Application Note B-TA1043

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B-TA1043 - Evaluation of CO_2 adsorption below ambient temperature by low-temperature STA

Introduction

Gas adsorption on a substance varies with temperature. Since the amount of adsorption generally increases at lower temperatures, it is desirable to evaluate the amount of adsorption up to a temperature range below room temperature. In this study, low-temperature STA was used to measure the amount of CO_2 adsorbed on HKUST-1, MOF (metal-organic structures), below room temperatures to evaluate CO_2 adsorption versus temperature.

Measurement and analysis example

The results of the low-temperature STA for sample HKUST-1 are shown in Figure 1. The STA equipped with a refrigerated cooling unit allows cooling down to -40°C and heating program measurements. The sample was pretreated by heating to 180°C in helium atmosphere, and then was cooled down to -40°C. The atmosphere was then switched to CO2 at each target temperature, and the amount of CO2 gas adsorbed by the samples was measured. The CO2 adsorption temperatures were kept at -29°C, -4°C, 12°C, and 23°C. After measuring the amount of adsorption at each temperature, the sample was reheated up to 180°C in helium atmosphere each time.

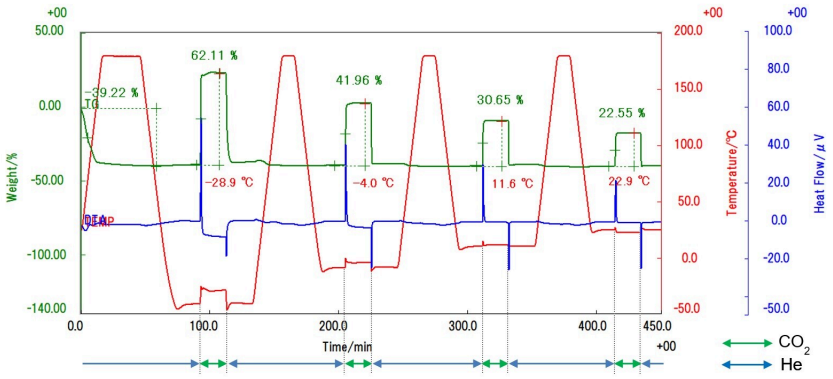

Figure 1: Results of low temperature STA measurement of HKUST-1

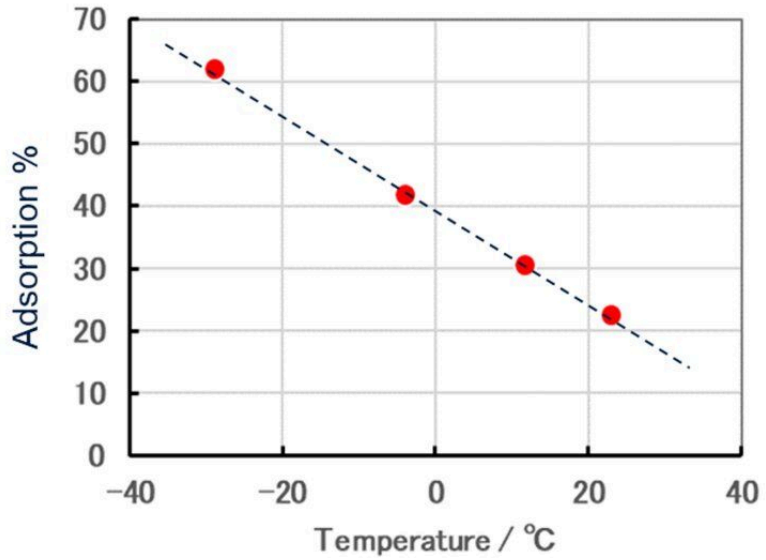

Figure 2: Plot of temperature vs. adsorption amount

The results of STA show a 40% mass loss during the first heating process. After cooling down and changing the atmosphere to CO_2 at -29°C, a 62% mass increase due to CO_2 gas adsorption is observed. Similarly, at -4°C, 42%, at 12°C, 31%, and at 23°C, 23% of CO_2 gas adsorption is observed, respectively. Figure 2 shows a plot of adsorption versus temperature obtained from a series of measurements. Thus, the low-temperature STA makes it possible to evaluate the temperature dependence of the adsorption properties of materials in the temperature range below room temperature.

Recommended equipment and software

► STA8122 + refrigerated cooling unit
► Vullios measurement and analysis software

(Samples provided by Prof R. Matsuda and Prof S. Kusaka, Nagoya University)