Sustainable dextrin based carbon nanofibers: Preparation, Characterization and Potential application in CO_2 mitigation

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Abstract

Carbon capture is an emerging technology crucial for mitigating climate change and reducing emission of greenhouse gas [1]. Various CO_2 adsorbent materials have been developed using complex, high-cost production methods and toxic reagents [2]. Electrospun carbon nanofibers (CNF) are increasingly becoming a key area of research in advanced functional materials, thanks to their mechanical properties, surface area, high flexibility, and stable physical and chemical characteristics [3]. This research presents a versatile, sustainable, and efficient approach to produce highly selective porous carbons fibers from maltodextrin polymer. Maltodextrin was used as precursor, with addition of citric acid as crosslinking agent and betaine. Pyrolysis was carried out in two stages: initially under a nitrogen (N_2) atmosphere, followed by physical activation under carbon dioxide (CO_2) at 825 °C. Scanning electron microscopy revealed that thermal treatment and physical activation under CO_2 atmosphere maintained the fibrous morphology and reduced the fiber diameter to 0.72 ± 0.12 µm. CNF exhibited a high surface area up to 974 $m^2 g^{-1}$ with microporous structure. CO_2 and N_2 adsorption using microbalance, was employed to evaluate the selectively of CNF [4]. The adsorption-desorption isotherms showed that Q_{CO2}/Q_{N2} was greater than 8, indicating high selectivity of the adsorbent. Regeneration efficiency was up to 99% after three sorption-desorption cycles. The maximum adsorption capacity of CO_2 reached 3.61 mmol g^{-1} at 1 atm and 24 °C. Compared to commercial carbon Carboxen 564, presenting a maximum 2.05 mmol g^{-1} at 1 atm, these results highlight promising adsorption behavior of maltodextrin based CNF.

References

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