PRODUCTION OF SPHERICAL MOLECULARLY IMPRINTED POLYMERIC PARTICLES CONTAINING CO_2-PHILIC NANOCAVITIES

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In this study, we have developed novel spherical molecularly imprinted polymeric particles containing amine-decorated nanocavities for CO_2 capture, called CO_2-MIPs, using suspension polymerization (Fig. 1). The key parameters for high affinity of CO_2-MIPs towards CO_2 molecules are (a) tuned chemical architecture of the nanocavities, and (b) the presence of amine functional groups, which are covalently incorporated within the nanocavities. Previously, it was shown that CO_2-MIPs produced by bulk polymerization have a high CO_2 selectivity (separation factor up to 340) and stable capture capacity in the presence of moisture and impurities, such as SO_2, NO, and O_2 [1, 2]. However, the bulk polymerization includes crushing, grinding and sieving steps, which are time-consuming and wasteful, because only 30-40% of particles can be recovered. In addition, the produced particles have irregular shapes and sizes and can undergo mechanical attrition and break down to finer particles during the CO_2 capture process. Moreover, the bulk polymerization process is hardly scalable. On the other hand, suspension polymerization is an established method for industrial-scale production of polymeric particles in which each individual monomer drop acts as a tiny batch reactor, leading to an increase in the heat transfer and faster polymerization.

The size of the particles was 70-210 µm, depending on the agitation speed in the jacketed reactor. The nitrogen adsorption-desorption analysis showed Type IV isotherm, implying the uniform pore size distribution. The specific surface area and pore volume of the particles were up to 457 m^2/g and 0.92 cm^3/g respectively. The thermogravimetric analysis revealed that the particles were thermally stable up to 220°C. By comparing CO_2 breakthrough curves of imprinted polymer (CO_2-MIPs) and non-imprinted polymer (NIPs) particles, it was found that the presence of nanocavities resulted in a higher CO_2 capture capacity (Fig. 1c). In addition, increasing the NH_2 density caused higher CO_2 uptake.

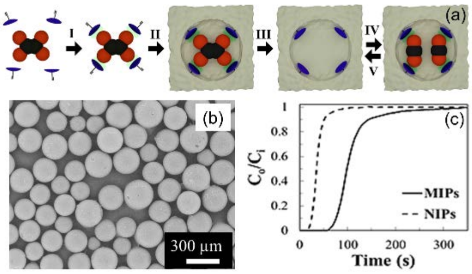

Figure 1. (a) A conceptual scheme of CO_2-MIPs synthetize process: (I) Monomer-template self-assembly, (II) Crosslinking of monomer-template complex, (III) Template removal, (IV) CO_2 capture, (V) CO_2 released; (b) SEM image of produced particles; (c) Comparison of CO_2 capture capacity of MIPs and NIPs. Acrylamide was used as a monomer,

References

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[2] Zhao, Y.; Shen, Y.; Ma, G.; Hao, R., Environ. Sci. Technol, vol 48 (2014), 1601–1608.