Ecole d'ingénieurs et d'architectes de Fribourg
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Ionic liquids for CO_2 capture

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Research Topic

CO_2 Capture

Keywords

Ionic liquid, amino acid, CO_2 capture, chemisorption, TGA/DSC 1

Figure 1 : *Picture of a TGA/DSC 1 from Mettler-Toledo*

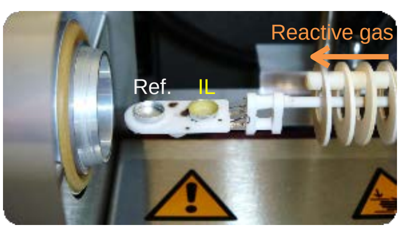

Figure 2 : *Picture of the sensor of the TGA/DSC 1 with the reference and the IL containing pans*

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Context

The level of CO_2 in the atmosphere is rising dramatically leading to an increase of average temperatures on Earth. Thus, solutions to reduce the emissions of this greenhouse gas have to be found.
Ionic liquids (ILs) are efficient media for the capture of carbon dioxide. Their negligible vapor pressure and their stability offer a strong advantage compared to the amine solutions currently used in the flue gas treatment industry.
The use of ILs ensures no contamination of the treated gas as well as no loss of the ILs by evaporation. Moreover, by tuning their anion and cation one is able to design their physical and chemical properties such as corrosivity, viscosity and above all their CO_2 absorption capacity. Chemisorption of CO_2 is observed when the IL is functionalized.
We are studying the CO_2 absorption capacity of novel ILs.

Methodology

A TGA/DSC 1 from Mettler-Toledo AG (Fig. 1) was used for the experiments. The ionic liquid is applied as a thin layer in an aluminium pan (aluminium standard 40µL from Perkin Elmer, Fig. 2).
First, after loading, the sample is purged with N_2 for 6 hours at 60ml/min at the analysis temperature and atmospheric pressure. Then the reactive gas is switched from N_2 to CO_2 25 mL/min and the analysis is carried on for 36 hours.
The protective gas is N_2 at 12 mL/min. It is required to ensure a complete stability of the system before the experiments and a blank curve is run to evaluate the impact of the buoyancy effect of the gas.

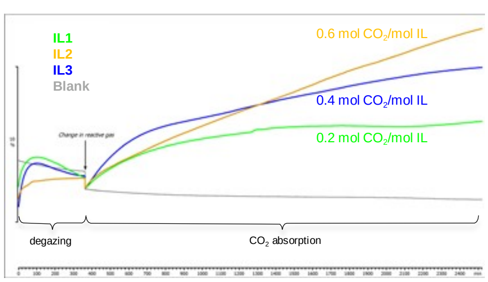

Figure 3 : *TGA curves of three ionic liquids and blank curve.*

Results

The CO_2 absorption capacity of three different ILs has been investigated (Fig. 3). IL1 , IL2 and IL3 are different either in terms of cation or anion. The equilibrium was not reached during the time of analysis so the capacity obtained offers only a first insight into the ability of those ILs to absorb CO_2.
In addition, the absorption capacity of IL3 has been measured at three different temperatures (Fig. 4). As the temperature increases, the initial rate of absorption increases, but an equilibrium between absorption and desorption process is reached at 80°C which means that the absorption must be run at a lower temperature.

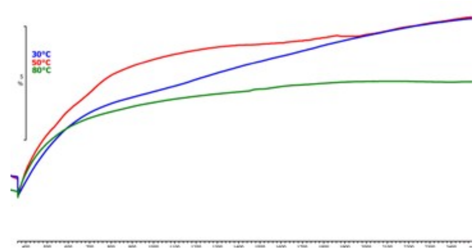

Figure 4 : *Capture of CO_2 by IL3 at 30°C (blue curve), 50°C (red curve) and 80°C (green curve); graph showing the evolution of mass after 6 hours of analysis (switch to CO_2)*

Conclusion

We developed a simple method to evaluate the CO_2 absorption capacity of ionic liquids by thermogravimetric analysis (TGA). This is a cheap and easy way to screen ILs and allows to evaluate the kinetics of absorption. Moreover, only a few miligrams of material are required to run an experiment. The limiting issue is the long analysis time.
By minimal manipulations one is able to perform absorption – desorption cycles to investigate the recyclability of the IL.
It would even be possible to extract the calorimetric data thanks to the DSC sensor of the TGA/DSC 1.

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