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Porous ionic liquids for sustainable separations

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PURPOSE OF THE ABSTRACT

Among the alternative sorbents potentially capable of outperforming current separation technologies, in particular gas separations, ionic liquids are promising candidates. Their most attractive feature is the possibility of tuning their physical and chemical properties through proper pairing of anions and cations, which can include reactive groups, enabling the selective absorption of different gases, even at low partial pressures [1].

We will describe ionic liquid-based absorbents which are liquids with permanent porosity [2], designed to selectively absorb different gases. The absorbents are stable suspensions of metal-organic frameworks (MOFs) in salts whose ion pairs are too voluminous to enter the solid pores [3]. The increase in gas absorption, when compared with the pure ionic liquids, is proportional to the amount of porous solid in suspension. The thermodynamic analysis of the absorption data, as well as molecular dynamics simulations, show that the driving force for gas absorption by the porous ionic liquids is energetic as well as structural and thus is controlled by gas-solid affinity or by the porous liquid free volume [4].

Porous ionic liquid absorbents can be designed to react with different gases at mild conditions of temperature and pressure. We show that porous ionic liquids prepared as stable suspensions of ZIF-8 in phosphonium acetate or levulinate salts can selectively absorb carbon dioxide with a capacity more than 100% higher than that of the pure MOF at 1 bar and 303 K [5] as shown in the figure.

Porous ionic liquids can also be designed to promote the reaction, at mild conditions of temperature and pressure, of the gases absorbed. We have shown that carbon dioxide can be catalytically coupled with epoxides to form cyclic carbonates in porous ionic liquids containing alkylphosphonium halides and ZIF-8. The high activity and selectivity observed under mild reaction conditions indicate that porous ionic liquids are a promising and sustainable family of sorbents for gaseous reactive separations [6].

FIGURES

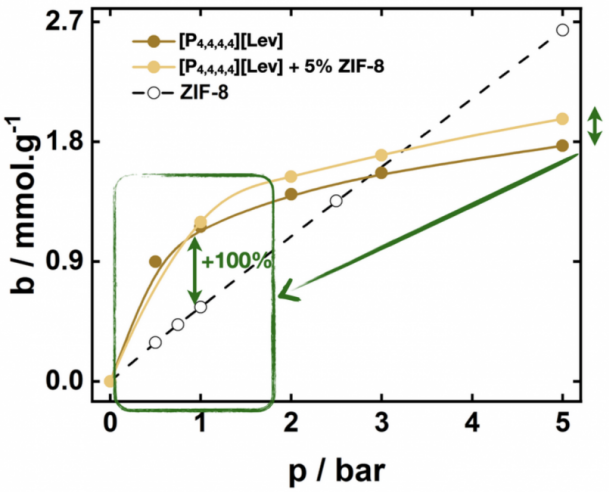

FIGURE 1

Figure 1

Absorption of carbon dioxide, in the 0-5 bar pressure range and at 303 K, by a phosphonium levulinate-based porous ionic liquid.

FIGURE 2

KEYWORDS

porous liquids | separations | ionic liquids | gas capture and utilisation

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