SYNTHESIS AND CHARACTERIZATION OF MAGNETIC CARBON DOTS (CDS)-BASED HYBRID MATERIAL AS AN ADSORBENT FOR THE REMOVAL OF ORGANIC DYE FROM WATER

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ABSTRACT

Nowadays, water quality encounters severe challenges due to the highly increasing population, industrialization and agricultural activities [1]. Unfortunately, it is estimated that 80 % of the global industrial and municipal water is released into the environment without undergoing treatment; the percentage is even higher in the least developed countries due to the absence of proper facilities [2]. Over the years, the scientific community has dedicated efforts to the successful removal of water pollutants through various methods, including adsorption [3], photocatalysis [4], advanced oxidation processes [5], membrane separation [6], etc. Among these techniques, adsorption is the most popular because of its simplicity, high efficiency, low-cost, minimum energy requirement and absence of secondary waste production during the process [7]. In this study, a carbon dots (CDs)-based hybrid material was developed as an adsorbent for water treatment application from organic dyes, such as Congo Red (CR). CDs consist of either an amorphous or a crystalline carbon core surrounded by various surface functionalities (e.g. −OH, −COOH, −C=O, −C−O−C, etc.) [8]. They have been employed as adsorbents due to the surface functional groups abundance, and the ease of surface functionalization, which could be tailored to enhance selectivity towards specific pollutants. However, due to their high hydrophilicity, they cannot be easily separated from the solution after their utilization. Therefore, their combination with magnetic nanoparticles (MNPs) has been considered as an ideal option, as they could be easily retrieved by applying an external magnetic field [9, 10]. Herein, a magnetic CDs-$CuFe_2O_4$ nanohybrid material was successfully prepared through a solvothermal process and utilized as an adsorbent for the removal of CR dye from aqueous environment. The nanohybrid material combines interactive surface functional groups due to CDs and high magnetic saturation, resulting in enhanced selectivity towards CR dye and easy separation after utilization with an external magnet. The as-prepared material was characterized by various techniques, including XRD, micro-Raman, FT-IR, HR-TEM/EDS, N_2 porosimetry, and SQUID. Finally, its capability in the removal efficiency of CR dye was investigated at different initial CR concentrations, contact times and pH values via UV-Vis spectroscopy.

KEYWORDS: adsorption, carbon dots, copper ferrite, hybrids

REFERENCES

[1] Rathi B. S., Kumar P. S., Vo D.V.N. (2021). *Sci. Total Environ*., 797, 149134.
[2] Lin L., Yang H., Xu X. (2022). *Front. Environ. Sci.,* 10.
[3] Rashid, R.; Shafiq, I.; Akhter, P.; Iqbal, M. J.; Hussain. (2021). *M. Environ. Sci. Pollut. Res.* 28, 9050-9066.
[4] Ren G., Han H., Wang Y., Liu S., Zhao, J., Meng X., Li Z. (2021). *Nanomaterials*, 11, 1804.
[5] Lucas M. S., Peres J. A., Li Puma G. (2021). *Water,* 13, 1309.
[6] Obotey E., Rathilal S. (2020). *Membranes*, 10, 89.
[7] Chatterjee S., Guha N., Krishnan S., Singh K., Mathur P., Rai, D. K. (2020). *Sci. Rep.,* 10, 111.
[8] Arcudi F., Dorđević L., Prato M. (2019) *Acc. Chem. Res.*, *52*, 2070-2079.
[9] Zourou A., Ntziouni A., Adamopoulos N., Roman T., Zhang F., Terrones M., Kordatos K. V. (2022). *Carbon Trends*, 7, 100147.
[10] Zourou A., Ntziouni A., Adamopoulos N., Roman T., Zhang F., Terrones M., Kordatos, K. V. (2023). *J. Phys. Chem. Solids*, 181, 111490.