New findings on CO_2 adsorption on chitosan aerogels

Philipp D. Niemeyer, Lorenz Ratke, Barbara Milow

German Aerospace Center, 51147 Cologne, Germany

Philipp.Niemeyer@dlr.de

Numerous publications describe amine groups bearing materials for selective CO_2 separation. Most of those materials are of microporous nature. The Young-Laplace equation predicts CO_2 condensation at 273 K in pores below 6 nm. Therefore it is of interest if the recorded CO_2 adsorption isotherms show CO_2 condensation in specific pores or reveal selective adsorption on surfaces. To overcome the question of condensation in pores or adsorption via amine groups we investigated mesoporous chitosan aerogel beads with a mean pore size of 40 nm.

CO_2 sorption isotherms were recorded at 273 K and 298 K, see Figure 1. The isotherm shape reveals partly irreversible adsorption reactions. The adsorption branch was recorded up to 100 kPa. The subsequent recorded desorption branch does not match the adsorption branch. A difference builds up between adsorption and desorption. At the end of desorption the starting and ending values do not match.

Four different adsorption reactions are responsible for the CO_2 sorption isotherms of chitosan aerogel beads. Those are: 1) covalent reaction according to the carbamate mechanism $[RNHCO_2]^- + [RNH_3]^+$, 2) charge\adsorptive interaction $[RNHCO_2\backslash CO_2]^-$ and $[RNH_3\backslash CO_2]^+$, 3) dipole\adsorptive interaction $ROH\backslash CO_2$, and 4) non-specific London interaction $\#\backslash CO_2$. Maximum adsorption capacities at 100 kPa of 1 mmol/g and 0.6 mmol/g were recorded at 273 K and 298 K respectively. At low CO_2 absolute pressure of 0.25 kPa the adsorption capacities are 0.05 mmol/g and 0.03 mmol/g at 273 K and 298 K respectively.

Microporous and amine group bearing materials published usually report adsorption capacities of at least one order of magnitude larger than those found in our studies. The comparison of adsorption capacities from mesoporous and amine bearing chitosan aerogels with microporous and amine bearing materials emphasizes the importance of micropores for selective CO_2 separation due to pore condensation.

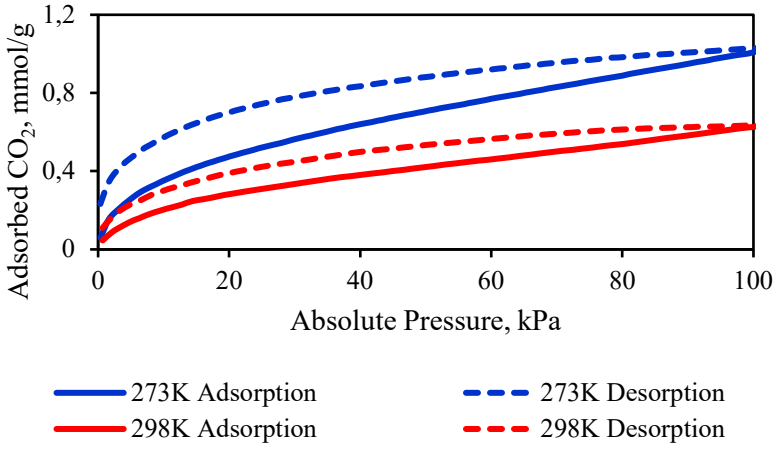

Figure 1 CO_2 sorption isotherms on chitosan aerogel beads.