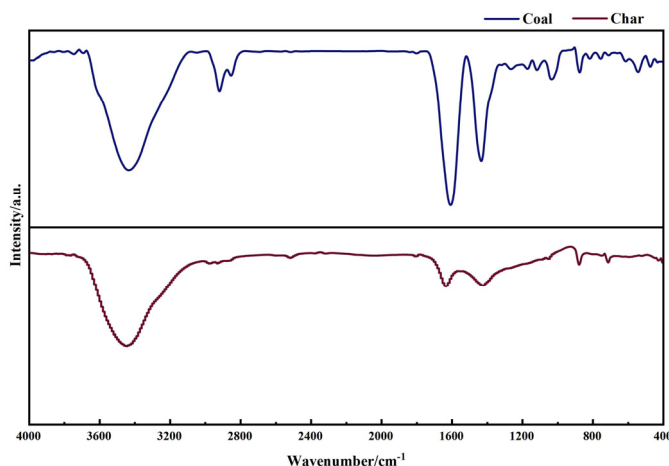


**Supplementary Materials:** A Fourier transform infrared detection method was employed for auxiliary detection (Thermo Scientific Nicolet iS20). Prior to the experiment, the dried coal sample was combined with potassium bromide at a ratio of 1:100. The instrument's scanning time was set to 32 seconds. The acquisition wavenumber was selected within the range of 400-4000  $\text{cm}^{-1}$  [1-3]. Figure S1 illustrates the changes in characteristic peaks of coal and char. The intensity of the characteristic peaks in the 2800-3000 $\text{cm}^{-1}$  interval (aliphatic C-H stretching region) and the 1500-2800 $\text{cm}^{-1}$  interval (C = O, aromatic C = C stretching region) decreased significantly, indicating the removal of side chains and heterocycles in coal during pyrolysis. Additionally, a noticeable reduction in functional group types is observed in the 400-1300 $\text{cm}^{-1}$  interval (fingerprint region), suggesting that pyrolysis at 700 °C promotes the fracture and decomposition of chemical bonds [4]. The peak of -OH in the range of > 3040  $\text{cm}^{-1}$  does not show a significant decrease with increasing temperature. This could be due to the absorption of moisture by the char during grinding with KBr powder [5].



**Figure S1.** the FTIR spectra of coal and char.

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