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Carbon dioxide adsorption over amine modified silica: effect of amine basicity and entropy factor on isosteric heats of adsorption

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Abstract

SBA-15 mesoporous silica was modified with 3-aminopropyl (AP), N-propyl ethylenediamine (DA) and N-propyl diethylenetriamine (TA) ligands. The prepared materials were characterized by thermogravimetry (TGA), small angle X-ray scattering (SAXS), nitrogen adsorption/desorption and transmission electron microscopy (HRTEM). The carbon dioxide adsorption/desorption experiments were performed at 273 K, 293 K, 313 K and 333 K. The adsorption capacity of CO_2 at pressures below 2 kPa well correlates with number of amine centers in the respective ligand. Based on the adsorption isotherms, measured at different temperatures, the isosteric heats of adsorption (Q_{st}) were calculated. The Q_{st} values correlate with the basicity of the nitrogen atoms of respective amine ligands and their steric availability. The AP and DA ligands with the higher basicity of amine nitrogen showed the higher isosteric heats of adsorption at zero coverage (Q_{st} = 72 kJ/mol), while TA ligand, with the lower basicity and steric availability of nitrogen atoms exhibited at zero coverage the lowest value of isosteric heat of adsorption (Q_{st} = 40 kJ/mol). This low value shows, that in