Direct access to primary amines and particle morphology control in nanoporous CO_2 sorbents

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Chemical tuning of nanoporous, solid sorbents for an ideal CO_2 binding requires unhindered amine functional groups on the pore walls. Although common for soluble organics, post-synthetic reduction of nitriles in porous networks often fail due to the insufficient and irreversible metal hydride penetration. Here, we synthesized a nanoporous network with pendant nitrile groups, microsphere morphology and in large scale. The hollow microspheres were easily decorated with primary amines through in situ reduction by widely available boranes. CO_2 capture capacity of the modified sorbent was increased up to four times of the starting nanoporous network with a high heat of adsorption (98 kJ/mol). Surface area can be easily tuned between 1 and 354 m^2/g. Average particle size (~50 µm) is also quite suitable for CO_2 capture applications where processes like fluidized bed require spheres of micron sizes.

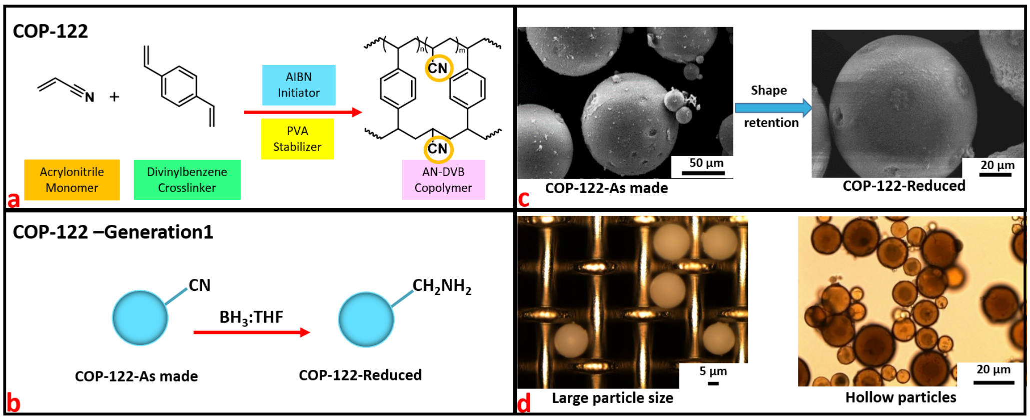

Figure 1. (a) Synthesis of acrylonitrile-divinylbenzene copolymer (COP-122) by suspension polymerization. The resulting nanoporous network polymer has the shape of spherical beads with dangling -CN groups spread out inside each polymer particle (b) Synthetic pathway to reduce nitrile groups on COP-122. After reduction, amine groups are obtained on polymer surface and inside the pores (named as COP-122-Generation1). (c) SEM picture of a single polymer particle surrounded by other particles. Morphology of COP-122-Generation1 is retained after reduction. (d) Optical microscope image of COP-122 particles. Large particle size of COP-122 makes it suitable for industrial applications.

[1] Nesibe A Dogan, Ercan Ozdemir, Cafer T Yavuz, ChemSusChem, 2017, doi:10.1002/cssc.201700190