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Advanced SiO_2-based adsorbent for CO_2 capture

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The increasing need to reduce carbon dioxide emissions has intensified research into efficient solid adsorbents for post-combustion CO_2 capture. Intensive research has therefore been devoted to advanced adsorbents such as zeolites, porous carbons, metal–organic frameworks (MOFs), and metal oxides. In recent years, amine-functionalized mesoporous materials have attracted particular attention because amino groups exhibit strong affinity toward CO_2. These materials often combine high adsorption capacity, rapid kinetics, easy regeneration, and good cyclic stability. Mesoporous silica is especially attractive, and its CO_2 capture performance can be significantly enhanced by grafting amine-containing compounds onto the surface [1,2].

This study investigated the CO_2 adsorption properties of amine-functionalized mesoporous silica and organosilica materials. Ordered mesoporous supports were synthesized and subsequently modified with an amine-containing silane coupling agent. Textural characterization confirmed the preservation of mesostructured porosity, high specific surface area, and narrow pore size distribution after functionalization. The modified materials showed substantially higher CO_2 adsorption capacities than the original samples, particularly under ambient conditions. Additionally, amine grafting significantly improved CO_2/N_2 selectivity, indicating enhanced separation performance. Overall, these results demonstrate that amine-functionalized mesoporous silicas are promising candidates for efficient and selective CO_2 capture applications.

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