Pillared amino-modified magadiite: The effect on CO$_2$ adsorption capacity

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Abstract: CTA-magadiite pillarization results in a porous material whose structure and morphology are dependent on the reaction media and are also reflected on CO$_2$ adsorption capacity.

Key words: Magadiite, pillarization, adsorption.

Introduction

The pillarization process (PC) in the crystalline structure of magadiite (phylosilicate) builds a continuous network of pores with controlled pore size and distribution. The subsequent functionalization and insertion of the pending amino group (APTS) on pillar CTA-magadiite creates sites capable of absorbing CO$_2$ at room temperature.

The objective of this paper is to investigate the best pillarizing procedure, acidic or alkaline, which produce a large surface area solid with increased gas adsorption capacity.

Results and Discussion

The studies of pillarization procedure at acid (PC-CTA-magadiite (A)) and alkaline media (PC-CTA-magadiite(B)) in direct synthesis CTA-magadiite was made to observe variations in structure and morphological characteristics of the obtained materials. The type of hydrolysis of the pillarizing agent (TEOS) reflects on the materials characteristics and its BET area, as seen in Table 1.

The changes in porous properties with the pillarizing reaction (APT-CTA-magadiite (B) and (A)), indicates that the addition of APTS during pillarization caused the decrease in pore sizes. (Figure 1)

Table 1. BET$^*$ and DFT$^\#$ analysis of porous materials.

<table>
<thead>
<tr>
<th>Sample</th>
<th>$S_{BET}$ $^{**}$ m$^2$/g</th>
<th>$D_p$ $^{**}$ nm</th>
<th>$V_p$ $^{**}$ cm$^3$/g</th>
<th>$C_{ap}$ $^{**}$ mmol g$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC-CTA-magadiite (B)</td>
<td>602</td>
<td>4.89</td>
<td>1.1</td>
<td>-</td>
</tr>
<tr>
<td>PC-CTA-magadiite (A)</td>
<td>673</td>
<td>1.06</td>
<td>0.40</td>
<td>-</td>
</tr>
<tr>
<td>APT-CTA-magadiite (A)</td>
<td>114</td>
<td>55.9</td>
<td>0.75</td>
<td>1.78</td>
</tr>
<tr>
<td>APT-CTA-magadiite (B)</td>
<td>121</td>
<td>16.7</td>
<td>0.71</td>
<td>3.87</td>
</tr>
</tbody>
</table>

$^*$ surface area, $^\#$ pore diameter, $^{**}$ pore volume, $^{**}$ adsorption capacity

Figure 1: N$_2$ adsorption/desorption isotherms.

The termoprogrammed desorption studies (TPD) on Figure 2, show large difference on gas adsorption capacity. The APT-CTA-magadiite (B) is approximately 217 % more capable of CO$_2$ adsorption than APT-CTA-magadiite (A).

Figure 2: CO$_2$ desorption study (TPD) at 50°C.

Conclusions

Both APTS-modified and pillared CTA-magadiite adsorb CO$_2$; the hydrolysis procedure controls the CO$_2$ adsorption capacity. In spite of their different characteristics, the APT-CTA-magadiite (B) is the most effective for the purpose of the present study.

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