Supplementary Material

CO_2 capture by Supported Ionic Liquid Phase (SILP): Highlighting the role of the particle size

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Table S 1: Isotherm models employed in the work

Isotherm Model	Equation	R^2 coefficient
Langmuir	$w_{CO_2} = \frac{IP_1 \cdot p_{CO_2}}{1 + IP_2 \cdot p_{CO_2}}$	0.86-0.87
Freundlich	$w_{CO_2} = IP_1 \cdot p_{CO_2}^{IP_2}$	0.95-0.97
Langmuir-Freundlich	$w_{CO_2} = \frac{IP_1 \cdot IP_2 \cdot p_{CO_2}^{IP_3} \cdot e^{IP_4/T}}{1 + IP_5 \cdot p_{CO_2}^{IP_3} \cdot e^{IP_6/T}}$	> 0.99

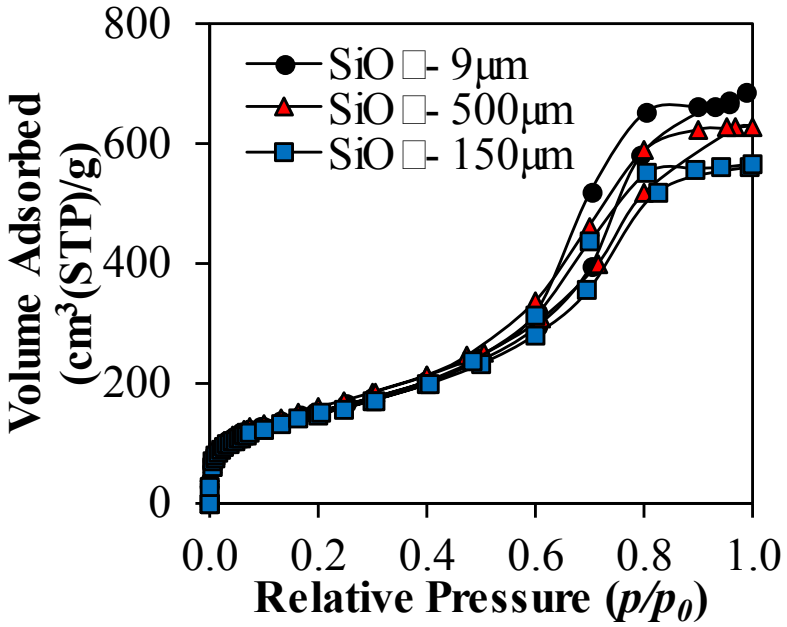

Figure S1: 77K N_2 adsorption/desorption isotherms of empty SiO_2 of three different sizes used in this work

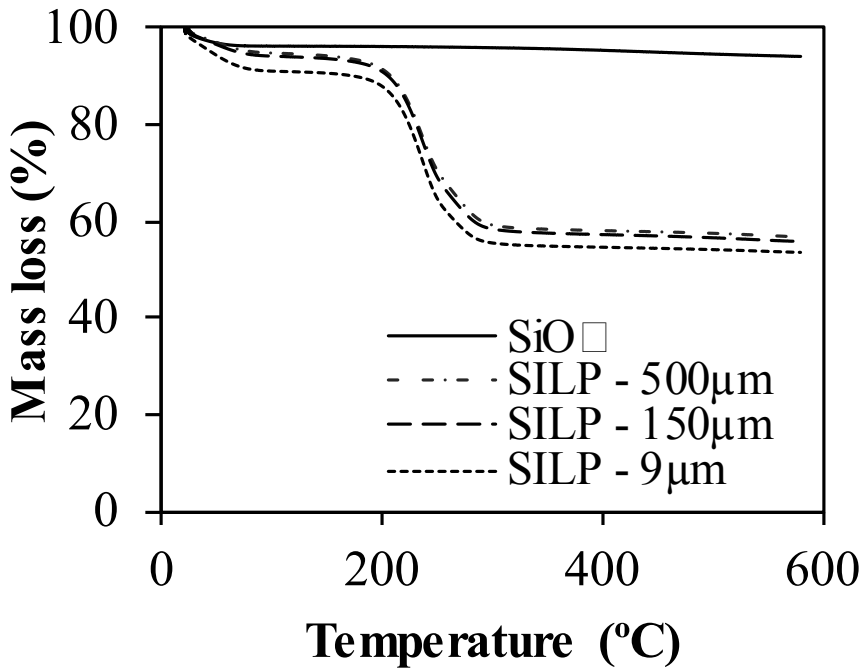

Figure S2: TGA analysis of empty silica (SiO_2) and SILP [bmim][acetate] of three different particle sizes (SILP 500 – 9 µm). Analysis carried out with a temperature increase of 10 ºC·min^{-1} under 50 mL·min^{-1} of N_2.

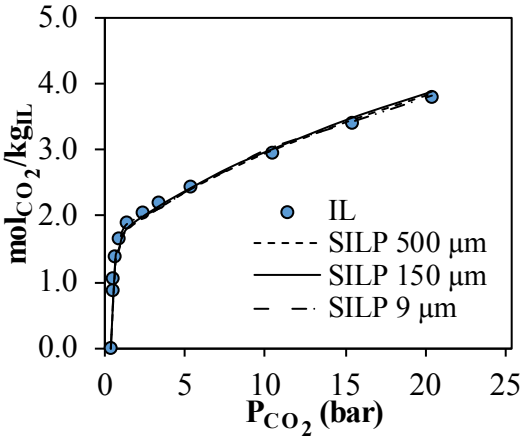

Figure S3: Comparison of CO_2 sorption isotherms on SILP of different particle sizes and on neat IL at 299 K.

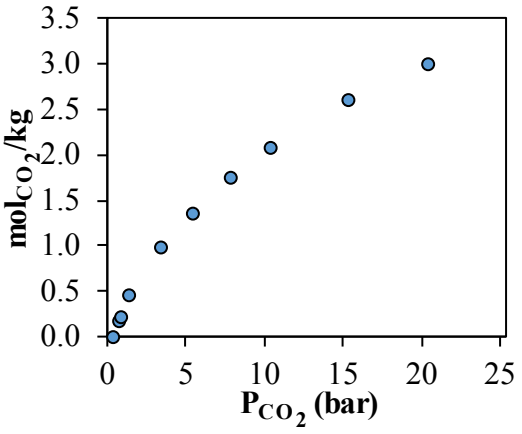

Figure S 4: CO_2 adsorption isotherm of empty SiO_2-500 µm.

Table S 2: Additional Aspen Adsorption input required to simulate in dynamic mode.

Bed characteristics	
Inter-particle porosity (m^3 void/m^3 bed)	0.5
Sorbent properties	
Intra-particle porosity (m^3 void/m^3 bed)	$1 \cdot 10^{-10}$
Sorbent solid bulk density (kg/m^3)	810
Sorbent particle radius (mm)	$2.5 \cdot 10^{-7}$-$1.0 \cdot 10^{-1}$

The inter-particle porosity was 0.5 in all cases due to the typical ranges in conventional adsorbents, such as zeolites or active carbons [1-3]. Moreover, the expected maximum inter-particle porosity considering spherical adsorbents is 0.6, so a value of 0.5 seems to be reasonably good for the estimations. The intra-particle porosity was $1 \cdot 10^{-10}$ because the pores of the SiO_2 particles are completely filled of IL (as demonstrated with the textural analysis by means of 77 K N_2 adsorption/desorption isotherms). In Aspen Adsorption, the solid bulk density is referred to the bed apparent density [1], which was experimentally calculated from the experimental fixed-bed tested. The sorbent particle radius was varied from 0.5 – 1000 μm.

References

1. Bhatt, T.S., et al., *Experimental and Modeling Analysis of Dual-Reflux Pressure Swing Adsorption Process.* Industrial & Engineering Chemistry Research, 2014. **53**(34): p. 13448-13458.
2. Webley, P.A., et al., *A New Multi-bed Vacuum Swing Adsorption Cycle for CO2 Capture from Flue Gas Streams.* Energy Procedia, 2017. **114**: p. 2467-2480.
3. Hauchhum, S., P. Mahanta, and J. De Wilde, *Capture of CO2 from Flue Gas onto Coconut Fibre-Based Activated Carbon and Zeolites in a Fixed Bed*. Vol. 110. 2015.