One-pot synthesis of HKUST-1 monolith for CO_2 adsorption

CO_2吸着用 HKUST-1 モノリスのワンポット合成

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1. Introduction

Metal-organic-framework (MOF) is drawn attention as CO_2 adsorbent. Shape forming technology for powdery MOF is required in order to generate objects of millimetric dimensions with enough mechanical resistance for application in industry[1]. In this study, alumina tube and Cu cube were used as the metal source for MOF preparation and a part of them was directly converted into MOF monoliths. The preparation method of MOF monolith and its adsorption property were investigated.

2. Experimental

Two types of monoliths containing MOFs, HKUST-1 and MIL-96, were prepared. HNO_3, trimesic acid (TMA), and porous α-alumina tube were used as raw materials for MIL-96 preparation. Porous Cu cube was used for HKUST-1 preparation instead of α-alumina tube. Either alumina tube or Cu cube was placed into the aqueous solution of HNO_3 and TMA, and then hydrothermally treated by using glass-lined autoclave. The effect of these preparation conditions on the preparation of MOF monolith was studied.

MIL-96 powder was synthesized according to the literature[2] as reference material. HKUST-1 powder (Basolite C-300) was purchased from Sigma-aldrich.

CO_2 adsorption properties of prepared MOF powder and monoliths were measured by volumetric adsorption method (Belsorp-MAX, microtracBEL).

3. Results and discussion

The concentrations of HNO_3 and TMA and the conditions of hydrothermal treatment were widely changed. By the optimization of synthesis conditions, the contents of MIL-96 and HKUST-1 in monoliths increased up to 6.0 and 32 wt%, respectively.

Fig. 1 shows the morphological features of raw materials of metal sources and monoliths synthesized. The surface of alumina tube was fully covered with MIL-96 crystals and the color of alumina tube changed to yellow. The surface of Cu cube was converted to HKUST-1 as well.

Fig. 2 shows the isotherms of CO_2 on MIL-96 and HKUST-1 monoliths and powders at 298 K. The adsorbed amount of CO_2 at 100 kPa on MIL-96 monoliths and powder were 140 and 95 cm^3(STP) g^{-1}, respectively. HKUST-1 powder and monolith showed almost the same values of the CO_2 adsorbed amount, 99 cm^3(STP) g^{-1}.

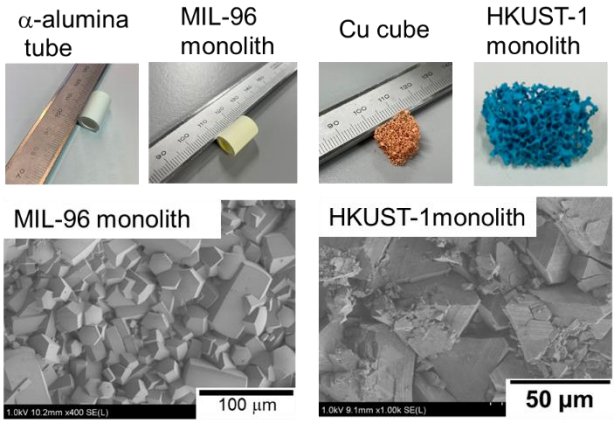

Fig. 1 Typical photo and FE-SEM images of α-alumina, MIL-96 monolith, Cu cube and HKUST-1 monolith.

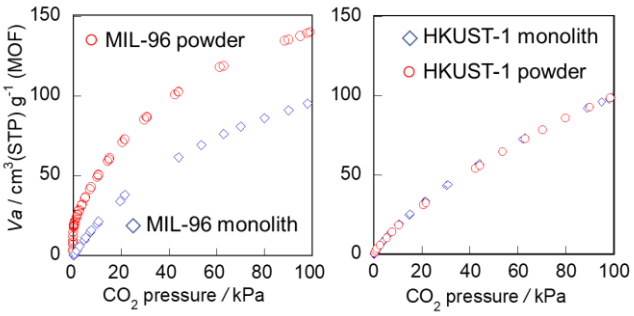

Fig. 2 CO_2 isotherms on MIL-96 and HKUST-1 at 298 K.

References

1) Bazer-Bachi, D., *et al., Powder Technol.*, **255** (2014) 52-29.
2) Benoit, V. *et al., J. Mater. Chem. A*, **6** (2018) 2081-2090.

