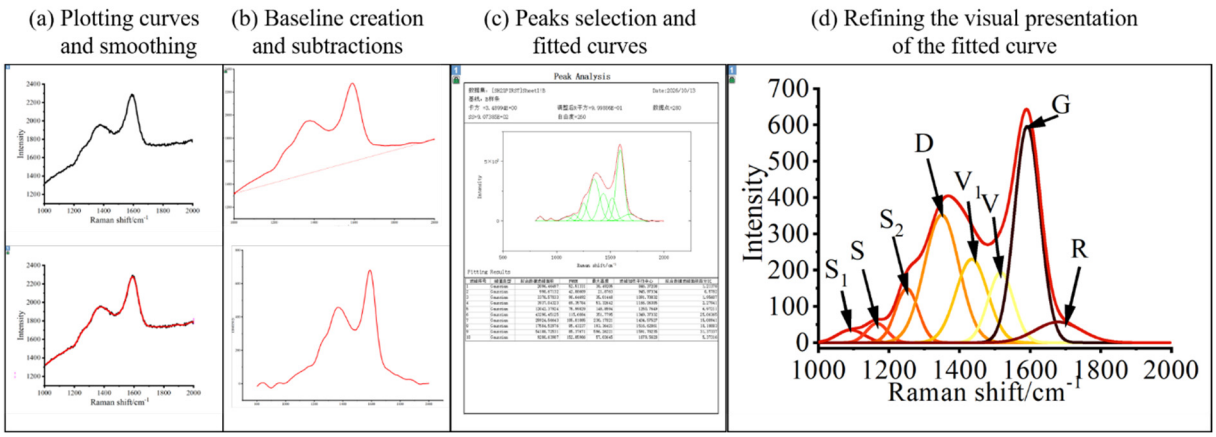


Figure S1. The detailed peak-fitting procedures of Raman spectra.

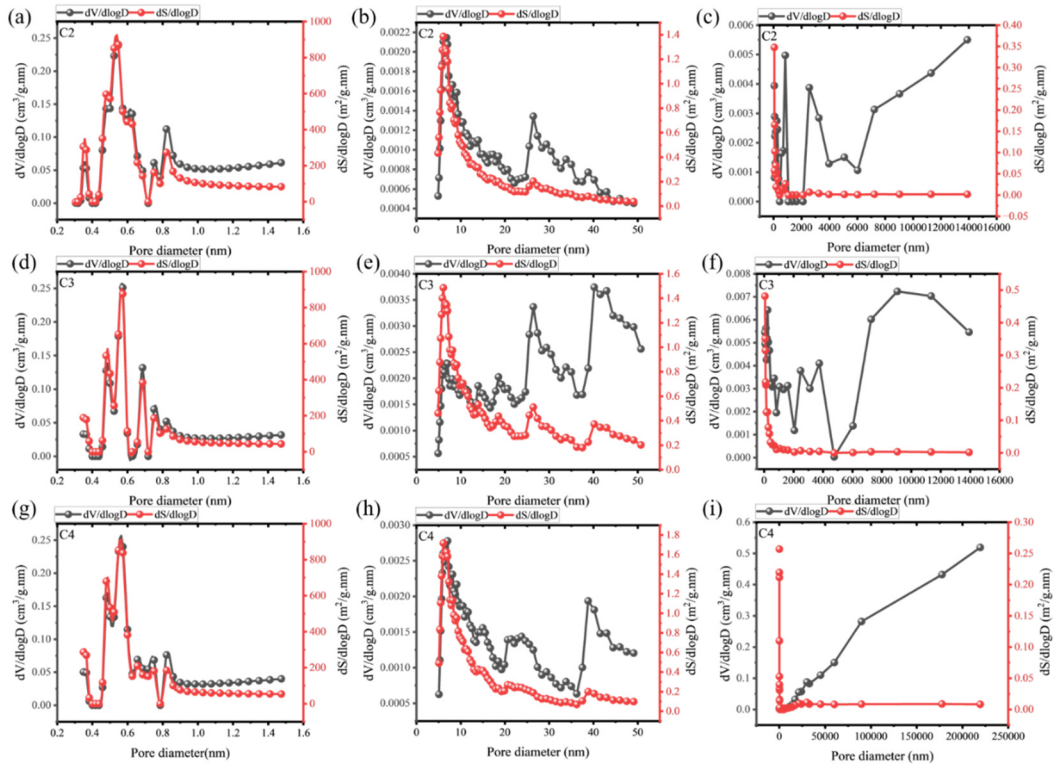


Figure S2. Pore size distributions of coal samples. (a), (d), (g) are micropores; (b), (e), (h) are mesopores; (c), (f), (i) are macropores.

Equations (S1)-(S10) for calculating the fractal dimension of surface morphology (Ds), the calculations were referred to Elson et al. (1995) [35].

$$\varphi(x) = \lim_{l\to\infty} \sum_{n\to-\infty}^{\infty} \frac{1}{2l} \left(\int_{-l}^{l} \varphi_l(t) e^{-in\pi/t} dt\right) e^{in\pi x/l}, \tag{S1}$$

$$\Delta\omega = 2\pi\Delta f = \frac{\pi}{l}, \tag{S2}$$

$$\varphi(x) = \frac{1}{2\pi} \lim_{\Delta\omega\to 0} \sum_{n\to-\infty}^{\infty} \left[\left(\int_{\frac{\pi}{\Delta\omega}}^{-\frac{\pi}{\Delta\omega}}\right) \varphi_l(t) e^{-in\Delta\omega x}\right] \Delta\omega = \frac{1}{2\pi}\int_{-\infty}^{\infty} \left(\int_{-\infty}^{-\infty} \varphi(t) e^{-i\omega t} dt\right) e^{i\omega x} d\omega, \tag{S3}$$

$$\varphi(x) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\omega) e^{i\omega x} d\omega, \tag{S4}$$

$$F(\omega) = \int_{-\infty}^{\infty} \varphi(t)\, e^{-i\omega t} dt, \tag{S5}$$

$$F(\omega, \tau) = \int_{0}^{\tau} \varphi(t)\, e^{-i\omega t} dt, \tag{S6}$$

$$S(\omega) = \frac{1}{\tau}[F(\omega, \tau)]^{2}, \tag{S7}$$

$$S(\omega) \infty \omega^{-\beta}, \tag{S8}$$

$$\log[S(\omega)] = -\beta \log\omega + \log m, \tag{S9}$$

$$D_s = \frac{(7-\beta)}{2}, \tag{S10}$$

Equations (S11)-(S13) for calculating the fractal dimension of surface pore (D), the calculations were referred to Mandelbrot (1975) [37].

$$\lim_{\Delta s\to 0} N(\Delta) \Delta s^{D} = C, \tag{S11}$$

$$D = -\lim_{\Delta s\to 0} \frac{\log N(\Delta s)}{\log \Delta o}, \tag{S12}$$

$$N(\Delta s) \approx c(1/\Delta s)^{D}, \tag{S13}$$

Table S1. Definitions of notations.

Symbol	Definition
x	spatial coordinate
$\varphi(x)$	autocorrelation function of the surface-height field
f	spatial frequency
ω	angular frequency
$F(\omega)$	spectral density function (Fourier transform of φ)
t, τ	integration variable and its upper limit
$S(\omega)$	power spectral density (PSD)
β	spectral exponent (slope of log $S(\omega)$ vs log ω)
Ds	surface fractal dimension
D	pore fractal dimension
S	pore perimeter
A	pore area
l	half-length of space interval $[-l,l]$
n	the index of the Fourier-series harmonics
m	proportional constant of PSD power law