Synthesis of PEI Loaded Mesoporous Materials

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Introduction

본 연구에서는 다공성 메조포어 실리카 내부에 PEI (Polyethyleneimine) 을 함침시킨 CO_2 흡착제를 제조하고, 합성한 물질의 물성분석을 수행한 다음, Thermo gravimetry를 이용하여 CO_2 흡착용량을 측정하였다.

다양한 세공구조의 메조포어 실리카를 지지체로 활용하였으며, 3차원의 확장된 세공을 지니는 메조포어 실리카를 이용하여 기존 문헌의 결과보다 향상된 흡착결과를 얻을 수 있었다.

Synthesis procedure

(1) Principle of Impregnation

(a) Basic principle

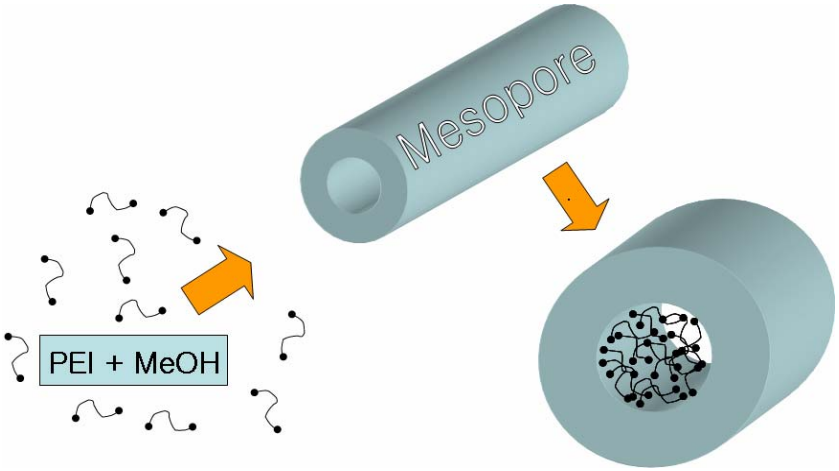


Figure 1. The basic principle of PEI (polyethylen-eimine) loading due to concentration gradient of polymer

(b) Concept about Channels

(i) 2-D Channel

(ii) 3-D Channel

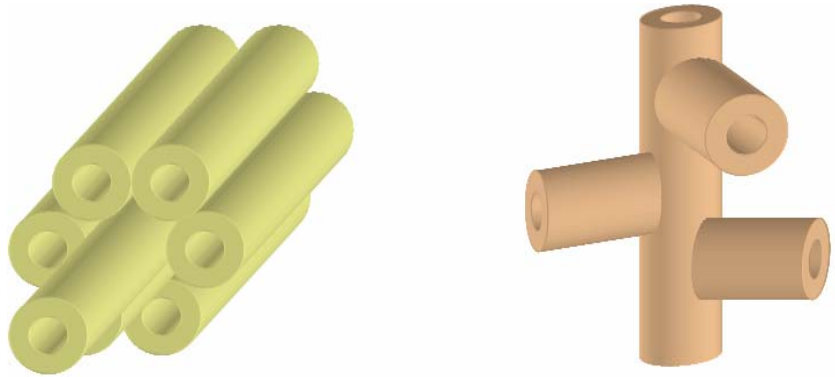
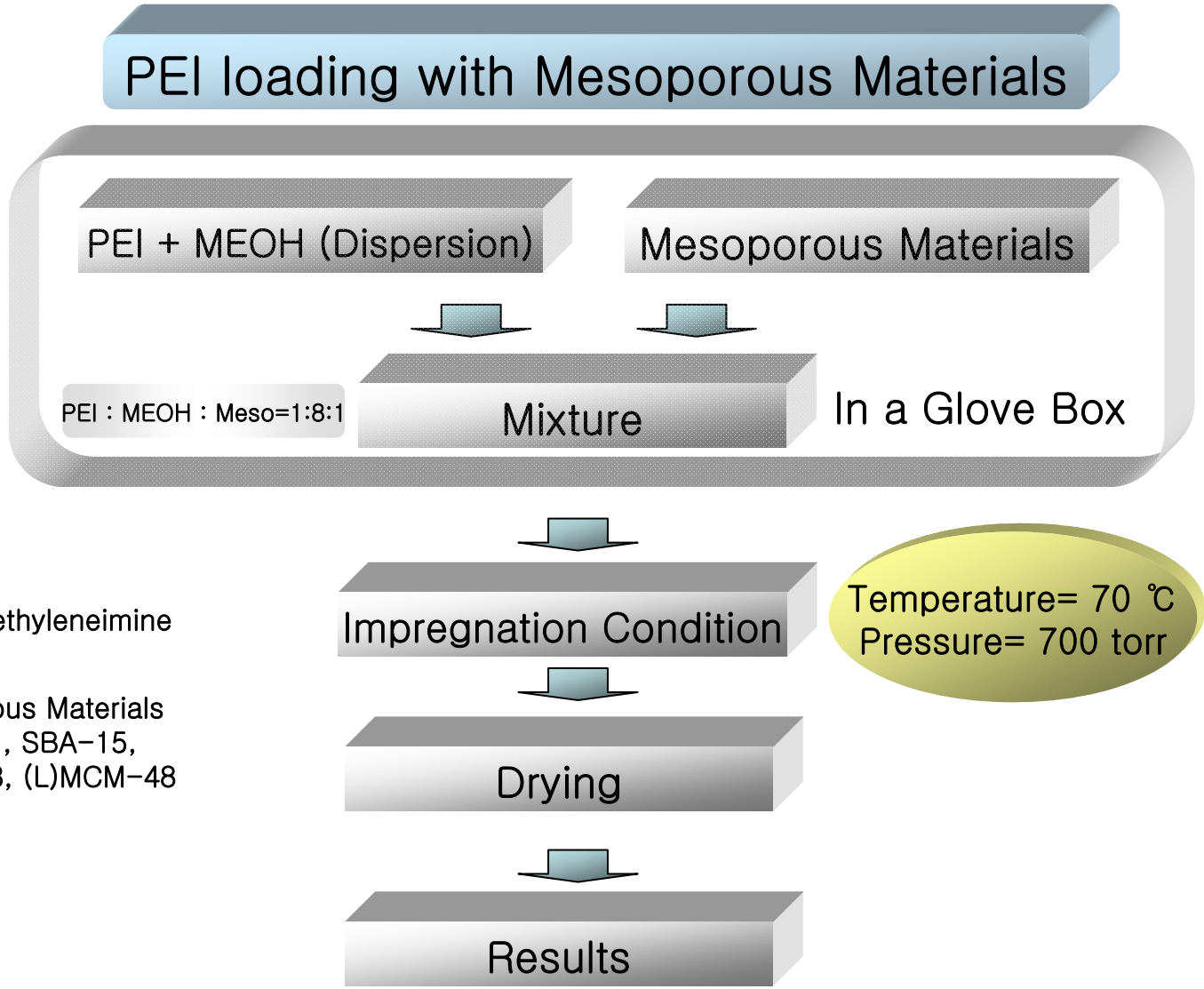


Figure 2. 2-D channel and 3-D channel using supporters (i)MCM-41,SBA-15 (ii)MCM-48, Large pore MCM-48

Synthesis Procedure



*PEI=Polyethyleneimine

*Mesoporous Materials
= MCM-41, SBA-15,
MCM-48, (L)MCM-48

Results and Discussion

* X-Ray Diffraction

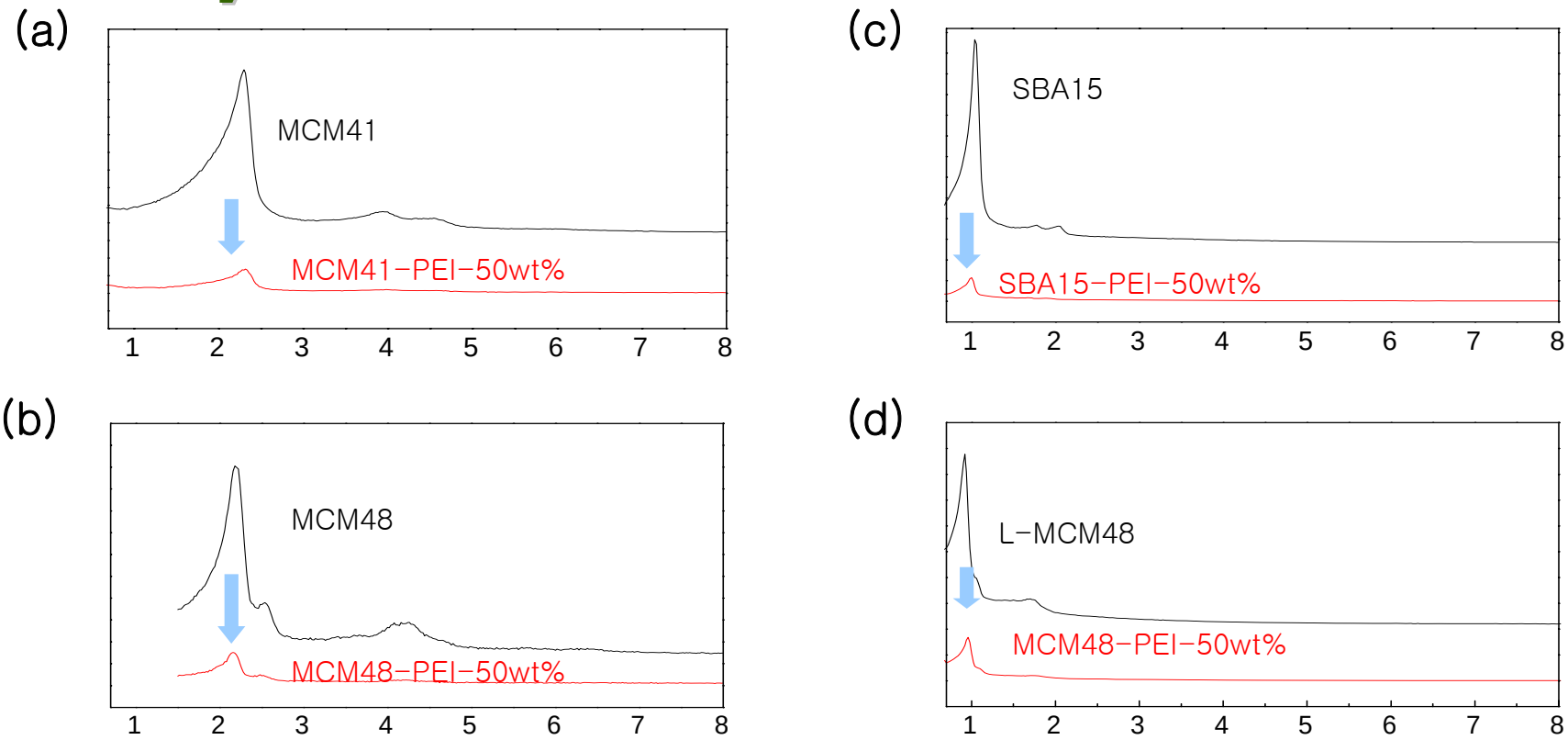


Figure 3. (a) PEI loading with MCM41, (b) PEI loading with SBA15, (c) PEI loading with MCM48, (d) PEI loading with L-MCM48

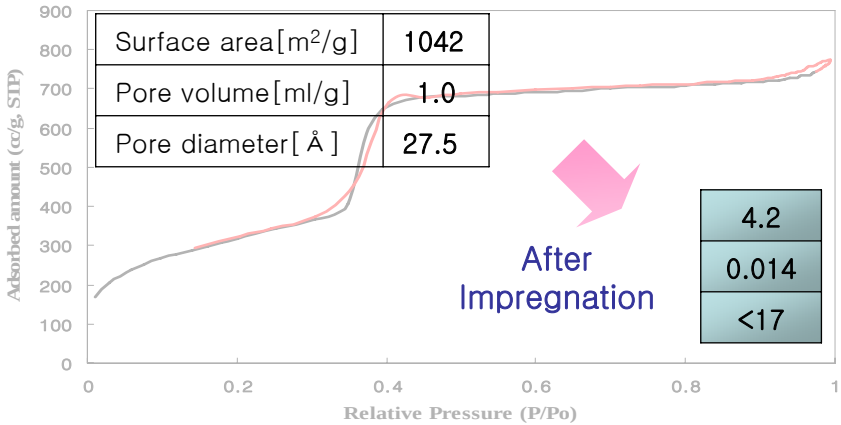
*When you compare each picture, you can find the common thing.

-That is decrease of intensity after PEI loading.

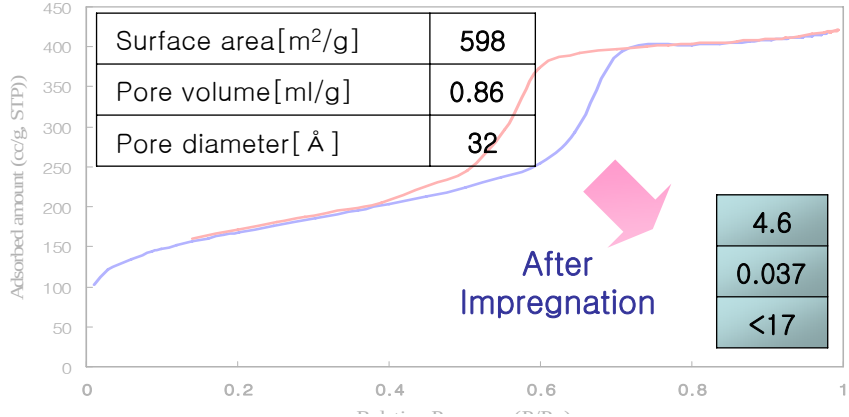
-It means that PEI goes into pores due to concentration gradient of it

Results and Discussion

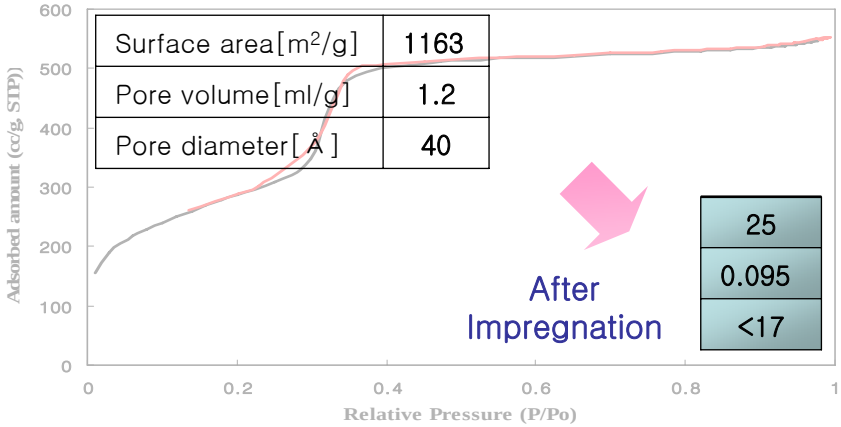
*N_2 adsorption/desorption isotherms



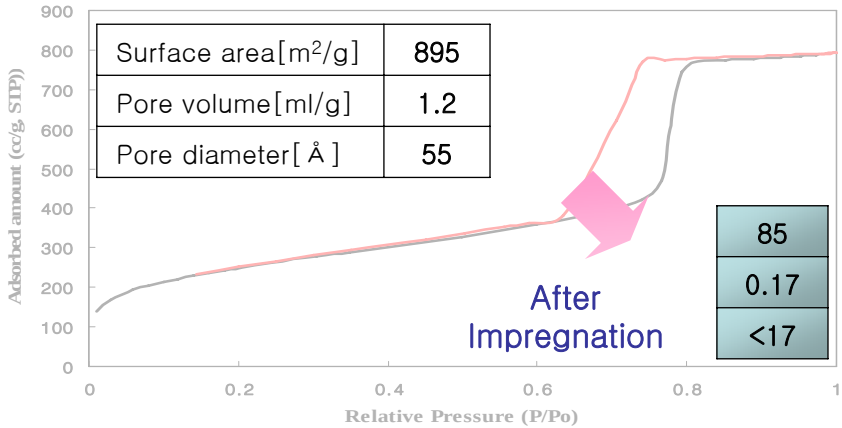
(a) MCM41 & MCM41-PEI 50wt%



(b) SBA15 & SBA15-PEI 50wt%



(c) MCM48 & MCM48-PEI 50wt%



(d) L-MCM48 & L-MCM48-PEI 50wt%

* There is still 15% pore volume of L-MCM48.

Results and Discussion

*CO_2 Adsorption / Desorption

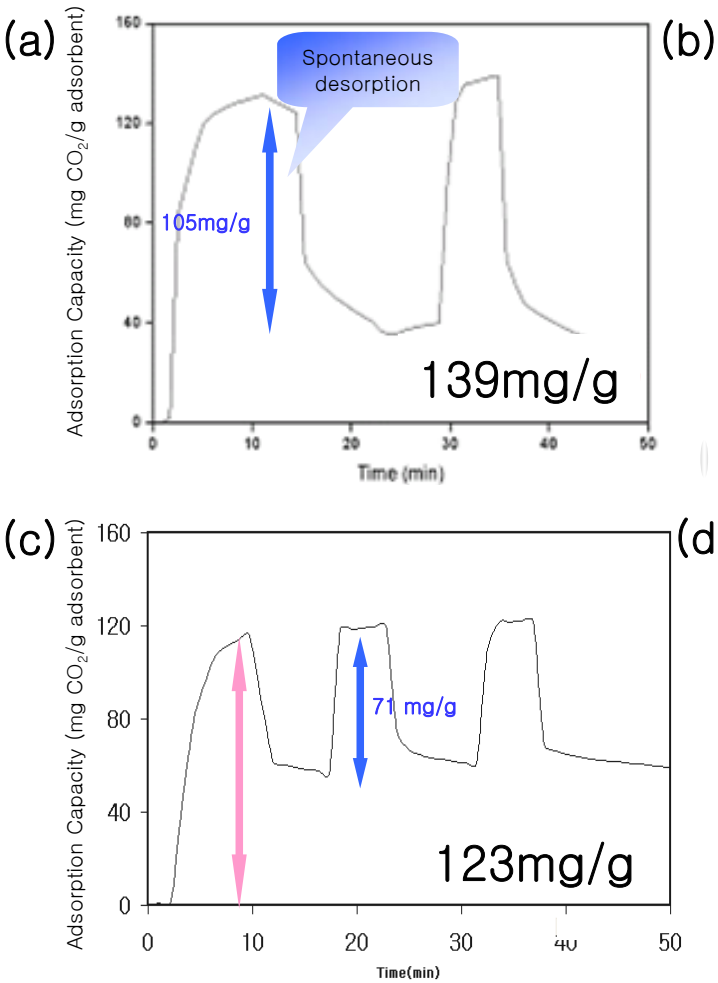


Figure 5. (75℃ adsorption/75℃desoprtion)
(a)MCM41-PEI loaded 50wt%,
(b)SBA15-PEIloaded 50wt%,
(c)MCM48-PEI loaded 50wt%,
(d)L-MCM48-PEI loaded 50wt%
and the highest capacity of each sample using TGA-DT

★The highest adsorption capacity is about 120~150 (mg/g adsorbent). The capacity of samples were similar because the quantity of PEI were same every experiment.
Comparing these samples with pure PEI and the original mesoporous materials, we know the capacity is about 2 times and 30 times.

Results and Discussion

*Thermal Gravimetric Analysis (TGA)

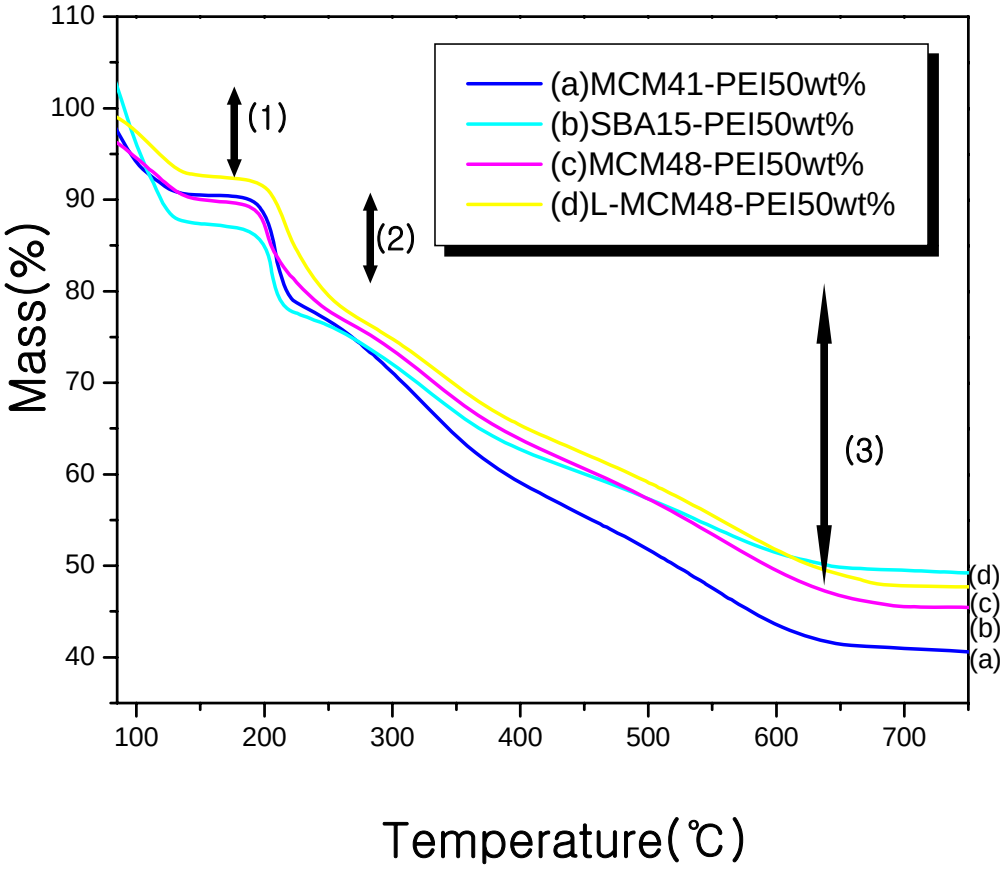


Figure 6. Thermal Gravimetric Analysis

(1)Due to water or other gases.

(2)Due to PEI loaded around out side of pores.

(3)Due to PEI loaded in pores.

Results and Discussion

* Comparing Mesoporous PEI Material with other CO_2 adsorbents

Materials	CO_2 Adsorption Capacity [mg/g adsorbent]
Si-MCM41	8.6[Ref.]
Al-MCM41-100	7.6[Ref.]
Pure PEI(50wt%)	54 [Ref.]
MCM41-PEI50wt%	139
SBA15-PEI50wt%	135
MCM48-PEI50wt%	123
(L)MCM-PEI50wt%	149
AMS	112

Table1.Comparison another CO_2 adsorbents

Conclusions

(1)Molecular baskets (mesoporous silica + PEI) have high CO_2 adsorption capacity.

(2)Adsorption capacity is depended on pore volumes, pore diameter and surface area.

(3)The most critical issue is to put PEI into mesopores in order to make molecular basket.

(4)They have high CO_2 adsorption (/desorption) capacity at 75℃ and they
can be used as a gas adsorbents.

If we can apply mesoporous materials having large pore volume and pore diameter, it is possible to further improve the adsorption capacity.