Evaluating the Impact of Synthesis Conditions on the Microstructure and CO_2 Adsorption and Separation of Nitrogen-Doped Biochar

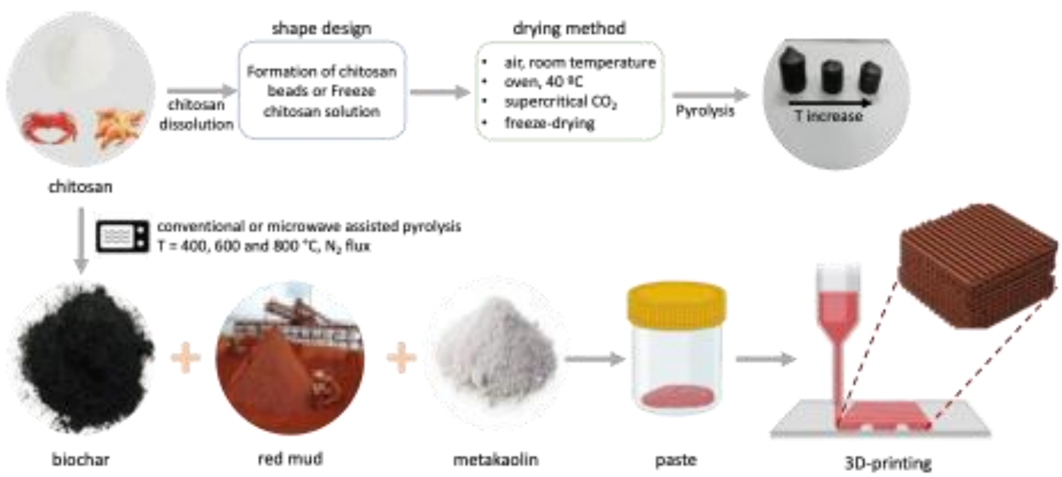
Mirtha Lourenço

CICECO - Aveiro Institute of Materials, Department of Chemistry, University of Aveiro - Portugal

The CO_2 impact on climate change has led to a focus on advancing CO_2 capture technologies, with biochar emerging as a promising adsorbent. Produced through pyrolysis of biowaste, biochar offers customizable properties and sustainable production by adjusting pyrolysis conditions and using diverse feedstocks[1].

Our research aims to enhance CO_2 capture technologies by designing biochar adsorbents derived from chitosan, employing innovative strategies to improve adsorption performance. By using advanced characterization techniques such as XPS, gas sorption isotherms, electron microscopy, and operando TGA-IR, we seek to gain a comprehensive molecular-level understanding of biochar microstructure and CO_2 adsorption mechanisms.

We evaluated the effects of polymerization, drying methods, heating techniques, and pyrolysis temperatures on the textural properties and adsorption behavior of chitosan-derived biochar. Additionally, we explored the feasibility of creating a 3D-printed biochar composite with inorganic polymers (Scheme 1). Our findings demonstrate the effectiveness of biochar in CO_2 adsorption applications, particularly for CO_2/CH_4 and CO_2/N_2 separation under both dry and moist conditions.



Through the development of powder and self-standing N-doped biochar adsorbents with diverse textural properties, we identified correlations between microstructure and CO_2 capture and separation efficiency. These moisture-tolerant materials, dominated by physisorption, are well-suited for integration into industrial-scale cyclic separation processes. The sustainable production of biochar, achieved without additional activation or functionalization procedures, combined with their self-standing configurations, positions these residue-derived adsorbents as highly promising for large-scale CO_2 adsorption-separation applications.

ACKNOWLEDGMENT

This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020 (DOI 10.54499/UIDB/50011/2020), UIDP/50011/2020 (DOI 10.54499/UIDP/50011/2020) & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020), financed by national funds through the FCT/MCTES (PIDDAC). The authors thank the European Union's Horizon 2020 research and innovation program (grants agreement 865974)) and the European Union's Horizon Europe research and innovation program (grants agreements 101090287 and 101065059). MAOL also thanks FCT for a Junior Researcher Position (CEECIND/01158/2021).

REFERENCES

[1] Y. Qiao and C. Wu, Carbon Capture Science & Technology, 2, 100018, 2022.