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Mesoporous carbon obtained from tannin biomass and modified with sulfur for CO2 capture

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The ongoing increase in greenhouse gas (GHG) emissions, specially CO2, and the resulting climate effects represent one of the greatest challenges faced by civilization. The capture of CO2 using mesoporous materials has emerged as an efficient solution for this problem. To produce porous carbons for CO2 capture applications, it is necessary for these materials to not only possess high adsorptive capacity but also exhibit selectivity for interacting with CO2, which can be achieved through surface functionalization with heteroatoms. Sulfur is an element that has stood out in the functionalization of carbon materials for use in CO2 capture. This work aimed to synthesize activated and functionalized porous carbons through the solvent-free synthesis method, using tannin biomass as a precursor of carbon and sodium thiosulfate as an activating and functionalizing agent, aiming at its application in CO2 capture. Four materials were produced: CP, CPS-1, CPS-2, and CPS-3. CP is the non-activated/functionalized material, and CPS-1, CPS-2, and CPS-3 are the materials synthesized using different mass ratios of sodium thiosulfate. The materials were characterized using thermogravimetric analysis, Raman spectroscopy, elemental analysis (CHNSO), nitrogen physisorption analysis, X-ray diffraction, and scanning/transmission electron microscopy. Subsequently, CO2 adsorption capacities were evaluated through an exploratory capture study. Thermogravimetric analyses revealed that the materials exhibited high thermal stability up to temperatures near 400 °C. Transmission electron microscopy and X-ray diffraction showed that the precursor material exhibited mesopores of different diameters with a certain degree of ordering, and the materials synthesized using sodium thiosulfate maintained this ordering. Nitrogen physisorption analysis indicated a significant increase in surface characteristics, such as specific surface area and microporosity, in materials synthesized with higher proportions of sodium thiosulfate. The material synthesized with the highest proportion of this salt demonstrated the highest values, evidencing its activating capacity. Elemental analysis revealed the presence of sulfur and oxygen in all materials synthesized with sodium thiosulfate, confirming its functionalizing capacity. The characterizations performed confirmed the simultaneous activation and functionalization capacity of this agent, conferring essential properties to the produced materials for CO2 capture and selectivity. Through exploratory capture studies, it was possible to observe that the materials exhibited CO2 adsorption capacities, with CPS-3 material standing out, showing an 8% mass gain, indicating the potential of these materials for application in CO2 capture technologies.