Abstract

Science and technology expect substantially improved thermal insulation from nanoporous materials. If it were an option to use glass, temperature-stable and sustainable nanofoams could be produced. In an attempt to reach this goal, we exploit the idea to use glass nano- and micro-particles as well as water as ideal blowing agent for fabricating a highly porous glass foam according to a method known as "nanofoams by continuity inversion of dispersions" (NF-CID). The method utilizes preferably monodisperse solid nano- (or micro-) particles, which are closely packed and soaked with water within a pressure-proof, locked container. Subsequently temperature and pressure are raised above the supercritical state of water (i.e. larger than T_c = 647 K, p_c = 221 bar). Fusion of the glass particles leads to a continuity inversion, which creates supercritical (*sc*-) H_2O inclusions within the now continuous glass matrix. Foaming is initiated by releasing the pressure, whereby the foam solidifies due to expansion cooling. We examined the inversion process as it depends on temperature and exposure time to ensure the applicability of the approach to glass particles. The foaming process was investigated as function of temperature, pressure, exposure time and the nature of the applied raw material. We adapted the parameters to obtain porous glasses and glass foams with a pore size of d_{pore} = 5 µm – 36 µm. The most relevant properties of the particles are morphology and composition. On the one hand, the size correlates directly with the size of the *sc*-H_2O inclusions and therefore with the pore diameter of the resulting foam. On the other hand, *sc*-H_2O diffuses into the glass and becomes molecularly deposited within the glass matrix and is able to inflate the glass during the expansion. The composition of the glass is important for the thermal behavior of the material. Nanosized particles with a composition close to soda-lime-silicate glass are identified as promising candidates with a low transformation temperature T_g. Therefore, calcium and sodium doped silica particles were generated employing different synthetic strategies. By varying the reaction conditions, particles of different composition and size of d_P= 20 nm – 100 nm are now available. The thermal behavior and morphology of the doped particles are examined by differential scanning calorimetry and scanning electron microscopy to ensure their suitability for the NF-CID approach. First foaming experiments show the applicability of the approach also to our own synthesized glass particles.