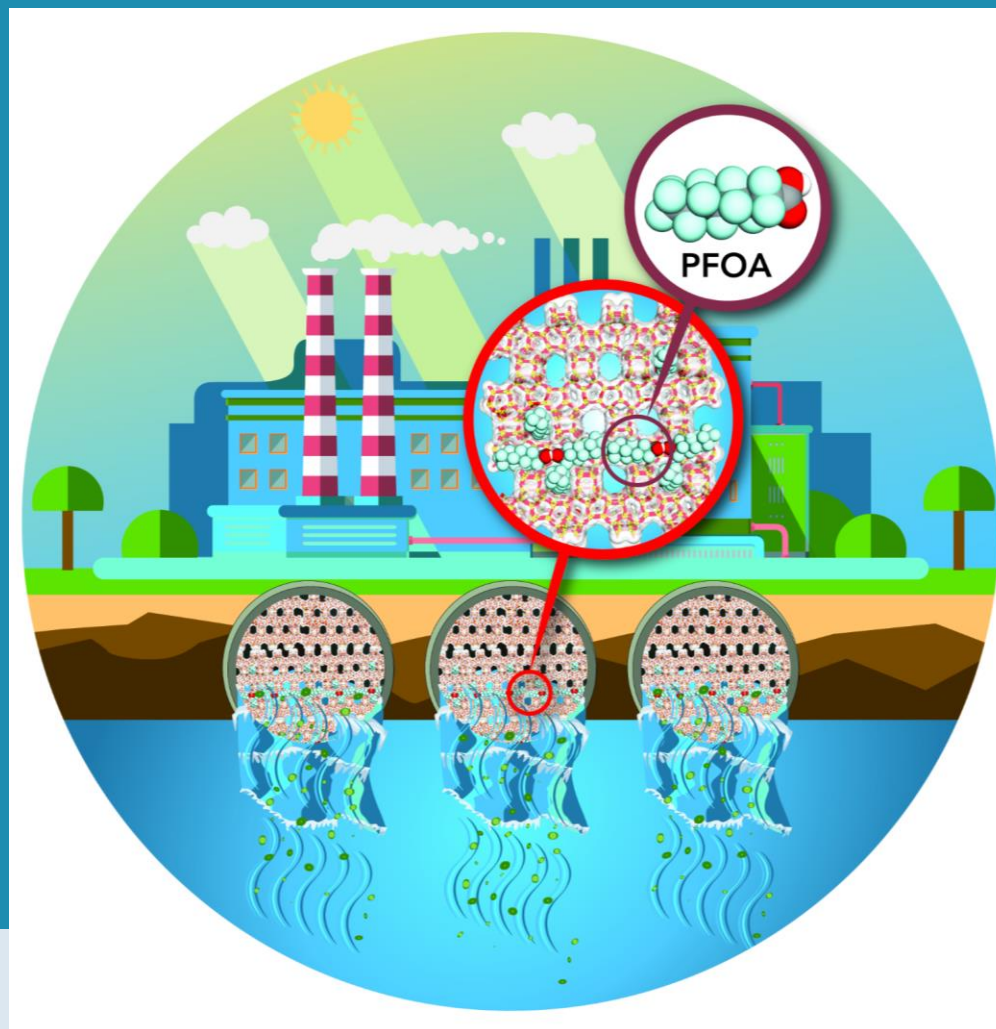


PFAS contaminant adsorption on all-silica zeolite Beta

██████████
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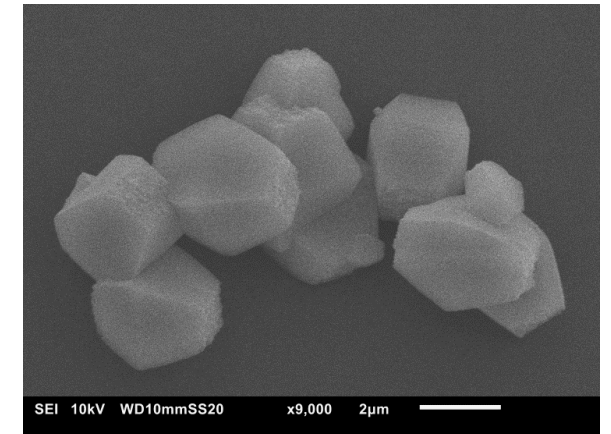
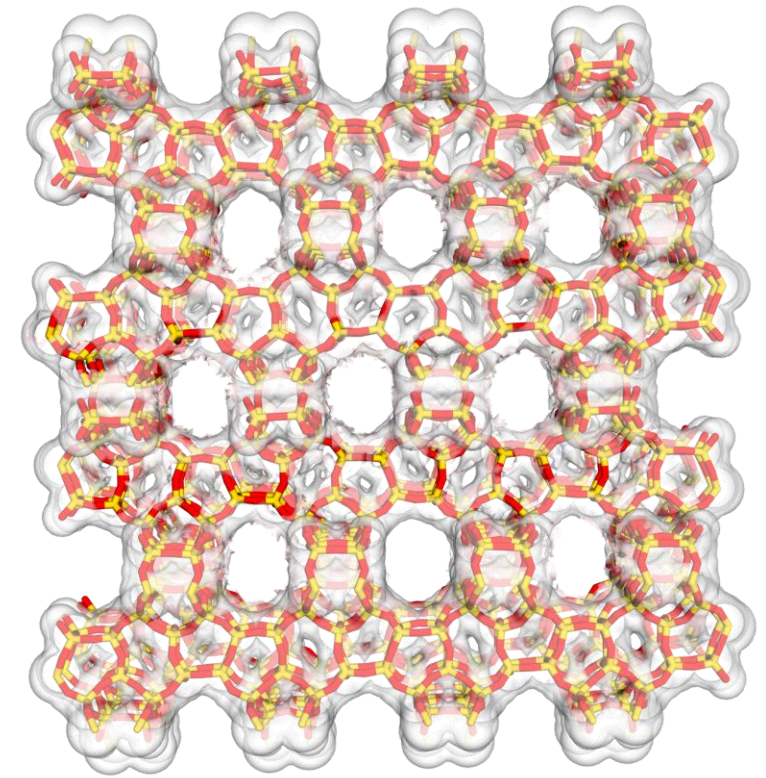
Angew. Chem. Int. Ed. **2020**, 59, 14086-14090

Zeolites

- Crystalline microporous material (pores < 1 nm)
- Inorganic
- Commercially produced

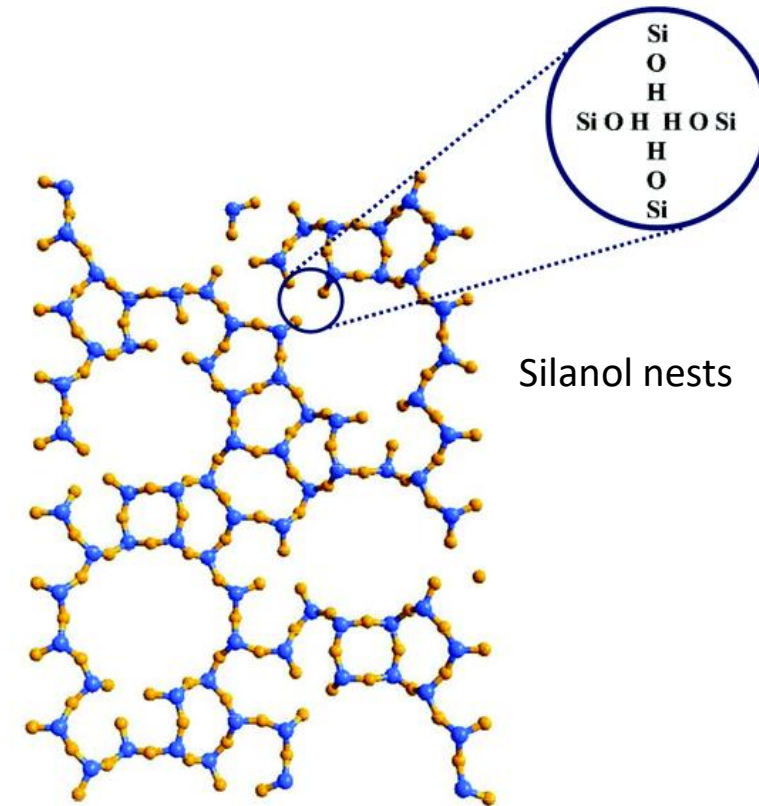
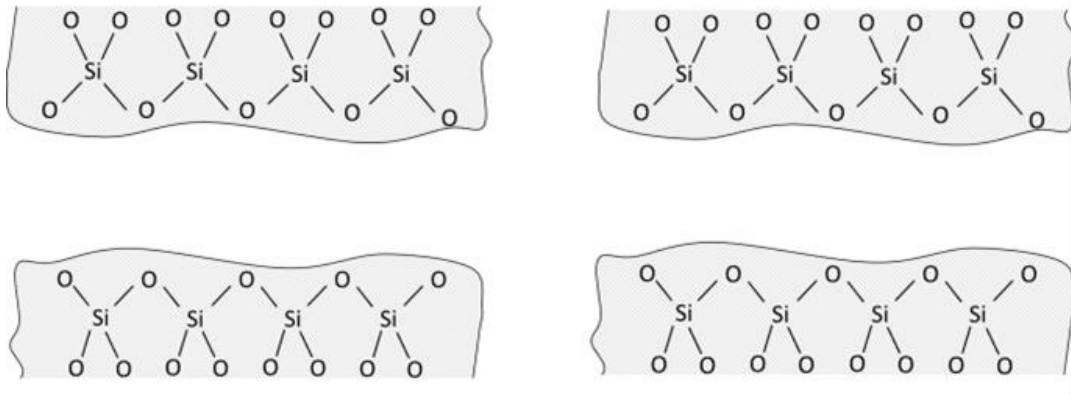
Beta topology (*BEA)

- 3D channel structure
- 12-membered rings
- Straight channels in a & b direction ($6.6 \times 6.7 \text{ \AA}$)
- Tortuous channels in c direction ($5.6 \times 5.6 \text{ \AA}$)



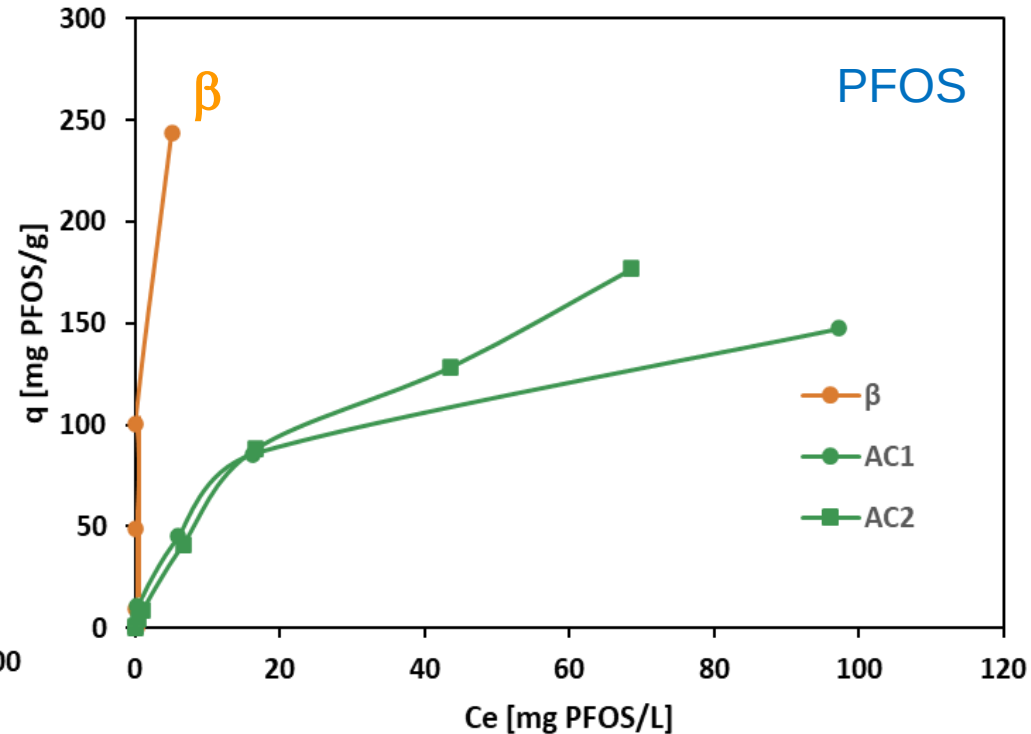
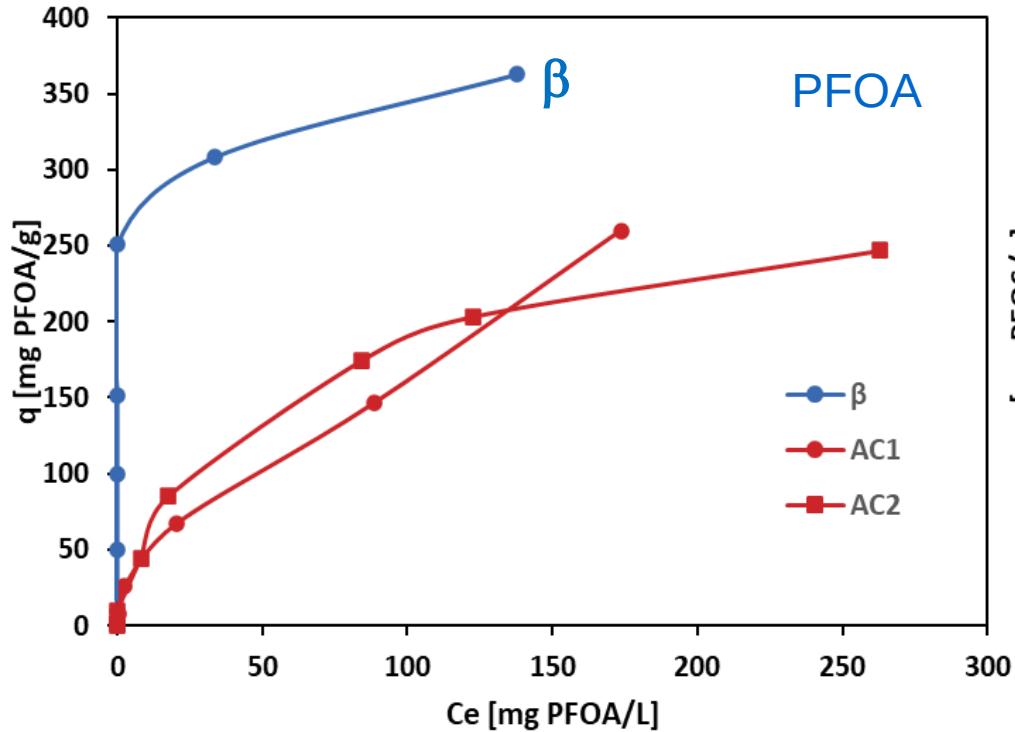
All-silica zeolite Beta

- No framework aluminum
- Fluoride mediated synthesis
 - Defect-free (no silanol nests)
 - Hydrophobic channels



Siliceous zeolite Beta with silanol defects
(*Green Chem.*, **2014**, 16, 2281-2291)

Adsorption isotherms; capacity



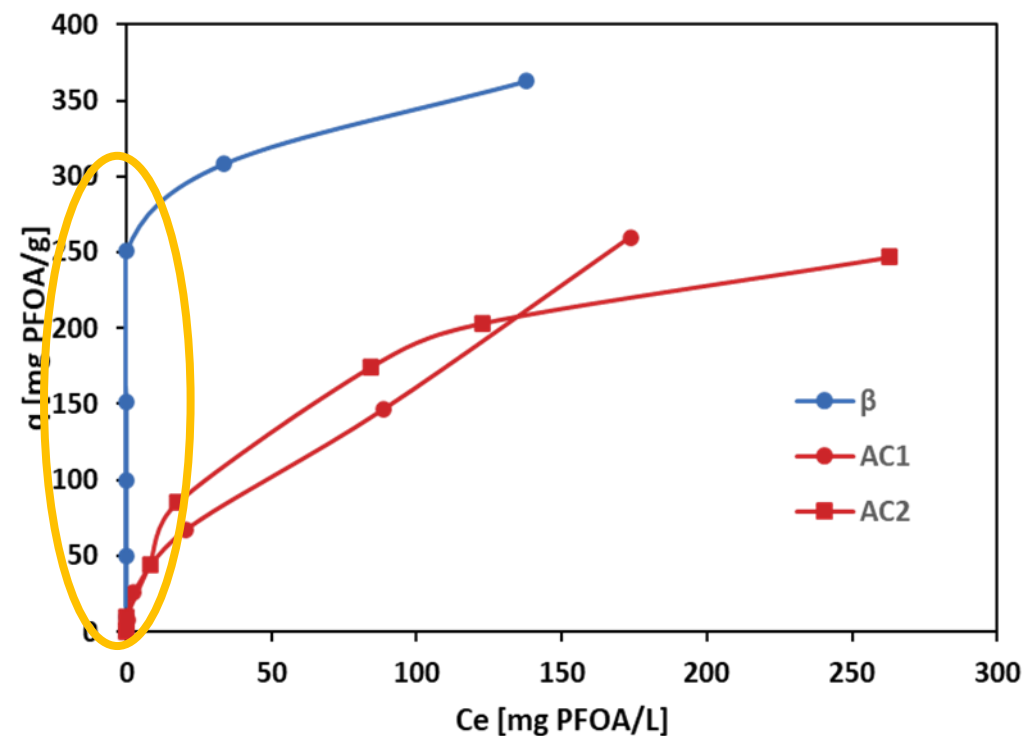
All-silica zeolite Beta (β)

Commercial activated carbons: Filtrisorb 400 (AC1) Norit SX 1G (AC2)

q = saturation capacity = $\frac{(C_0 - C_e) \cdot V_{\text{sample}}}{m_{\text{adsorbent}}}$; C_e = equilibrium PFAS concentration after 24 h

Beta zeolite >> commercial carbon materials

Isotherms: affinity



All-silica zeolite Beta (β);
Commercial activated carbons: Filtrisorb 400 (AC1), Norit SX 1G (AC2)

High affinity $\xrightarrow{\text{Quantified by}}$ $K_d = q / c_e \text{ (L/kg)}$

Adsorbent	C ₀ (mg PFAS/L)	Adsorbent loading (g/L)	Log K _d for PFOA	Log K _d for PFOS
AC1*	0.1	2.5	3.6	3.9
AC2*	0.1	2.5	3.7	4.3
β**	0.1	1	>5.3	>5.5

*Experimental: 100 mg of adsorbent was contacted for 7 days with 40 mL of a 0.1 mg/L PFAS solution (Data adapted from: *J. Environ. Chem. Eng.*, **2020**, 8, 103744)

** Experimental: 5 mg of adsorbent was contacted for 24 hours with 5 mL of a 0.1 mg/L PFAS solution

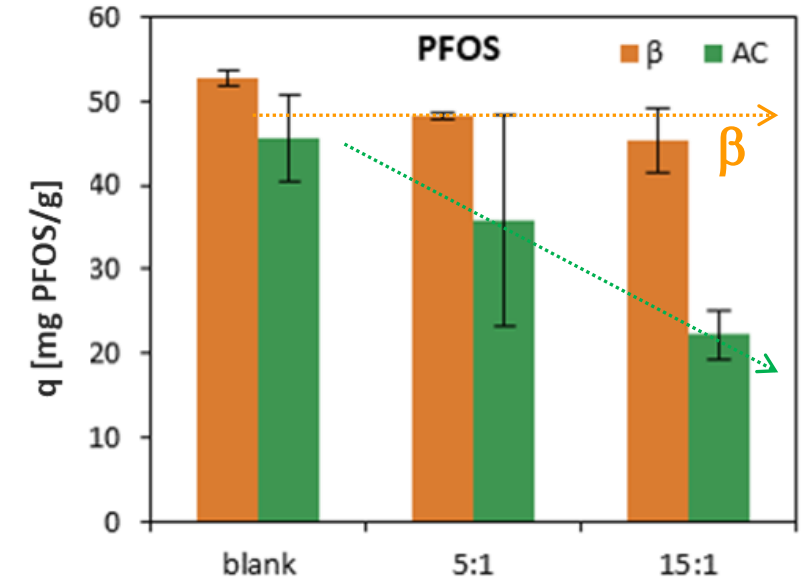
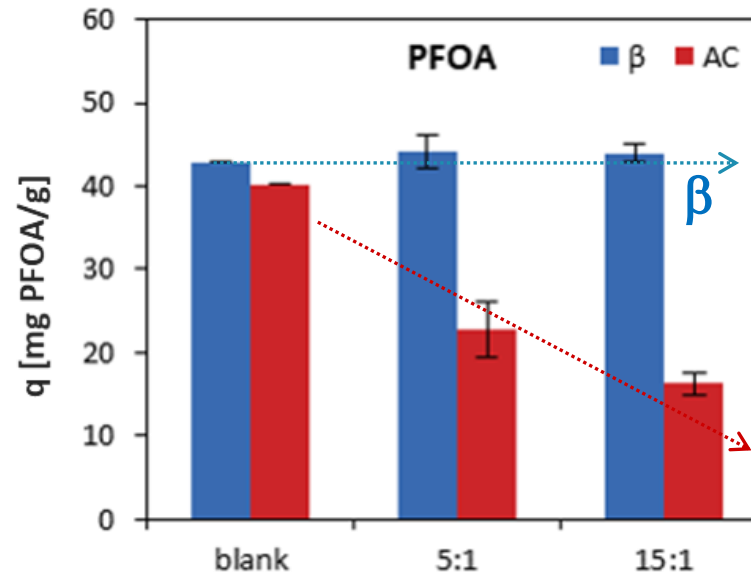
Beta zeolite >> commercial carbon materials

Experimental: 5 mg of adsorbent was contacted for 24 hours
with 5 mL of an aqueous solution containing PFOA
(concentrations ranging from 0.1 to 500 mg/L)

Isotherms: selectivity

Adsorption selectivity experiments in presence of 5 organic competitors:

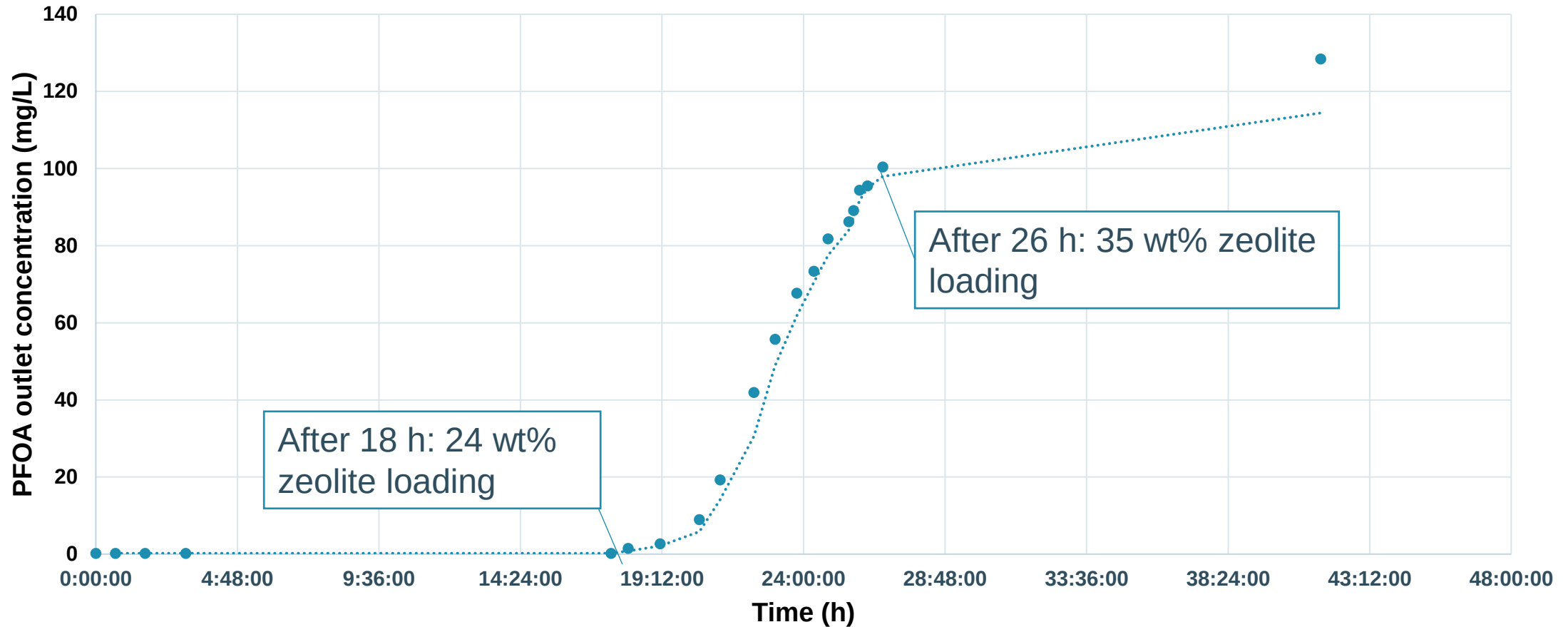
- Caprylic acid
- Sodium dodecylsulfate
- Phenol (~humic acid)
- Benzoic acid (humic acid)
- Adipic acid (dicarboxylic acid)



Beta zeolite >> commercial carbon materials

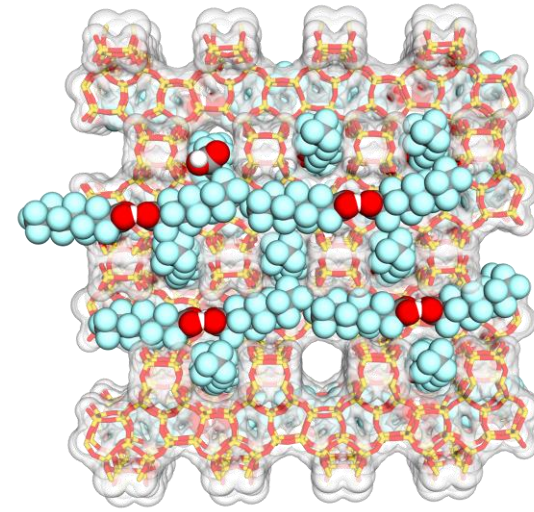
Scalability:column experimenys

Lab-scale column experiment



Zeolite Beta adsorbent

- Scalable material (industrially produced)
- Excellent regeneration: thermal / liquid phase



Open challenges

- Expand zeolite adsorbents to **wider range of PFAS**
- Best **interface** between desorption and destruction
- **Destruction** technique in fully contained system – with 100 % mass balance on inorganic fluoride