

Abstract

Validation of Spent Coffee Grounds as Precursors for the Development of Sustainable Carbon Dot-Based for Fe³⁺ Optical Sensing †

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† Presented at the 1st International Electronic Conference on Chemical Sensors and Analytical Chemistry, 1–15 July 2021; Available online: <https://csac2021.sciforum.net/>.

Abstract: Carbon dots (CDs) are fluorescence carbon-based nanomaterials that possess several properties such as photoluminescence, biocompatibility and good water solubility. They can be fabricated from a large variety of precursors; however, most available organic molecules are still expensive and their use or synthesis can lead to significant challenges to the environment and human health. It has become desirable to use biomass waste as alternative precursors in the synthesis of CDs, given that biomass waste material is ubiquitous, nontoxic, cheap and renewable. Spent coffee grounds (SCGs) are the residues of the treatment of coffee powder can be a potential carbon source to a more environmentally sustainable synthesis route. In this work, we fabricated SCG-based CDs via one-pot and solvent-free carbonization at 200 °C of solid samples generating particles with sizes between 2.1 and 3.9 nm. These carbon nanoparticles exhibited blue fluorescence and excitation-dependent emission of carbon dots with moderate quantum yields (2.9–5.8%). The presence of heavy metals in water resources, such as Fe³⁺, can lead to adverse health effects. SCG-based CDs showed potential for being used as optical Fe³⁺ optical sensors, with Life Cycle Assessment (LCA) studies validating the SCGs as more sustainable precursors than classical precursors, both considering a weight- or function-based functional unit.

Keywords: spent coffee grounds; carbon dots; sustainability; sensing



Citation: Crista, D.M.A.; da Silva, J.C.G.E.; da Silva, L.P. Validation of Spent Coffee Grounds as Precursors for the Development of Sustainable Carbon Dot-Based for Fe³⁺ Optical Sensing. *Chem. Proc.* **2021**, *5*, 17. <https://doi.org/10.3390/CSAC2021-10452>

Academic Editor: Elena Benito-Peña

Published: 30 June 2021

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Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/CSAC2021-10452/s1>.

Funding: Acknowledgment to projects PTDC/QUI-QFI/2870/2020 and UIDB/00081/2020. Also acknowledge for funding the PhD grant SFRH/BD/144423/2019 (D.M.A.C.), and funding Scientific Employment Stimulus CEECIND/01425/2017 (L.P.d.S.).

Conflicts of Interest: The authors declare no conflict of interest.



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