

# Sorption and swelling of coal under unconstrained conditions

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## Introduction

The adsorption capability of coal to different gasses and the induced swelling are fundamental input parameters for coal seam gas reservoir simulation.

The sorption capacity of coal is usually measured by the volume method, pressure method or gravity method, where coal is normally crushed into powders. Parameters such as the Langmuir pressure constant and volume are obtained by fitting the adsorption curves. The measurement of corresponding deformation of coal is not very common.

In this work, a specially designed sample cell was fitted to the Quantachrome's high pressure gas adsorption system (20MPa maximum pressure) to measure the adsorption capacity of a bituminous coal under different pressures. At the same time the system captured the volumetric strain of coal during the adsorption process using three strain gauge TDS-150 (Figure 1). Four pressure values were tested, rising from 1 MPa to 7 MPa with an increment of 2 MPa. Nitrogen and helium gasses were used to conduct the work, and the injection sequence was explained in Figure 2.

The facility offers a reliable experimental capability for direct measurements of both isothermal curves and sorption-induced strain - important inputs for reservoir modelling.

## Experimental apparatus

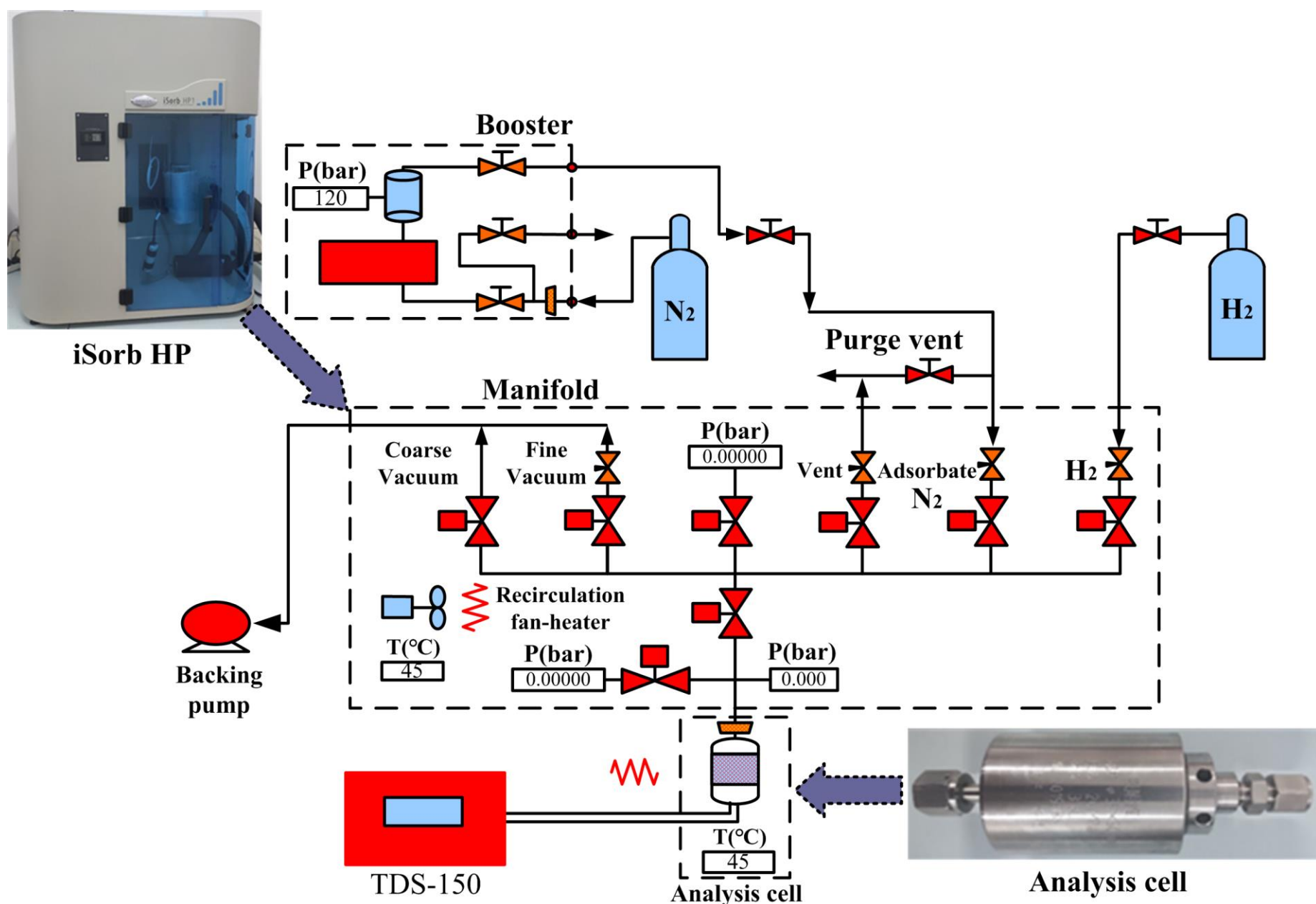


Figure 1: Experimental apparatus

## Results

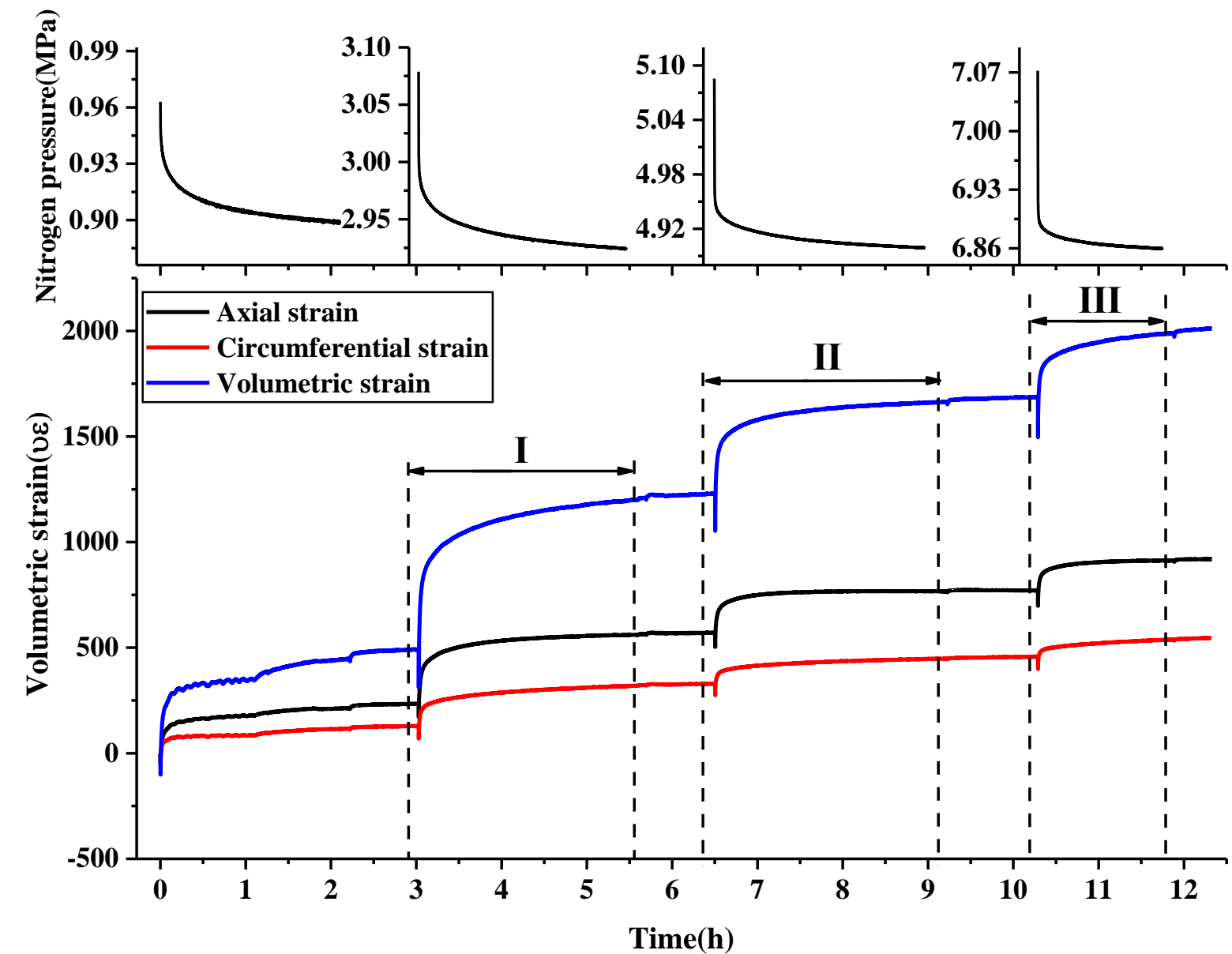


Figure 2: Pressure and volumetric strain evolution

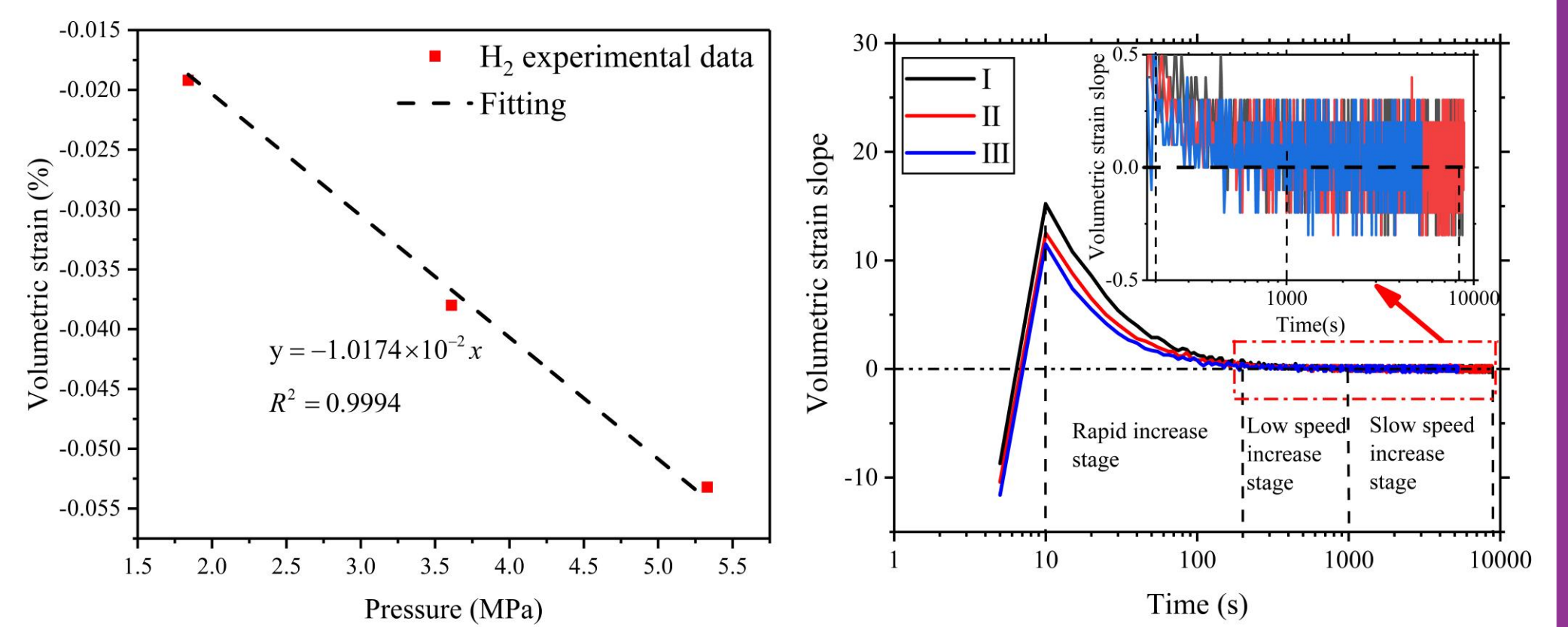


Figure 3: Volumetric response to helium (left) and nitrogen injection

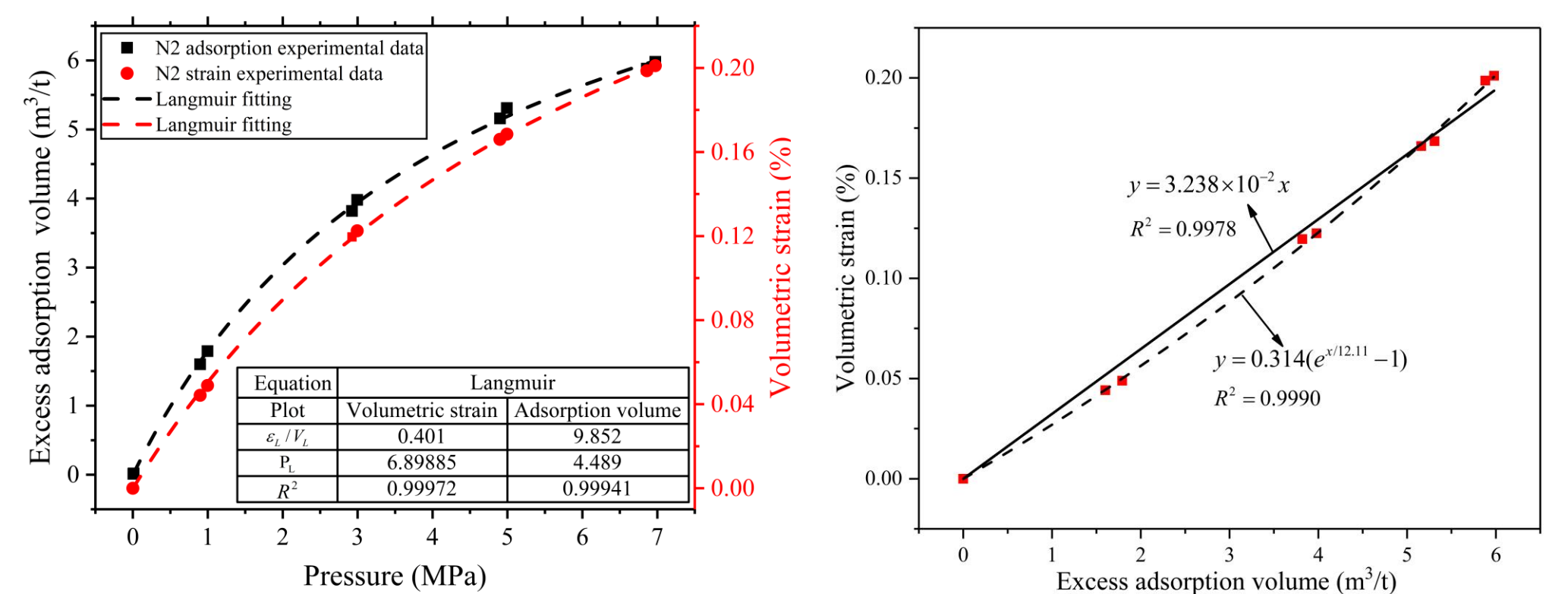


Figure 4: Langmuir isothermal and swelling measurement during nitrogen adsorption

The helium injection results show that volumetric strain increases linearly with pore pressure, which gives a coal buck modulus of 9.8 GPa (Figure 3).

The nitrogen injection results show that (a) coal swelling follows approximately a linear relationship with excess adsorption volume (Figure 4): every cubic meter increase in gas adsorption causes 0.0324% strain increase, and (b) for each step, coal clearly experiences three stages: instant compaction, rapid rebound due to cleat pressure increase, and slow rebound due to gas diffusion (Figure 3).

## References

- Quantachrome Instruments, "high pressure gas sorption system operating manual", 2012.
- Clarkson C R, Bustin R M. The effect of pore structure and gas pressure upon the transport properties of coal: a laboratory and modeling study. 2. Adsorption rate modeling[J]. Fuel, 1999, 78(11):1345-1362.