Amine-modified Carbon Aerogels for CO_2 Capture†

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Abstract: Ten different amines of different molar mass and structure were deposited from aqueous and methanolic solutions of different concentrations onto two types of carbon aerogel. Thermogravimetric analysis (TGA) was used to quantify the loading, thermal stability and CO_2 capture capacity of the materials. Our results show that the amount of amine deposited did not depend on the solvent used, but was generally greater from more concentrated solutions, and increased with increasing molar mass. Deposition of amines was principally achieved by adsorption onto the mesopore walls, but without complete pore filling, and also, in some cases, by adsorption in the aerogel micropores. It was also concluded that the thermal stability of the amines deposited on the walls of the mesopores was independent of the solvent used, concentration or aerogel type. Preliminary studies of CO_2 adsorption–desorption were carried out and a good correlation between $\ln(C_n)$ and 1/T, where C_n is the capacity at temperature T, was found. This enabled direct comparison to be made with published results obtained at different temperatures, and it was found that those obtained in this work were highly comparable with others found for amine-impregnated porous materials with similar amine loadings.

INTRODUCTION

Currently, the most widely used process for capturing CO_2 from flue gases involves post-combustion wet-scrubbing with aqueous amine solutions. Some of the disadvantages of this process are toxicity, strong odour and corrosiveness of liquid amines as well as the difficulty of recycling. With the objective of overcoming such problems there has been an increasing interest in the development of solid adsorbents that can be used in alternative CO_2 capture and separation processes and a number of significant reviews have been published in the last few years (Choi *et al*. 2009; D'Alessandro *et al*. 2010; Hedin *et al*. 2010). One common strategy has been to deposit amines on high surface area porous carbons (Zinnen *et al*. 1989; Liang *et al*. 1995; Aroua *et al*. 2008; Nabais *et al*. 2008; Grondein and Bélanger 2011; Khalil *et al*. 2012) or onto other porous solids (Xu *et al*. 2002; Zhang *et al*. 2005; Gray *et al*. 2008; Zelenak *et al*. 2008; Chatti *et al*. 2009; Mello *et al*. 2011; Aziz *et al*. 2012). In our work, we have used carbon aerogels as the solid adsorbent because they are monolithic and have a high surface area contained within a uniform and controllable mesopore structure. Our aim was to compare a range of amines of different molar mass and structure and to establish the level of deposition from different solutions, in order to evaluate the thermal stability of the deposited amines and to obtain a preliminary evaluation of the performance of the materials for adsorption and subsequent desorption of CO_2.

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