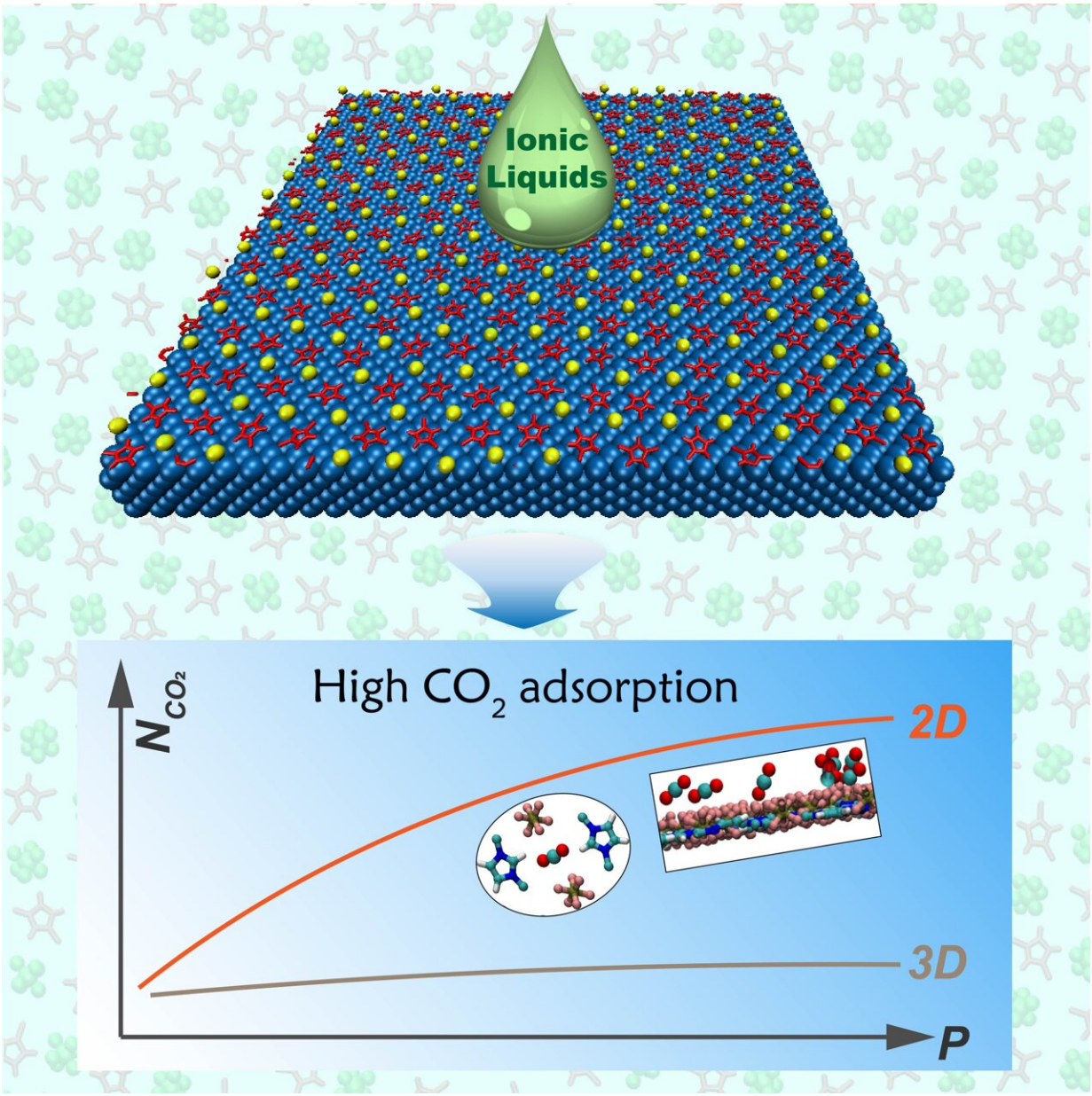
Two-dimensional ionic liquids to effectively capture carbon dioxide

July 12 2022



The ultrahigh CO_2 adsorption capacity of two-dimensional ionic liquids. Credit: IPE

In the context of global concerns about climate change and greenhouse gas control, a new technology for CO_2 capture, utilization, and storage has attracted broad attention.

Ionic liquids, composed of only cations and anions, are considered a new type of CO_2 adsorbent due to their ultralow vapor pressure and environmentally friendly features.

Recently, a group led by Profs Zhang Suojiang and He Hongyan from the Institute of Process Engineering (IPE) of the Chinese Academy of Sciences (CAS) has found that two-dimensional ionic liquids show a completely different melting behavior than when in bulk phase, leading to a high CO_2 adsorption capacity and structural robustness during the CO_2 adsorption-desorption process.

This study was published in *Cell Reports Physical Science* on July 12.

The researchers found that ionic liquids can form a two-dimensional-monolayer, ordered, checkerboard structure when supported by a metal surface. The two-dimensional ionic liquids exhibited anomalous stepwise melting processes, involving localized-rotated, out-of-plane-flipped, and fully disordered states, rather than the single melting point for the bulk ionic liquids.

"Anions and cations are arranged together in a checkerboard manner, thus forming a two-dimensional, ordered Z-bond network. This makes it more likely for the multi-step melting behaviors such as ionic rotation and flip," said Prof. He.

The massive molecular dynamics simulation indicates that the two-dimensional ionic liquids show excellent performance for CO_2 capture due to the unsaturated and exposed Z-bonds. The mole fraction of CO_2 adsorbed by two-dimensional [Mmim] PF_6 was improved by at least one order of magnitude compared with the corresponding bulk ionic liquids.

"The higher CO_2 adsorption capability suggests that such two-dimensional ionic liquids could serve as functional layers of the catalyst to enhance the mass transfer process of CO_2, which is important for the fixation and conversion of CO_2," said Associate Professor Wang Yanlei of IPE.

This two-dimensional editing technique for ionic liquids is expected to provide a new method for the precise control and functional design of liquids, which is promising for various chemical engineering applications involving solvents, electrolytes, and liquid catalysts.

More information: Hongyan He, Two dimensional ionic liquids with anomalous stepwise melting process and ultrahigh CO2 adsorption capacity, *Cell Reports Physical Science* (2022). DOI: 10.1016/j.xcrp.2022.100979. www.cell.com/cell-reports-phys … 2666-3864(22)00265-X

Provided by Chinese Academy of Sciences