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Exceptional CO2 absorption by covalent organic polymers (COPs)

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Efficient CO2 scrubbing without a significant energy penalty remains an outstanding challenge for fossil fuel-burning industries where aqueous amine solutions are still widely used. Porous materials have long been evaluated for next-generation CO2 adsorbents. Porous polymers, robust and inexpensive, show promise as feasible materials for the capture of CO2 from warm exhaust fumes. We report the syntheses of porous covalent organic polymers (COPs) with CO2 adsorption capacities of up to 5616 mg/g (a world record-measured at high pressures, i.e., 200 bar) and industrially relevant temperatures (as warm as 65 C). COPs are stable in boiling water for at least one week, and near infinite CO2/H2 selectivity is observed. Theoretical calculations refer to an amorphous extended framework as density is likely the main reason for exceptional CO2 capacities. COPs 1-2 feature basic nitrogen sites that show chemospecific affinity towards acidic gases such as CO2. COP-3 has reasonably high surface area (418 m2/g), effective for low pressure operations. Post-combustion carbon capture from fossil fuel power plants demands pressures of up to 6 bar and a minimum temperature of 40 C. By tuning their architecture, we show that COPs reach to 3 mmol CO2/g sorbent at 6 bar and 45 C. High and low pressure capacities make these porous polymer structures viable alternatives to amine scrubbers*.

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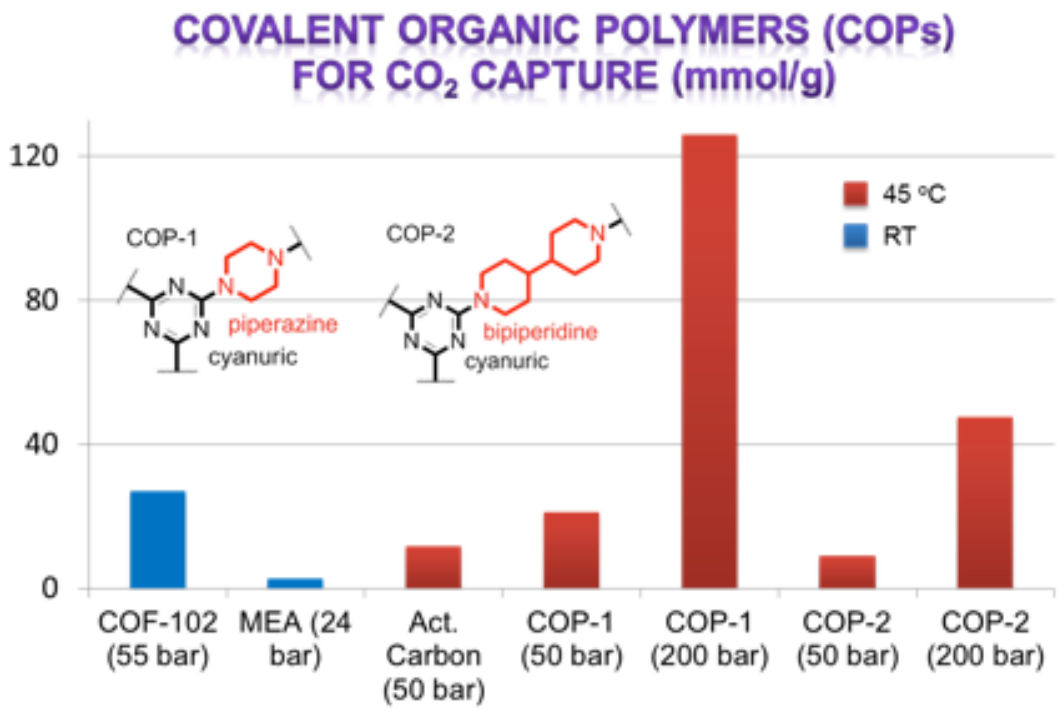
COVALENT ORGANIC POLYMERS (COPs)
FOR CO_2 CAPTURE (mmol/g)
120
80
40
0
45 °C
RT
COP-1
piperazine
cyanuric
COP-2
bipiperidine
cyanuric
COF-102 (55 bar)
MEA (24 bar)
Act. Carbon (50 bar)
COP-1 (50 bar)
COP-1 (200 bar)
COP-2 (50 bar)
COP-2 (200 bar)