Adsorption and desorption of CO$_2$ on active coal

Introduction
Capture of carbon dioxide from fossil fuel power plants via adsorption and sequestration of carbon dioxide in unmineable coal seams are achievable near-term methods of the reducing atmospheric emissions of this greenhouse gas. The evaluation of CO$_2$ adsorption and desorption characteristics on finely crushed and uncrushed samples is critical for CO$_2$ sequestration in coal beds.

The TG-DSC technique is the ideal tool for such investigations:
- the thermogravimetric signal provides the amount of CO$_2$ adsorbed or desorbed on the coal sample
- the DSC signal measures the corresponding enthalpy: exothermic during adsorption (that means an increase of the temperature during the sequestration process) or endothermic during the desorption (that means cooling of the coal material)

Experimental
Sample: active coal
Mass: 29.1 mg
Temperature range: -50 °C to 50 °C
Atmosphere: CO$_2$

Results and conclusions
The sample of active coal is cooled down from 50 °C to -50 °C, then maintained at -50 °C during more than one hour before reheated at 50 °C under pure CO$_2$.
The TG curve shows the mass increase of the sample corresponding to the CO$_2$ adsorption. The saturation of the sample is obtained during the isothermal step at -50 °C.
When heating the mass loss on the TG curve indicates the CO$_2$ desorption. It is noticed that the desorption is not complete.
The DTG curves give an information on the rate of CO$_2$ adsorption and desorption.
On the DSC curve, the CO$_2$ adsorption corresponds to an exothermic effect and the desorption to an endothermic effect.
With such a TG-DSC experiment, it is possible to determine the corresponding enthalpies of adsorption or desorption versus the amount of CO$_2$ adsorbed or desorbed on the sample.