High-Resolution Micropore Characterization of Activated Carbon Using Nitrogen Adsorption on the Matrix 1000

Introduction

Activated carbon is widely used in adsorption, catalysis, and purification due to its extensive micropore structure (pores < 2 nm). Accurate characterization of these pores is critical for optimizing material performance. The Matrix 1000 gas sorption analyzer, developed by Advanced Measurement Instruments, enables high-resolution micropore analysis through nitrogen (N_2) adsorption at 77 K. This application note demonstrates the Matrix 1000's ability to perform simultaneous, high-throughput micropore characterization across four independent stations, delivering exceptional resolution and repeatability at low relative pressures (down to 10^{-8} P/P_0).

Experimental Setup

Sample Preparation

A commercially available activated carbon with well-characterized micropore properties was used. Samples were degassed under vacuum at 573 K for 10 hours to remove adsorbed species, ensuring accurate measurement of the intrinsic pore structure.

Instrument Configuration

The Matrix 1000 was configured with four independent analysis ports, each equipped with 1000, 10, and 0.1 Torr transducers to capture low-pressure adsorption data. Full adsorption/desorption isotherms were collected at 77 K with relative pressures ranging from 10^{-8} to 1 P/P_0. Data analysis included BET surface area, total pore volume, micropore volume, and pore size distribution, primarily using the Horvath-Kawazoe (HK) method.

Results and Discussion

Surface Area and Pore Volume

The Matrix 1000 analyzed four identical samples across its stations. The table below summarizes the BET surface area, total pore volume, HK micropore volume, and median pore diameter, along with their relative standard deviations (RSD%) to assess station-to-station repeatability.

	Station 1	Station 2	Station 3	Station 4
BET Surface Area (m^2/g)				
Mean	1907.56	1914.82	1917.18	1906.30
RSD%	0.14	0.31	0.05	0.10

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Total Pore Volume (cm³/g)				
Mean	0.905	0.910	0.910	0.909
RSD%	0.42	0.22	0.17	0.17
HK Micropore Volume (cm³/g)				
Mean	0.777	0.780	0.780	0.776
RSD%	0.27	0.27	0.07	0.07
HK Median Pore Diameter (nm)				
Mean	0.687	0.683	0.681	0.685
RSD%	0.34	0.17	0.00	0.08

Table 1: Summarized Data on the Matrix

The low RSD% values (0.05–0.42%) across all metrics indicate excellent station-to-station repeatability, highlighting the Matrix 1000's sensor stability and precise vacuum control. The BET surface areas (~1906–1917 m²/g) and micropore volumes (~0.776–0.780 cm³/g) are consistent with activated carbon properties, confirming the system's accuracy.

Adsorption/Desorption Isotherms

The overlaid N_2 adsorption/desorption isotherms for all four stations (Figure 1) show tight overlap, demonstrating consistent performance across ports. The isotherms exhibit clear Type I behavior, indicative of micropore dominance.

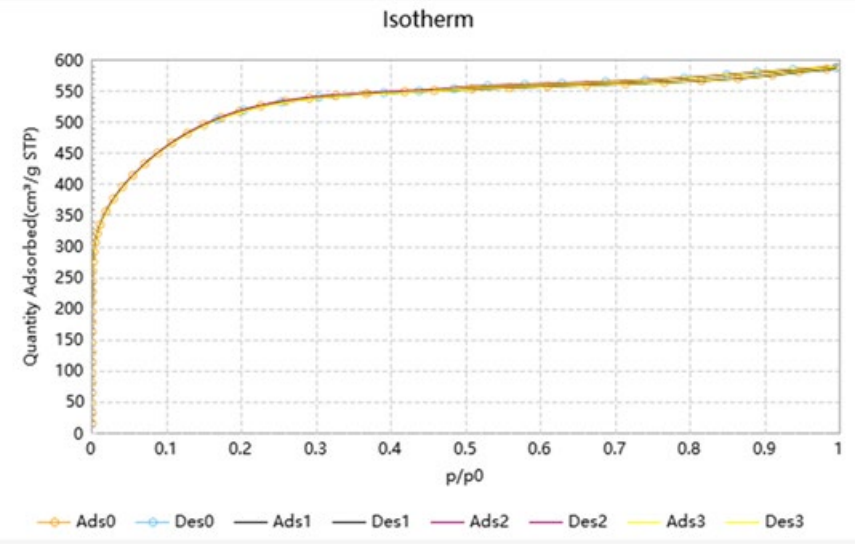

Figure 1: Isotherm overlay of the 4-station Matrix

Pore Size Distribution

The HK-derived pore size distribution curves (Figure 2) are nearly identical across stations, with a

median pore diameter of ~0.681–0.687 nm, confirming the Matrix 1000's ability to resolve micropore structures (< 2 nm).

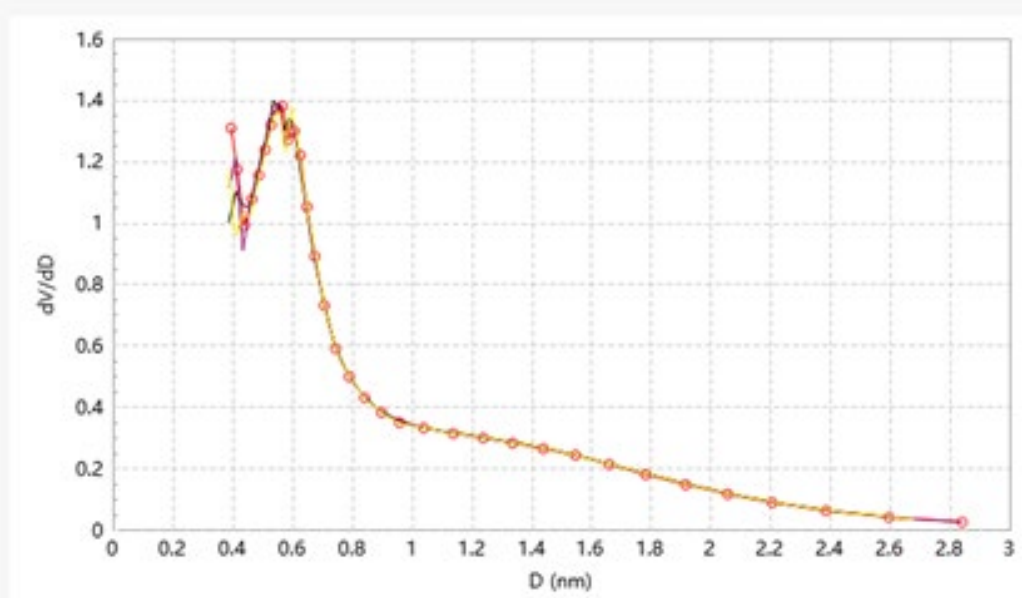

Figure 2: Pore size distribution overlay on the Matrix

Conclusions

The Matrix 1000 gas sorption analyzer excels in high-resolution micropore characterization of activated carbon. Key findings include:

- **High Throughput**: Simultaneous analysis on four stations without compromising data quality.
- **Superior Resolution**: Precise measurements at low relative pressures (10^{-8} P/P_0) enable detailed micropore analysis.
- **Excellent Repeatability**: Low RSD% (0.05–0.42%) across BET surface area, pore volume, and micropore metrics.

The Matrix 1000 combines affordability, throughput, and resolution, making it an ideal tool for researchers and industries requiring accurate micropore characterization.