

Introduction

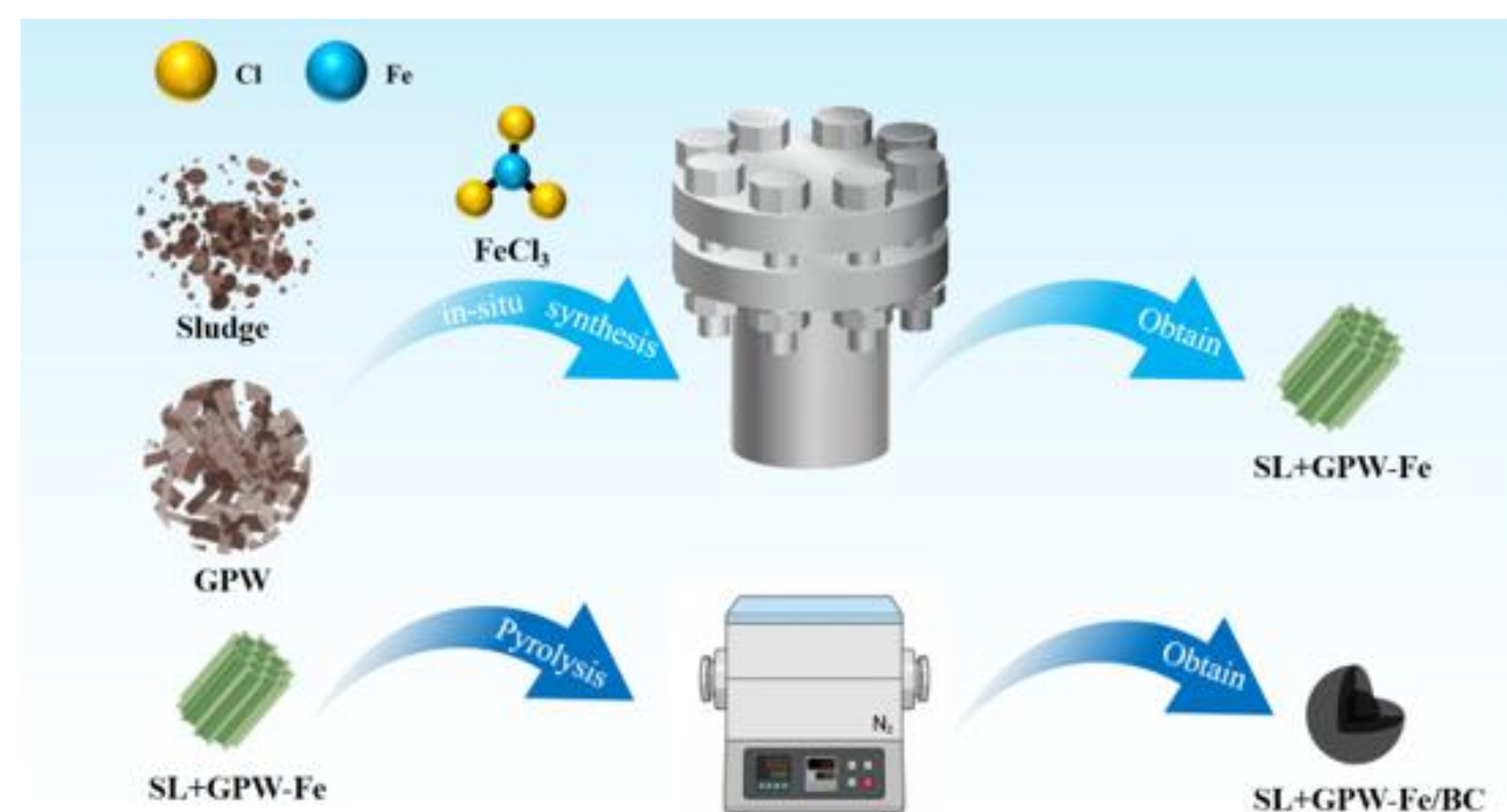
The valorization of urban biowaste into functional materials offers a sustainable route to address both waste management and water pollution challenges. In this work, hydrochars and derived biochars were produced from sewage sludge and pruning residues from parks and gardens. Hydrothermal carbonization was conducted at 240 °C, both in the absence and presence of FeCl_3 as a structure-directing and catalytic agent. The resulting hydrochars were subsequently pyrolyzed at 800 °C to obtain biochars with enhanced physicochemical properties.

The synthesized materials were evaluated as catalysts for the activation of peracetic acid (PAA) in the degradation of emerging contaminants in water, using sulfamethoxazole as a model compound. Comprehensive characterization revealed that Fe-modified materials exhibited improved surface area, porosity, and the incorporation of iron species, which played a key role in catalytic performance.

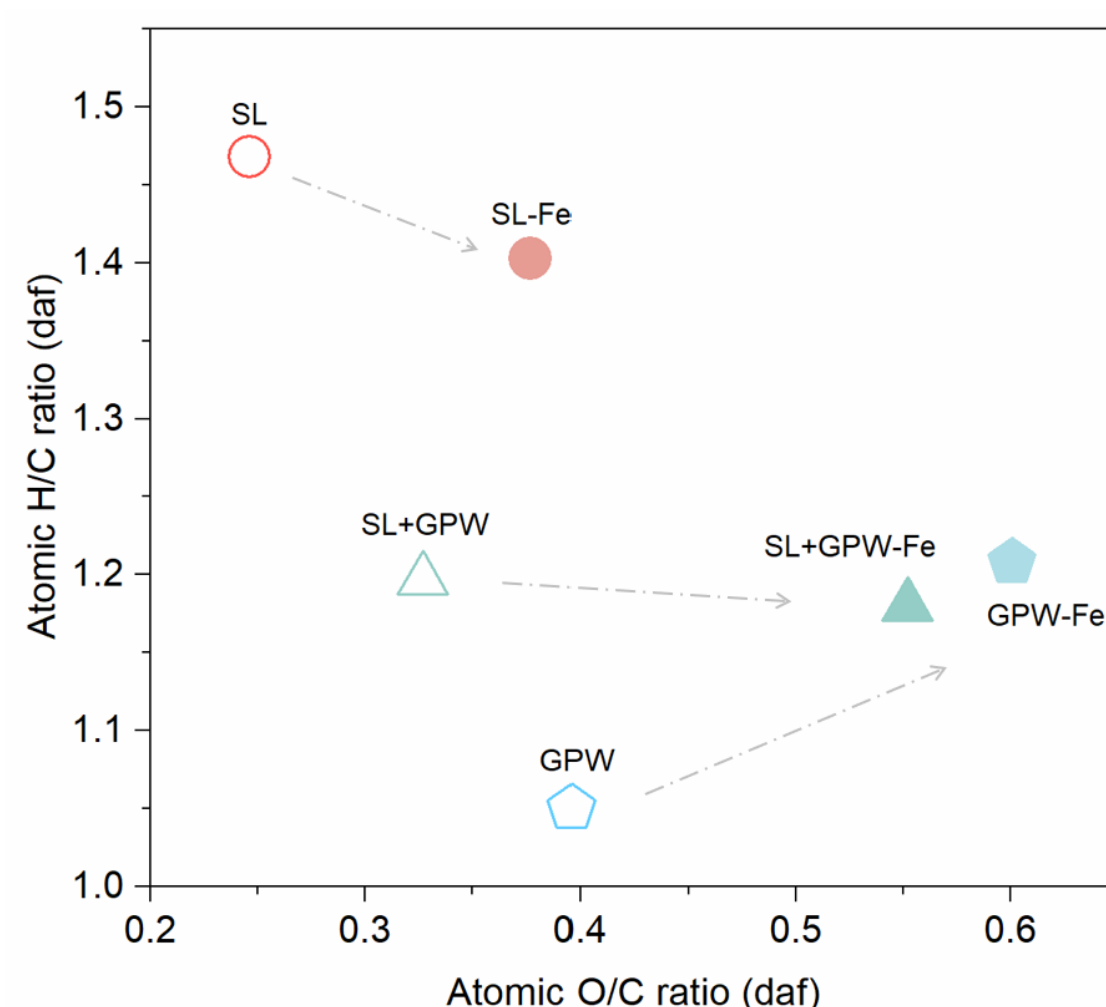
Synthesis

Hydrochars were prepared by hydrothermal carbonization (HTC) in a 2 L stainless-steel pressure reactor (PARR 4530, Parr Instrument Company, Illinois, USA). HTC was conducted at 240 °C for 1 h under autogenous pressure. The resulting slurry was centrifuged at 3700 rpm for 45 min and recovered hydrochars were dried at 60 °C for 24 h, ground, and sieved to a particle size below 2 mm.

Scheme of the synthesis of the hydrochars

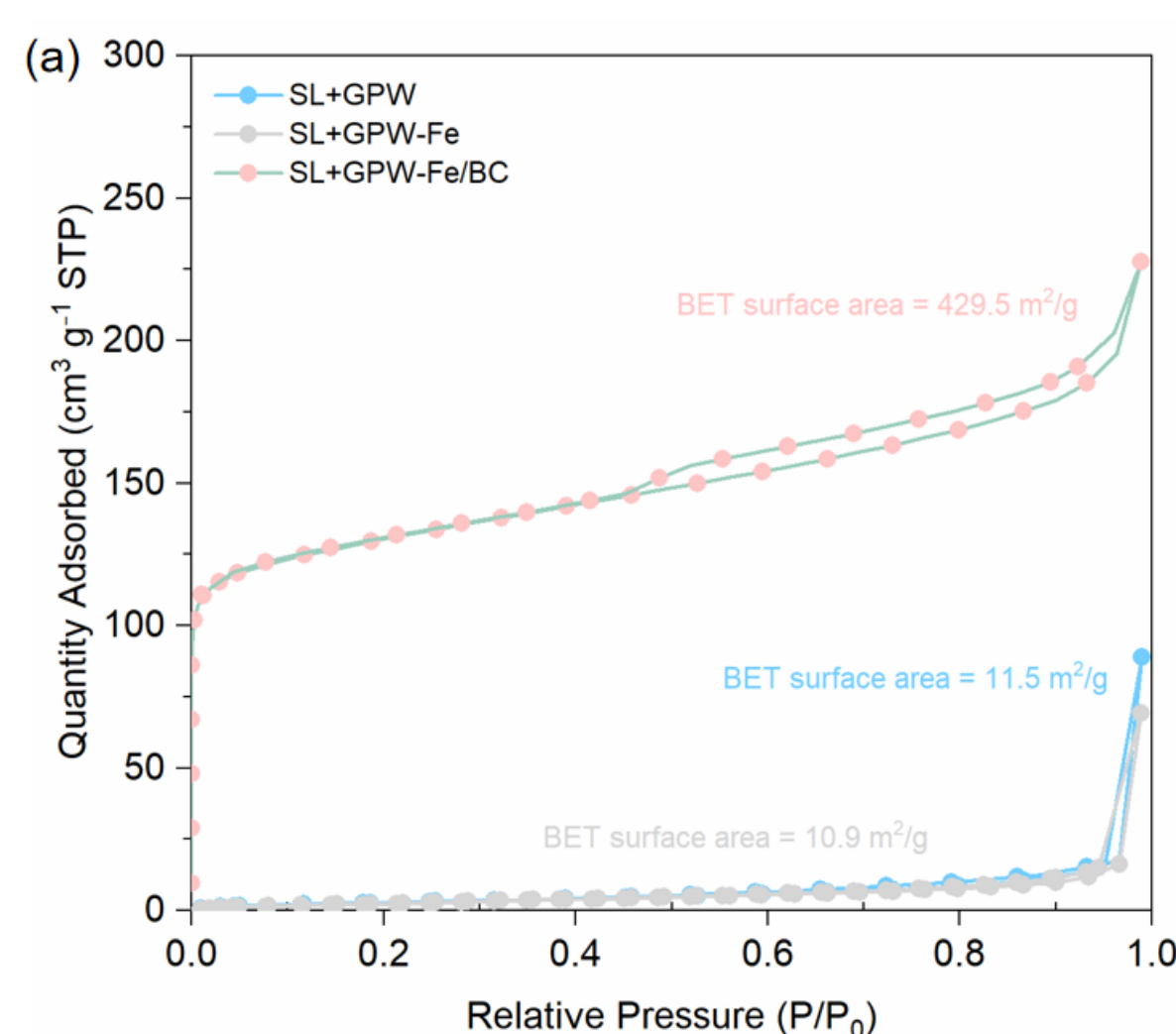


Results



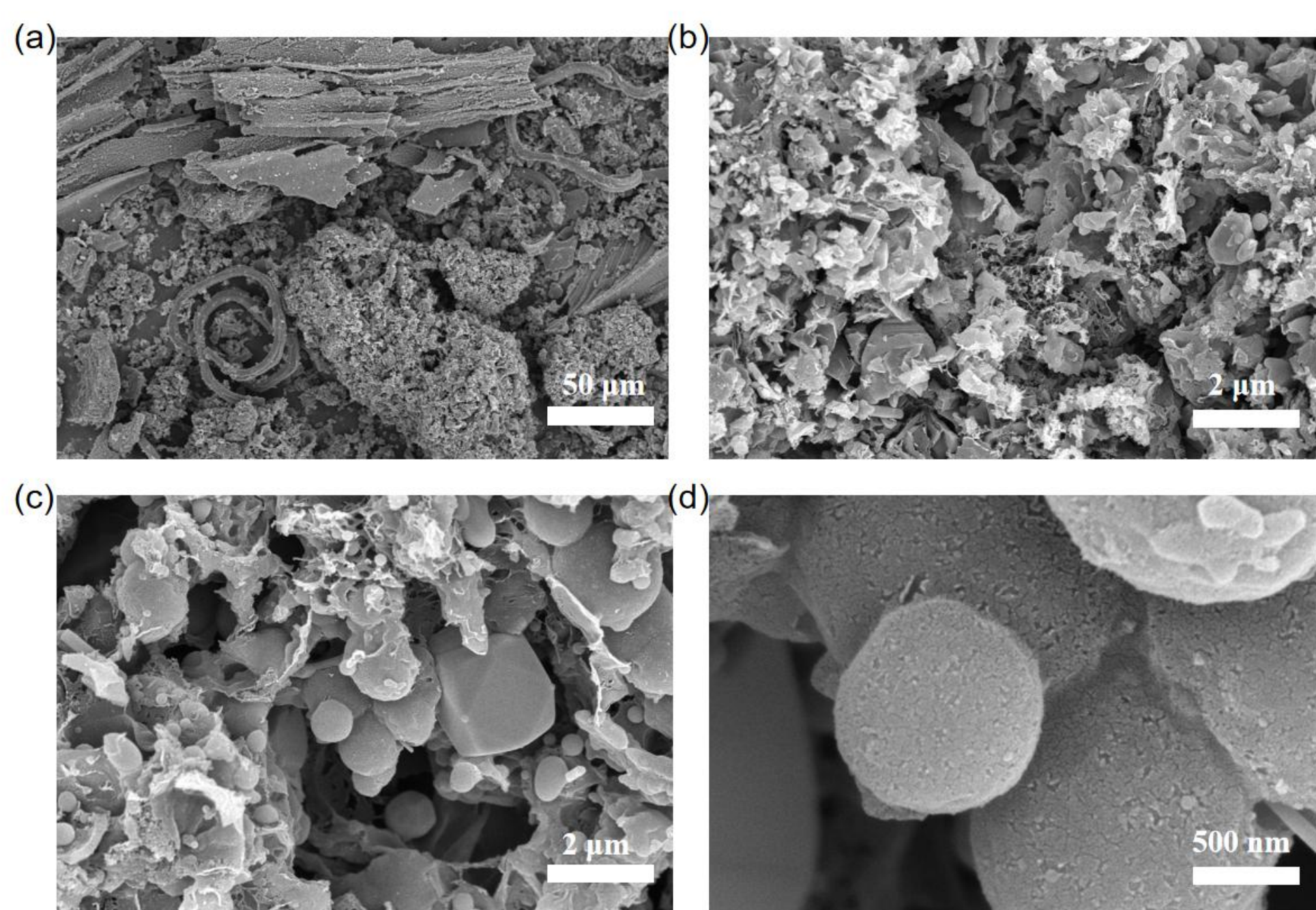
Van Krevelen diagram of hydrochars

FeCl_3 -induced acid-catalyzed hydrolysis, Fe-organic complexation, redistribution of carbon-containing intermediates, and retention of Fe-associated oxygen-containing species



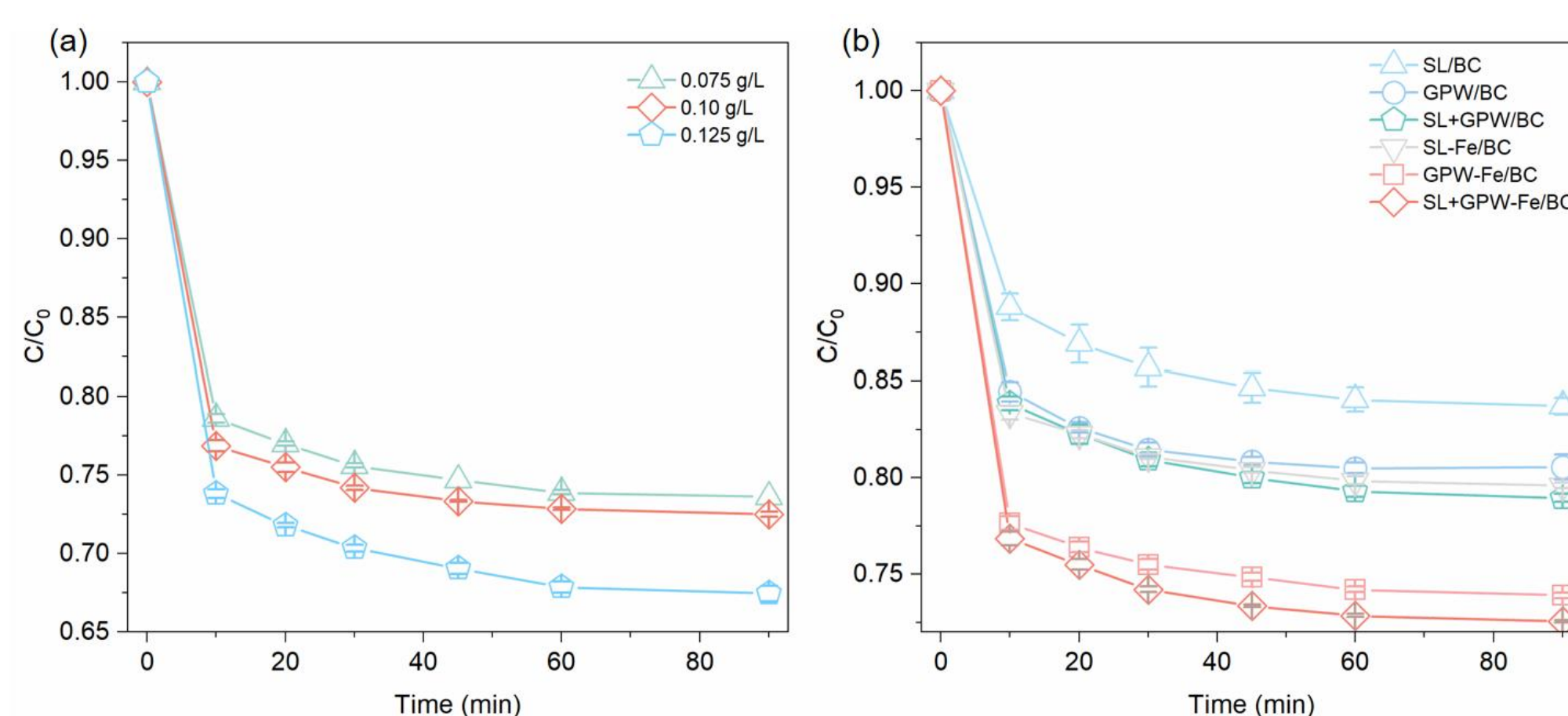
N_2 adsorption-desorption isotherms

FeCl_3 -assisted HTC acted mainly as a precursor-organization step, whereas subsequent high-temperature pyrolysis was responsible for pore opening, volatile release, carbon-framework reconstruction and Fe-associated activation/etching effects



SEM images of SL+GPW-Fe/BC at different magnifications

(a) Low-magnification SEM image showing the heterogeneous macroscopic morphology of SL+GPW-Fe/BC. (b, c) High-magnification images revealing the porous and rough carbonaceous framework. (d) Enlarged SEM image showing spherical particles and nanoscale surface roughness on the biochar matrix.



SMX Removal Performances

- SMX removal on SL+GPW-Fe/BC occurred rapidly within the first 10 min for all tested dosages, followed by a slower decrease and an apparent plateau after approximately 30 min. Increasing the catalyst dosage from 0.075 to 0.125 g L⁻¹ enhanced SMX removal, as expected from the greater number of accessible reaction sites.
- Fe-containing biochars, especially SL+GPW-Fe/BC and GPW-Fe/BC, exhibited stronger SMX removal than most non-Fe biochars, which can be related to their higher surface affinity, Fe-associated surface domains and more developed porous structures after pyrolysis.