphene quantum dots through the charge transfer effect of functional groups,” *ACS Nano*, vol. 7, no. 2, pp. 1239–1245, Feb. 2013, doi: 10.1021/NN304675G/SUPPL_FILE/NN304675G_SI_001.PDF.
- [176] K. Dimos, “Carbon Quantum Dots: Surface Passivation and Functionalization,” *Curr. Org. Chem.*, vol. 20, no. 6, pp. 682–695, Aug. 2015, doi: 10.2174/1385272819666150730220948.
- [177] L. Li and T. Dong, “Photoluminescence tuning in carbon dots: surface passivation or/and functionalization, heteroatom doping,” *J. Mater. Chem. C*, vol. 6, no. 30, pp. 7944–7970, Aug. 2018, doi: 10.1039/C7TC05878K.
- [178] B. Yao, H. Huang, Y. Liu, and Z. Kang, “Carbon Dots: A Small Conundrum,” *Trends Chem.*, vol. 1, no. 2, pp. 235–246, May 2019, doi: 10.1016/J.TRECHM.2019.02.003.
- [179] P. Tian, L. Tang, K. S. Teng, and S. P. Lau, “Graphene quantum dots from chemistry to applications,” *Mater. Today Chem.*, vol. 10, pp. 221–258, Dec. 2018, doi: 10.1016/J.MTCHEM.2018.09.007.
- [180] M. Li *et al.*, “Graphene quantum dots as the hole transport layer material for high-performance organic solar cells,” *Phys. Chem. Chem. Phys.*, vol. 15, no. 43, pp. 18973–18978, Oct. 2013, doi: 10.1039/C3CP53283F.
- [181] S. H. Song, M. Jang, H. Yoon, Y. H. Cho, S. Jeon, and B. H. Kim, “Size and pH dependent photoluminescence of graphene quantum dots with low oxygen content,” *RSC Adv.*, vol. 6, no. 100, pp. 97990–97994, 2016, doi: 10.1039/c6ra21651j.
- [182] S. Bolisetty, M. Peydayesh, and R. Mezzenga, “Sustainable technologies for water purification from heavy metals: review and analysis,” *Chem. Soc. Rev.*, vol. 48, no. 2, pp. 463–487, 2019, doi: 10.1039/c8cs00493e.
- [183] P. B. Tchounwou, C. G. Yedjou, A. K. Patlolla, and D. J. Sutton, “Heavy Metals

Toxicity and the Environment,” doi: 10.1007/978-3-7643-8340-4_6.

- [184] J. Lian, Q. Xu, Y. Wang, and F. Meng, “Recent Developments in Fluorescent Materials for Heavy Metal Ions Analysis From the Perspective of Forensic Chemistry,” *Front. Chem.*, vol. 8, p. 1016, Nov. 2020, doi: 10.3389/FCHEM.2020.593291/BIBTEX.
- [185] Y.-H. Shin, M. Teresa Gutierrez-Wing, and J.-W. Choi, “Review—Recent Progress in Portable Fluorescence Sensors,” *J. Electrochem. Soc.*, vol. 168, no. 1, p. 017502, 2021, doi: 10.1149/1945-7111/abd494.
- [186] P. Li and S. F. Y. Li, “Recent advances in fluorescence probes based on carbon dots for sensing and speciation of heavy metals,” *Nanophotonics*, vol. 10, no. 2, pp. 877–908, 2021, doi: 10.1515/nanoph-2020-0507.
- [187] N. De Acha, C. Elosúa, J. M. Corres, and F. J. Arregui, “Fluorescent sensors for the detection of heavy metal ions in aqueous media,” *Sensors (Switzerland)*, vol. 19, no. 3, 2019, doi: 10.3390/s19030599.
- [188] C. Edward Raja and G. S. Selvam, “Construction of green fluorescent protein based bacterial biosensor for heavy metal remediation,” *Int. J. Environ. Sci. Technol.*, vol. 8, no. 4, pp. 793–798, 2011, doi: 10.1007/bf03326262.
- [189] M. I. Gaviria-Arroyave, J. B. Cano, and G. A. Peñuela, “Nanomaterial-based fluorescent biosensors for monitoring environmental pollutants: A critical review,” *Talanta Open*, vol. 2, no. June, 2020, doi: 10.1016/j.talo.2020.100006.
- [190] S. Duhan, K. Sahoo, S. K. Singh, and M. Kumar, “Development of ultrasensitive and As(iii)-selective upconverting (NaYF₄:Yb³⁺,Er³⁺) platform,” *Analyst*, vol. 145, no. 19, pp. 6378–6387, 2020, doi: 10.1039/d0an00717j.
- [191] X. Gao, C. Du, Z. Zhuang, and W. Chen, “Carbon quantum dot-based nanoprobe for metal ion detection,” *J. Mater. Chem. C*, vol. 4, no. 29, pp. 6927–6945, 2016, doi: 10.1039/c6tc02055k.
- [192] Y. Zhou, S. K. Sharma, Z. Peng, and R. M. Leblanc, “polymers Review Polymers in Carbon Dots: A Review,” 2017, doi: 10.3390/polym9020067.
- [193] R. Meena *et al.*, “Fluorescent carbon dots driven from ayurvedic medicinal plants for cancer cell imaging and phototherapy,” *Heliyon*, vol. 5, no. 9, p. e02483, 2019, doi: 10.1016/j.heliyon.2019.e02483.
- [194] M. Biswal, A. Banerjee, M. Deo, and S. Ogale, “From dead leaves to high energy density supercapacitors,” *Energy Environ. Sci.*, vol. 6, no. 4, pp. 1249–1259, Mar. 2013, doi: 10.1039/C3EE22325F.
- [195] D. A. Hines and P. V. Kamat, “Recent Advances in Quantum Dot Surface Chemistry,” *ACS Appl. Mater. Interfaces*, vol. 6, pp. 3041–3057, 2014, doi: 10.1021/am405196u.

- [196] W. Liu *et al.*, “Cite this,” *J. Mater. Chem. B*, vol. 4, p. 5772, 2016, doi: 10.1039/c6tb00976j.
- [197] H. Ding, X. H. Li, X. B. Chen, J. S. Wei, X. B. Li, and H. M. Xiong, “Surface states of carbon dots and their influences on luminescence,” *Journal of Applied Physics*, vol. 127, no. 23. 2020, doi: 10.1063/1.5143819.
- [198] S. A. A. Vandarkuzhali, V. Jeyalakshmi, G. Sivaraman, S. Singaravadivel, K. R. Krishnamurthy, and B. Viswanathan, “Highly fluorescent carbon dots from Pseudostem of banana plant: Applications as nanosensor and bio-imaging agents,” *Sensors Actuators B Chem.*, vol. 252, pp. 894–900, Nov. 2017, doi: 10.1016/J.SNB.2017.06.088.
- [199] S. Uran, A. Alhani, and C. Silva, “Study of ultraviolet-visible light absorbance of exfoliated graphite forms,” *AIP Adv.*, vol. 7, no. 3, 2017, doi: 10.1063/1.4979607.
- [200] M. Liu, “Optical Properties of Carbon Dots: A Review,” *Nanoarchitectonics*, vol. 1, no. 1, pp. 1–12, 2020, doi: 10.37256/nat.112020124.1-12.
- [201] R. Remelli, C. Varotto, D. Sandonà, R. Croce, and R. Bassi, “Chlorophyll binding to monomeric light-harvesting complex. A mutation analysis of chromophore-binding residues,” *J. Biol. Chem.*, vol. 274, no. 47, pp. 33510–33521, 1999, doi: 10.1074/jbc.274.47.33510.
- [202] S. Barazzouk, L. Bekalé, and S. Hotchandani, “Enhanced photostability of chlorophyll-a using gold nanoparticles as an efficient photoprotector,” *J. Mater. Chem.*, vol. 22, no. 48, pp. 25316–25324, 2012, doi: 10.1039/c2jm33681b.
- [203] J. M. S. Lopes, S. G. C. Moreira, and N. M. Barbosa Neto, “Selective inner-filter on the fluorescence response of chlorophyll and pheophytin molecules extracted from *Caesalpinia echinata* leaves,” *J. Braz. Chem. Soc.*, vol. 31, no. 1, pp. 162–169, 2020, doi: 10.21577/0103-5053.20190150.
- [204] Q. Zhao, W. Song, B. Zhao, and B. Yang, “Spectroscopic studies of the optical properties of carbon dots: Recent advances and future prospects,” *Mater. Chem. Front.*, vol. 4, no. 2, pp. 472–488, 2020, doi: 10.1039/c9qm00592g.
- [205] S. Chandra *et al.*, “High throughput electron transfer from carbon dots to chloroplast: A rationale of enhanced photosynthesis,” *Nanoscale*, vol. 6, no. 7, pp. 3647–3655, 2014, doi: 10.1039/c3nr06079a.
- [206] L. Wu *et al.*, “One-pot fabrication of dual-emission and single-emission biomass carbon dots for Cu²⁺ and tetracycline sensing and multicolor cellular imaging,” *Anal. Bioanal. Chem.*, vol. 412, no. 27, pp. 7481–7489, 2020, doi: 10.1007/s00216-020-02882-4.
- [207] Y. Cui, R. Liu, F. Ye, and S. Zhao, “Single-excitation, dual-emission biomass quantum dots: Preparation and application for ratiometric fluorescence imaging of coenzyme A in living cells,” *Nanoscale*, vol. 11, no. 19, pp. 9270–9275, 2019, doi:

10.1039/c9nr01809c.

- [208] C. Xia, S. Zhu, T. Feng, M. Yang, and B. Yang, “Evolution and Synthesis of Carbon Dots: From Carbon Dots to Carbonized Polymer Dots,” *Advanced Science*, vol. 6, no. 23, 2019, doi: 10.1002/advs.201901316.
- [209] L. Cunci *et al.*, “Platinum electrodeposition at unsupported electrochemically reduced nanographene oxide for enhanced ammonia oxidation,” *ACS Appl. Mater. Interfaces*, vol. 6, no. 3, pp. 2137–2145, 2014, doi: 10.1021/am4052552.
- [210] “IR Spectrum Table.” [Online]. Available: <https://www.sigmaaldrich.com/IN/en/technical-documents/technical-article/analytical-chemistry/photometry-and-reflectometry/ir-spectrum-table>. [Accessed: 18-Dec-2021].
- [211] A. Dager, takashi Uchida, toru Maekawa, and M. tachibana, “Synthesis and characterization of Mono-disperse carbon Quantum Dots from fennel Seeds: photoluminescence analysis using Machine Learning,” doi: 10.1038/s41598-019-50397-5.
- [212] V. N. Nemykin *et al.*, “Metal-free and transition-metal tetraferrocenylporphyrins part 1: Synthesis, characterization, electronic structure, and conformational flexibility of neutral compounds,” *J. Chem. Soc. Dalton Trans.*, no. 32, pp. 4233–4246, 2008, doi: 10.1039/b805156a.
- [213] L. A. A. Chunduri, A. Kurdekar, S. Patnaik, B. V. Dev, T. M. Rattan, and V. Kamiseti, “Carbon Quantum Dots from Coconut Husk: Evaluation for Antioxidant and Cytotoxic Activity,” *Mater. Focus*, vol. 5, no. 1, pp. 55–61, 2016, doi: 10.1166/mat.2016.1289.
- [214] A. Y. Lee *et al.*, “Raman study of D* band in graphene oxide and its correlation with reduction,” *Appl. Surf. Sci.*, vol. 536, no. September 2020, p. 147990, 2021, doi: 10.1016/j.apsusc.2020.147990.
- [215] D. Pooja, S. Saini, A. Thakur, B. Kumar, S. Tyagi, and M. K. Nayak, “A ‘Turn-On’ thiol functionalized fluorescent carbon quantum dot based chemosensory system for arsenite detection,” *J. Hazard. Mater.*, vol. 328, pp. 117–126, Apr. 2017, doi: 10.1016/J.JHAZMAT.2017.01.015.
- [216] K. Radhakrishnan and P. Panneerselvam, “Green synthesis of surface-passivated carbon dots from the prickly pear cactus as a fluorescent probe for the dual detection of arsenic(iii) and hypochlorite ions from drinking water,” *RSC Adv.*, vol. 8, no. 53, pp. 30455–30467, Aug. 2018, doi: 10.1039/C8RA05861J.
- [217] A. Tadesse, M. Hagos, D. Ramadevi, K. Basavaiah, and N. Belachew, “Fluorescent-Nitrogen-Doped Carbon Quantum Dots Derived from Citrus Lemon Juice: Green Synthesis, Mercury(II) Ion Sensing, and Live Cell Imaging,” *ACS Omega*, vol. 5, no. 8, pp. 3889–3898, 2020, doi: 10.1021/acsomega.9b03175.
- [218] S. Gao, G. Tan, H. Yuan, D. Xiao, and M. M. F. Choi, “A Simple Fluorometric Method

- Using Chlorophyll a for Determination of Hg²⁺ Ion,” *Microchim. Acta* 2006 1533, vol. 153, no. 3, pp. 159–162, Jan. 2006, doi: 10.1007/S00604-005-0471-Z.
- [219] M. Wang, G. Meng, and Q. Huang, “Spinach-extracted chlorophyll-a modified peanut shell as fluorescence sensors for selective detection of Hg²⁺ in water,” *Sensors Actuators B Chem.*, vol. 209, pp. 237–241, Mar. 2015, doi: 10.1016/J.SNB.2014.11.117.
- [220] Q. Zhang *et al.*, “The application of green-synthesis-derived carbon quantum dots to bioimaging and the analysis of mercury(II),” *J. Anal. Methods Chem.*, vol. 2019, 2019, doi: 10.1155/2019/8183134.
- [221] J. Liu *et al.*, “Selective detection of mercury ions based on tin oxide quantum dots: performance and fluorescence enhancement model,” *J. Mater. Chem. C*, vol. 9, no. 26, pp. 8274–8284, 2021, doi: 10.1039/d1tc00824b.
- [222] C. Karami, M. A. Taher, and M. Shahlaei, “A simple method for determination of mercury (II) ions by PNBS-doped carbon dots as a fluorescent probe,” *J. Mater. Sci. Mater. Electron.*, vol. 31, no. 8, pp. 5975–5983, 2020, doi: 10.1007/s10854-020-03157-5.
- [223] W. Yao, Y. Hua, Z. Yan, C. Wu, F. Zhou, and Y. Liu, “Sulfhydryl functionalized carbon quantum dots as a turn-off fluorescent probe for sensitive detection of Hg²⁺,” *RSC Adv.*, vol. 11, no. 57, pp. 36310–36318, 2021, doi: 10.1039/d1ra06527k.
- [224] G. K. Soni, N. Wangoo, C. Cokca, K. Peneva, and R. K. Sharma, “Analytica Chimica Acta Ultrasensitive aptasensor for arsenic detection using quantum dots and guanlyated Poly (methacrylamide),” *Anal. Chim. Acta*, vol. 1209, no. January, p. 339854, 2022, doi: 10.1016/j.aca.2022.339854.
- [225] G. Tang, J. Wang, Y. Li, and X. Su, “Determination of arsenic(iii) based on the fluorescence resonance energy transfer between CdTe QDs and Rhodamine 6G,” *RSC Adv.*, vol. 5, no. 23, pp. 17519–17525, 2015, doi: 10.1039/c4ra16789a.
- [226] N. Butwong, T. Noipa, R. Burakham, S. Srijaranai, and W. Ngeontae, “Determination of arsenic based on quenching of CdS quantum dots fluorescence using the gas-diffusion flow injection method,” *Talanta*, vol. 85, no. 2, pp. 1063–1069, 2011, doi: 10.1016/j.talanta.2011.05.023.
- [227] T. Shindhal *et al.*, “A critical review on advances in the practices and perspectives for the treatment of dye industry wastewater,” *Bioengineered*, vol. 12, no. 1, pp. 70–87, 2021, doi: 10.1080/21655979.2020.1863034/FORMAT/EPUB.
- [228] A. Sekar, R. Yadav, and N. Basavaraj, “Fluorescence quenching mechanism and the application of green carbon nanodots in the detection of heavy metal ions: a review,” *New J. Chem.*, vol. 45, no. 5, pp. 2326–2360, 2021, doi: 10.1039/d0nj04878j.
- [229] Z. Liang, M. Kang, G. F. Payne, X. Wang, and R. Sun, “Probing Energy and Electron Transfer Mechanisms in Fluorescence Quenching of Biomass Carbon Quantum Dots,”

2016, doi: 10.1021/acsami.6b04826.

- [230] J. Petrovi, G. Nikoli, and D. Markovi, "In vitro complexes of copper and zinc with chlorophyll," *J. Serbian Chem. Soc.*, vol. 71, no. 5, pp. 501–512, 2006, doi: 10.2298/JSC0605501P.
- [231] B. Fu, J. C. Hower, S. Dai, S. M. Mardon, and G. Liu, "Determination of Chemical Speciation of Arsenic and Selenium in High-As Coal Combustion Ash by X-ray Photoelectron Spectroscopy: Examples from a Kentucky Stoker Ash," *ACS Omega*, vol. 3, no. 12, pp. 17637–17645, 2018, doi: 10.1021/acsomega.8b02929.
- [232] X. Guo, M. Li, A. Liu, M. Jiang, X. Niu, and X. Liu, "Adsorption mechanisms and characteristics of Hg²⁺ removal by different fractions of biochar," *Water (Switzerland)*, vol. 12, no. 8, 2020, doi: 10.3390/W12082105.
- [233] E. Bentivegna, S. Gouy, A. Maulard, C. Chargari, A. Leary, and P. Morice, "Oncological outcomes after fertility-sparing surgery for cervical cancer: a systematic review," *Lancet. Oncol.*, vol. 17, no. 6, pp. e240–e253, Jun. 2016, doi: 10.1016/S1470-2045(16)30032-8.
- [234] "Cervical cancer." [Online]. Available: https://www.who.int/health-topics/cervical-cancer#tab=tab_1. [Accessed: 03-Feb-2022].
- [235] J. C. Roa *et al.*, "HPV genotyping from invasive cervical cancer in Chile," *Int. J. Gynecol. Obstet.*, vol. 105, no. 2, pp. 150–153, May 2009, doi: 10.1016/J.IJGO.2008.12.017.
- [236] Panagiotis Tsikouras *et al.*, "Cervical cancer: screening, diagnosis and staging ," *J BUON.*, vol. 21, no. 6, pp. 1563–1564, Nov. 2016.
- [237] G. P.C. Yee, P. de Souza, and L. M. Khachigian, "Current and potential treatments for cervical cancer," *Curr. Cancer Drug Targets*, vol. 13, no. 2, pp. 205–220, Mar. 2013, doi: 10.2174/1568009611313020009.
- [238] I. Singh, R. Arora, H. Dhiman, and R. Pahwa, "Carbon Quantum Dots: Synthesis, Characterization and Biomedical Applications," *Turkish J. Pharm. Sci.*, vol. 15, no. 2, p. 219, Aug. 2018, doi: 10.4274/TJPS.63497.
- [239] P. Devi, S. Saini, and K. H. Kim, "The advanced role of carbon quantum dots in nanomedical applications," *Biosens. Bioelectron.*, vol. 141, no. March, p. 111158, 2019, doi: 10.1016/j.bios.2019.02.059.
- [240] B. Unnikrishnan, R. S. Wu, S. C. Wei, C. C. Huang, and H. T. Chang, "Fluorescent Carbon Dots for Selective Labeling of Subcellular Organelles," *ACS Omega*, vol. 5, no. 20, pp. 11248–11261, 2020, doi: 10.1021/acsomega.9b04301.
- [241] S. E. A. Gratton *et al.*, "The effect of particle design on cellular internalization pathways," *Proc. Natl. Acad. Sci.*, vol. 105, no. 33, pp. 11613–11618, Aug. 2008, doi:

10.1073/PNAS.0801763105.

- [242] A. Nair, J. T. Haponiuk, S. Thomas, and S. Gopi, “Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID- 19 . The COVID-19 resource centre is hosted on Elsevier Connect , the company ’ s public news and information ,” no. January, 2020.
- [243] H. Wu *et al.*, “Applications of carbon dots on tumour theranostics,” *View*, vol. 2, no. 2, p. 20200061, Apr. 2021, doi: 10.1002/VIW.20200061.
- [244] X. Sui, C. Luo, C. Wang, F. Zhang, J. Zhang, and S. Guo, “Graphene quantum dots enhance anticancer activity of cisplatin via increasing its cellular and nuclear uptake,” *Nanomedicine Nanotechnology, Biol. Med.*, vol. 12, no. 7, pp. 1997–2006, 2016, doi: 10.1016/j.nano.2016.03.010.
- [245] V. K. Bajpai *et al.*, “Multifunctional N-P-doped carbon dots for regulation of apoptosis and autophagy in B16F10 melanoma cancer cells and in vitro imaging applications,” *Theranostics*, vol. 10, no. 17, pp. 7841–7856, 2020, doi: 10.7150/thno.42291.
- [246] R. Liu *et al.*, “A Distinctive Spinach-Based Carbon Nanomaterial with Chlorophyll-Rich and Near-Infrared Emission for Simultaneous In Vivo Biothiol Imaging and Dual-Enhanced Photodynamic Therapy of Tumor,” *Adv. Ther.*, vol. 2, no. 7, pp. 1–11, 2019, doi: 10.1002/adtp.201900011.
- [247] L. Behrendt, A. Brejnrod, M. Schliep, S. J. Sørensen, A. W. D. Larkum, and M. Kühl, “Chlorophyll f-driven photosynthesis in a cavernous cyanobacterium,” *ISME J. 2015* 99, vol. 9, no. 9, pp. 2108–2111, Feb. 2015, doi: 10.1038/ismej.2015.14.
- [248] M. Nasrollahzadeh, M. Sajjadi, S. M. Sajadi, and Z. Issaabadi, “Green Nanotechnology,” *Interface Sci. Technol.*, vol. 28, pp. 145–198, Jan. 2019, doi: 10.1016/B978-0-12-813586-0.00005-5.
- [249] X. Ren, F. Zhang, B. Guo, N. Gao, and X. Zhang, “Synthesis of N-doped Micropore carbon quantum dots with high quantum yield and dual-wavelength photoluminescence emission from biomass for cellular imaging,” *Nanomaterials*, vol. 9, no. 4, pp. 22–25, 2019, doi: 10.3390/nano9040495.
- [250] D. Magde, R. Wong, and P. G. Seybold, “Fluorescence Quantum Yields and Their Relation to Lifetimes of Rhodamine 6G and Fluorescein in Nine Solvents: Improved Absolute Standards for Quantum Yields¶,” *Photochem. Photobiol.*, vol. 75, no. 4, pp. 327–334, May 2007, doi: 10.1562/0031-8655(2002)0750327FQYATR2.0.CO2.
- [251] W. U. Khan *et al.*, “High quantum yield green-emitting carbon dots for Fe(III) detection, biocompatible fluorescent ink and cellular imaging,” *Sci. Rep.*, vol. 7, no. 1, pp. 1–9, 2017, doi: 10.1038/s41598-017-15054-9.
- [252] A. Dager, T. Uchida, T. Maekawa, and M. Tachibana, “Synthesis and characterization of Mono-disperse Carbon Quantum Dots from Fennel Seeds: Photoluminescence

- analysis using Machine Learning,” *Sci. Rep.*, vol. 9, no. 1, pp. 1–10, 2019, doi: 10.1038/s41598-019-50397-5.
- [253] E. Arkan, A. Barati, M. Rahmanpanah, L. Hosseinzadeh, S. Moradi, and M. Hajjalyani, “Green synthesis of carbon dots derived from walnut oil and an investigation of their cytotoxic and apoptogenic activities toward cancer cells,” *Adv. Pharm. Bull.*, vol. 8, no. 1, pp. 149–155, 2018, doi: 10.15171/apb.2018.018.
- [254] L. Rao *et al.*, “Highly photoluminescent and stable n-doped carbon dots as nanoprobes for Hg²⁺ detection,” *Nanomaterials*, vol. 8, no. 11, pp. 1–18, 2018, doi: 10.3390/nano8110900.
- [255] A. K. Samantara, S. Maji, A. Ghosh, B. Bag, R. Dash, and B. K. Jena, “Good’s buffer derived highly emissive carbon quantum dots: excellent biocompatible anticancer drug carrier,” *J. Mater. Chem. B*, vol. 4, no. 14, pp. 2412–2420, 2016, doi: 10.1039/c6tb00081a.
- [256] C. Correia, J. Martinho, and E. Maçôas, “A Fluorescent Nanosensor for Silver (Ag⁺) and Mercury (Hg²⁺) Ions Using Eu (III)-Doped Carbon Dots,” *Nanomaterials*, vol. 12, no. 3, p. 385, 2022, doi: 10.3390/nano12030385.
- [257] H. Lin, J. Huang, and L. Ding, “Preparation of Carbon Dots with High-Fluorescence Quantum Yield and Their Application in Dopamine Fluorescence Probe and Cellular Imaging,” *J. Nanomater.*, vol. 2019, 2019, doi: 10.1155/2019/5037243.
- [258] K. S. Prasad, G. Shruthi, and C. Shivamallu, “One-pot synthesis of aqueous carbon quantum dots using bibenzoimidazolyl derivative and their antitumor activity against breast cancer cell lines,” *Inorg. Chem. Commun.*, vol. 101, no. December 2018, pp. 11–15, 2019, doi: 10.1016/j.inoche.2019.01.001.
- [259] G. Zorn *et al.*, “X-Ray Photoelectron Spectroscopy Investigation of the Nitrogen Species in Photoactive Perfluorophenylazide-Modified Surfaces,” *J. Phys. Chem. C. Nanomater. Interfaces*, vol. 118, no. 1, p. 376, Jan. 2014, doi: 10.1021/JP409338Y.
- [260] D. Mohapatra *et al.*, “Carbon dots from an immunomodulatory plant for cancer cell imaging, free radical scavenging and metal sensing applications,” *Nanomedicine*, vol. 16, no. 23, pp. 2039–2059, 2021, doi: 10.2217/nnm-2021-0190.
- [261] P. Ionita, “Is DPPH Stable Free Radical a Good Scavenger for Oxygen Active Species?,” *Chem. Pap.*, vol. 59, no. 1, pp. 11–16, 2005.
- [262] L. Kumar, P. Harish, P. S. Malik, and S. Khurana, “Chemotherapy and targeted therapy in the management of cervical cancer,” *Curr. Probl. Cancer*, vol. 42, no. 2, pp. 120–128, Mar. 2018, doi: 10.1016/J.CURRPROBLCANCER.2018.01.016.
- [263] M. X. Zhao and B. J. Zhu, “The Research and Applications of Quantum Dots as Nano-Carriers for Targeted Drug Delivery and Cancer Therapy,” *Nanoscale Res. Lett.*, vol. 11, no. 1, pp. 1–9, Dec. 2016, doi: 10.1186/S11671-016-1394-9/FIGURES/8.

- [264] T. Edvinsson, “Optical quantum confinement and photocatalytic properties in two-, one- and zero-dimensional nanostructures,” *R. Soc. Open Sci.*, vol. 5, no. 9, Sep. 2018, doi: 10.1098/RSOS.180387.
- [265] W. A. A. Mohamed *et al.*, “Quantum dots synthetization and future prospect applications,” *Nanotechnol. Rev.*, vol. 10, no. 1, pp. 1926–1940, Jan. 2021, doi: 10.1515/NTREV-2021-0118/ASSET/GRAPHIC/J_NTREV-2021-0118_FIG_013.JPG.
- [266] S. L. Fink and B. T. Cookson, “Apoptosis, pyroptosis, and necrosis: mechanistic description of dead and dying eukaryotic cells,” *Infect. Immun.*, vol. 73, no. 4, pp. 1907–1916, Apr. 2005, doi: 10.1128/IAI.73.4.1907-1916.2005.
- [267] J. Briffa, E. Sinagra, and R. Blundell, “Heavy metal pollution in the environment and their toxicological effects on humans,” *Heliyon*, vol. 6, no. 9, p. e04691, Sep. 2020, doi: 10.1016/J.HELIYON.2020.E04691.
- [268] J. Ahmed, A. Thakur, and A. Goyal, “CHAPTER 1 Industrial Wastewater and Its Toxic Effects,” pp. 1–14, Nov. 2021, doi: 10.1039/9781839165399-00001.
- [269] S. Sharma and A. Bhattacharya, “Drinking water contamination and treatment techniques,” *Appl. Water Sci.* 2016 73, vol. 7, no. 3, pp. 1043–1067, Aug. 2016, doi: 10.1007/S13201-016-0455-7.
- [270] A. M. Ghazi and J. R. Millette, “Lead,” *Environ. Forensics Contam. Specif. Guid.*, pp. 55–79, Jan. 1964, doi: 10.1016/B978-012507751-4/50026-4.
- [271] D. Sofia, F. Gioiella, N. Lotrecchiano, and A. Giuliano, “Mitigation strategies for reducing air pollution,” *Environ. Sci. Pollut. Res.*, vol. 27, no. 16, pp. 19226–19235, Jun. 2020, doi: 10.1007/S11356-020-08647-X/FIGURES/2.
- [272] T. M. Chen, J. Gokhale, S. Shofer, and W. G. Kuschner, “Outdoor air pollution: nitrogen dioxide, sulfur dioxide, and carbon monoxide health effects,” *Am. J. Med. Sci.*, vol. 333, no. 4, pp. 249–256, 2007, doi: 10.1097/MAJ.0B013E31803B900F.
- [273] S. E. Bauer, D. Koch, N. Unger, S. M. Metzger, D. T. Shindell, and D. G. Streets, “Atmospheric Chemistry and Physics Nitrate aerosols today and in 2030: a global simulation including aerosols and tropospheric ozone,” *Atmos. Chem. Phys*, vol. 7, pp. 5043–5059, 2007.
- [274] B. Timmer, W. Olthuis, and A. Van Den Berg, “Ammonia sensors and their applications—a review,” *Sensors Actuators B Chem.*, vol. 107, no. 2, pp. 666–677, Jun. 2005, doi: 10.1016/J.SNB.2004.11.054.
- [275] M. Li, C. J. Weschler, G. Bekö, P. Wargocki, G. Lucic, and J. Williams, “Human Ammonia Emission Rates under Various Indoor Environmental Conditions,” *Environ. Sci. Technol.*, vol. 54, p. 3, 2022, doi: 10.1021/acs.est.0c00094.

- [276] A. A. Shahzad *et al.*, “A Low-Cost Device for Measurement of Exhaled Breath for the Detection of Obstructive Lung Disease,” *Biosens. 2022, Vol. 12, Page 409*, vol. 12, no. 6, p. 409, Jun. 2022, doi: 10.3390/BIOS12060409.
- [277] A. L. Wani, A. Ara, and J. A. Usmani, “Lead toxicity: a review,” *Interdiscip. Toxicol.*, vol. 8, no. 2, p. 55, Jun. 2015, doi: 10.1515/INTOX-2015-0009.
- [278] Z. Shamsollahi and A. Partovinia, “Recent advances on pollutants removal by rice husk as a bio-based adsorbent: A critical review,” *J. Environ. Manage.*, vol. 246, pp. 314–323, Sep. 2019, doi: 10.1016/J.JENVMAN.2019.05.145.
- [279] A. S. Maghsoudi, S. Hassani, K. Mirnia, and M. Abdollahi, “Recent Advances in Nanotechnology-Based Biosensors Development for Detection of Arsenic, Lead, Mercury, and Cadmium,” *Int. J. Nanomedicine*, vol. 16, p. 803, 2021, doi: 10.2147/IJN.S294417.
- [280] H. Kuang, C. Xing, C. Hao, L. Liu, L. Wang, and C. Xu, “Rapid and Highly Sensitive Detection of Lead Ions in Drinking Water Based on a Strip Immunosensor,” *Sensors (Basel)*, vol. 13, no. 4, p. 4214, 2013, doi: 10.3390/S130404214.
- [281] Q. Meng *et al.*, “Solution-sheared ultrathin films for highly-sensitive ammonia detection using organic thin-film transistors,” *J. Mater. Chem. C*, vol. 2, no. 7, pp. 1264–1269, Jan. 2014, doi: 10.1039/C3TC31762E.
- [282] A. G. Bannov, M. V. Popov, A. E. Brester, and P. B. Kurmashov, “Recent Advances in Ammonia Gas Sensors Based on Carbon Nanomaterials,” *Micromachines 2021, Vol. 12, Page 186*, vol. 12, no. 2, p. 186, Feb. 2021, doi: 10.3390/MI12020186.
- [283] G. Zamiri and A. S. M. A. Haseeb, “Recent Trends and Developments in Graphene/Conducting Polymer Nanocomposites Chemiresistive Sensors,” *Materials (Basel)*, vol. 13, no. 15, Aug. 2020, doi: 10.3390/MA13153311.
- [284] F. Ahmadi Tabr, F. Salehiravesh, H. Adelnia, J. N. Gavvani, and M. Mahyari, “High sensitivity ammonia detection using metal nanoparticles decorated on graphene macroporous frameworks/polyaniline hybrid,” *Talanta*, vol. 197, pp. 457–464, May 2019, doi: 10.1016/J.TALANTA.2019.01.060.
- [285] N. Joshi, T. Hayasaka, Y. Liu, H. Liu, O. N. Oliveira, and L. Lin, “A review on chemiresistive room temperature gas sensors based on metal oxide nanostructures, graphene and 2D transition metal dichalcogenides,” *Microchim. Acta 2018 1854*, vol. 185, no. 4, pp. 1–16, Mar. 2018, doi: 10.1007/S00604-018-2750-5.
- [286] D. T. Sun *et al.*, “Rapid, Selective Heavy Metal Removal from Water by a Metal-Organic Framework/Polydopamine Composite,” *ACS Cent. Sci.*, vol. 4, no. 3, pp. 349–356, Mar. 2018, doi: 10.1021/ACSCENTSCI.7B00605/ASSET/IMAGES/LARGE/OC-2017-00605D_0006.JPEG.

- [287] P. Jain, M. Guin, and N. B. Singh, "Metal Oxide Nanoparticles for Water Decontamination," pp. 245–278, 2022, doi: 10.1007/978-981-19-2332-6_11.
- [288] T. Y. Xing, J. Zhao, G. J. Weng, J. J. Li, J. Zhu, and J. W. Zhao, "Synthesis of dual-functional Ag/Au nanoparticles based on the decreased cavitating rate under alkaline conditions and the colorimetric detection of mercury(II) and lead(II)," *J. Mater. Chem. C*, vol. 6, no. 28, pp. 7557–7567, Jul. 2018, doi: 10.1039/C8TC01867G.
- [289] S. M. Ng, "Carbon Dots as Optical Nanoprobes for Biosensors," *Nanobiosensors Biomol. Target.*, pp. 269–300, Jan. 2019, doi: 10.1016/B978-0-12-813900-4.00012-9.
- [290] J. Liu, R. Li, and B. Yang, "Carbon Dots: A New Type of Carbon-Based Nanomaterial with Wide Applications," *ACS Cent. Sci.*, vol. 6, no. 12, pp. 2179–2195, Dec. 2020, doi: 10.1021/ACSCENTSCI.0C01306/ASSET/IMAGES/LARGE/OC0C01306_0007.JPEG.
- [291] D. Shukla *et al.*, "Label-Free Fluorometric Detection of Adulterant Malachite Green Using Carbon Dots Derived from the Medicinal Plant Source *Ocimum tenuiflorum*," *ChemistrySelect*, vol. 4, no. 17, pp. 4839–4847, May 2019, doi: 10.1002/SLCT.201900530.
- [292] H. Liu *et al.*, "Physically Flexible, Rapid-Response Gas Sensor Based on Colloidal Quantum Dot Solids," *Adv. Mater.*, vol. 26, no. 17, pp. 2718–2724, May 2014, doi: 10.1002/ADMA.201304366.
- [293] D. Sengottuvelu *et al.*, "Multicolor Nitrogen-Doped Carbon Quantum Dots for Environment-Dependent Emission Tuning," *ACS Omega*, vol. 7, no. 31, pp. 27742–27754, Aug. 2022, doi: 10.1021/ACSOMEGA.2C03912.
- [294] P. Huang, S. Xu, M. Zhang, W. Zhong, Z. Xiao, and Y. Luo, "Modulation doping of absorbent cotton derived carbon dots for quantum dot-sensitized solar cells," *Phys. Chem. Chem. Phys.*, vol. 21, no. 47, pp. 26133–26145, Dec. 2019, doi: 10.1039/C9CP04880D.
- [295] B. De and N. Karak, "A green and facile approach for the synthesis of water soluble fluorescent carbon dots from banana juice," *RSC Adv.*, vol. 3, no. 22, pp. 8286–8290, May 2013, doi: 10.1039/C3RA00088E.
- [296] A. Gupta, N. C. Verma, S. Khan, and C. K. Nandi, "Carbon dots for naked eye colorimetric ultrasensitive arsenic and glutathione detection," *Biosens. Bioelectron.*, vol. 81, pp. 465–472, Jul. 2016, doi: 10.1016/J.BIOS.2016.03.018.
- [297] S. Pandiyan *et al.*, "Biocompatible Carbon Quantum Dots Derived from Sugarcane Industrial Wastes for Effective Nonlinear Optical Behavior and Antimicrobial Activity Applications," *ACS Omega*, vol. 5, p. 30372, Dec. 2020, doi: 10.1021/acsomega.0c03290.
- [298] E. Akbari *et al.*, "Analytical calculation of sensing parameters on carbon nanotube based

gas sensors,” *Sensors (Switzerland)*, vol. 14, no. 3, pp. 5502–5515, 2014, doi: 10.3390/s140305502.

- [299] J. T. W. Yeow and Y. Wang, “A review of carbon nanotubes-based gas sensors,” *J. Sensors*, vol. 2009, 2009, doi: 10.1155/2009/493904.
- [300] W. Chen, F. Li, P. C. Ooi, Y. Ye, T. W. Kim, and T. Guo, “Room temperature pH-dependent ammonia gas sensors using graphene quantum dots,” *Sensors Actuators, B Chem.*, vol. 222, pp. 763–768, 2016, doi: 10.1016/j.snb.2015.09.002.
- [301] I. Karaduman, E. Er, H. Çelikkan, N. Erk, and S. Acar, “Room-temperature ammonia gas sensor based on reduced graphene oxide nanocomposites decorated by Ag, Au and Pt nanoparticles,” *J. Alloys Compd.*, vol. 722, pp. 569–578, 2017, doi: 10.1016/j.jallcom.2017.06.152.
- [302] M. M. Arafat, B. Dinan, S. A. Akbar, and A. S. M. A. Haseeb, “Gas Sensors Based on One Dimensional Nanostructured Metal-Oxides: A Review,” *Sensors 2012, Vol. 12, Pages 7207-7258*, vol. 12, no. 6, pp. 7207–7258, May 2012, doi: 10.3390/S120607207.
- [303] F. Noun, E. A. Jury, and R. Naccache, “Elucidating the Quenching Mechanism in Carbon Dot-Metal Interactions—Designing Sensitive and Selective Optical Probes,” *Sensors (Basel)*, vol. 21, no. 4, pp. 1–13, Feb. 2021, doi: 10.3390/S21041391.
- [304] N. H. Zainal Abidin *et al.*, “The effect of functionalization on rice-husks derived carbon quantum dots properties and cadmium removal,” *J. Water Process Eng.*, vol. 38, p. 101634, Dec. 2020, doi: 10.1016/J.JWPE.2020.101634.

List of Publications

1. **Md Bayazeed Alam**, Nurul Hassan, Kedar Sahoo, Manoj Kumar, Manju Sharma, Jayeeta Lahiri, Avanish Singh Parmar (2022). Deciphering Interaction between Chlorophyll functionalized Carbon Quantum Dots with Arsenic and Mercury Toxic Metals in Water as Highly Sensitive Dual-probe Sensor. *Journal of Photochemistry & Photobiology, A: Chemistry*. 431 (2), 114059.
2. **Md Bayazeed Alam**, Kanchan Yadav, Devyani Shukla, Ritu Srivastava, Jayeeta Lahiri, Avanish Singh Parmar (2019). Carbon Quantum Dot as Electron Transporting Layer in Organic Light Emitting Diode. *ChemistrySelect*. 4(25):7450-7454.
3. **Md Bayazeed Alam**, Tarun Minocha, Sanjeev K. Yadav, Avanish Singh Parmar (2022) Chlorophyll rich Carbon Quantum Dots exhibit strong therapeutic potential against cervical cancer. **Under review in ChemistrySelect**.
4. **Md Bayazeed Alam**, Kanchan Yadav, Devyani Shukla, Dhananjay Kumar Gaur, Avanish Singh Parmar, Synthesis and Characterization of Multifunctional Carbon Quantum Dots to fabricate Facile Sensing System for Ammonia Vapour and Lead. **(Submitted)**
5. **Md Bayazeed Alam**, Ashish Kumar, Razi Ahmad, Om Prakash Sinha, Avanish Singh Parmar, Ritu Srivastava, Octadecylamine Functionalized SWNT doped Polymer Based Optoelectronic Devices. **Under review in Optical Materials**.
6. Naresh Shyaga, Rahul Sharma, Nurul Hassan, **Bayazeed Alam**, Avanish Singh Parmar, Jayeeta Lahiri (2022). Influence of growth parameters on the dopant configuration of nitrogen-doped graphene synthesized from phthalocyanine molecules. *Journal of Materials Science: Materials in Electronics*. 33, pages19361–19375.
7. Nilanjan Basu, Alapan Dutta, Ranveer Singh, **Md. Bayazeed Alam**, Avanish S Parmar, Tapobrata Som, Jayeeta Lahiri (2022). Substrate roughness and crystal orientation controlled growth of ultra thin BN films deposited on Cu foils. *Applied Physics A*. 128, 392.
8. Debadatta Mohapatra, **Md. Bayazeed Alam**, Vivek Pandey, Ravi Pratap, Pawan K. Dubey, Avanish S. Parmar, Alakh N Sahu (2021). Carbon dots from immunomodulatory plant for cancer cell imaging, free radical scavenging, and metal sensing applications. *Nanomedicine*. 16,23.
9. Gaurav Gopal Naik, **Md. Bayazeed Alam**, Vivek Pandey, Debadatta Mohapatra, Pawan Kumar Dubey, Avanish S. Parmar, Alakh N. Sahu (2020). Multi-functional carbon dots from an Ayurvedic medicinal plant for cancer bioimaging applications. *Journal of Fluorescence* 30, 407-418.

10. Swati Kaushik, Sonu Gandhi, Mehak Chauhan,;Shaohua Ma, Souvik Das, Deepa Ghosh, Aneesh Chandrasekharan, **Md Bayazeed Alam**, Avanish Parmar, Alpana Sharma, T.R. Kumar, Dr. Deepa Suhag (2020). Water-templated, Polysaccharide-rich, Bio-artificial 3D Microarchitectures as Extra-Cellular Matrix Bioautomatons. ACS Applied Materials & Interfaces 12 (18) 20912-20921.
11. Gaurav Gopal Naik , **Md Bayazeed Alam**, Vivek Pandey, Pawan Kumar Dubey, Avanish S. Parmar, Alakh N. Sahu (2020). Pink Fluorescent Carbon Dots Derived from the Phytomedicine for Breast Cancer Cell Imaging. ChemistrySelect 5 (23) 6954- 60.