Amino Acid-Derived Solid Adsorbents for Direct Air Capture Applications

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In the field of direct air capture (DAC) technologies, which are designed to selectively capture carbon dioxide (CO_2) from atmospheric air, adsorption-based separation strategies are being actively developed worldwide, and early-stage commercialisation is already underway. To date, the adsorption-based DAC systems have primarily relied on solid adsorbents composed of polyamines and structurally related nitrogen-containing compounds, typically synthesised from fossil-based precursors and impregnated on porous inorganic supports.

On the other hand, increasing attention to the life cycle carbon footprint of DAC systems, including material production, deployment, recycling, and disposal, has led to interest in adsorbents fabricated from renewable, non-fossil-based feedstocks.[1] Among such candidates, amino acid salts including amino acid ionic liquids have attracted attention as promising CO_2-reactive materials.[2] However, their high hygroscopicity has generally limited their practical application as solid-state adsorbents.

In the present study, we developed a series of amino acid-based adsorbents that retain their solid state under exposure to humid CO_2. Coordination polymers with amino acids as ligands were designed as supports, and various basic salts including amino acid alkali metal salts were impregnated onto the supports. CO_2 adsorption tests under humid conditions (dew point: 20 °C, CO_2 concentration: 400 ppm, temperature: 40 °C) demonstrated that certain amino acid-based coordination polymers effectively suppress liquefaction under humid conditions and function as CO_2 adsorbents. Furthermore, accelerated degradation tests confirmed superior oxidative stability compared to conventional polyamine-based adsorbents.

References

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