ABSTRACT

Nanoporous insulating materials (NIMs) promise enormous energy savings through improved thermal insulation properties. But a cost-efficient production of such materials is still a major challenge for large-scale application. One promising route is the generation of polymeric nanofoams by continuity inversion of dispersion (NF-CID) which involves close packing of polymer nanoparticles, soaking with blowing agent (e.g. supercritical CO_2) and inversion into a continuous polymer matrix with a very high number density of blowing agent pools by exceeding T_G. A subsequent expansion leads to nanometer-sized bubbles and in consequence to a nanofoam. However, the foaming process is accompanied by aging effects. The kinetic details of these processes were examined via time-resolved small angle neutron scattering (SANS). After the proposed mechanism could be confirmed and supplemented, the gained knowledge was used to improve the resulting nanofoams. Given that the size of the initial colloidal crystals limits the size of the final foam, novel templates consisting of disordered pastes of water and polymer nanoparticles were utilized to overcome this restriction. Using in addition a low molecular oil as anti-aging agent it was possible to reach homogeneous foams with pore sizes of 100 - 200 nm also from these disordered templates which in principle can have any dimensions. For industrial production processes of nanoporous materials the use of a gaseous blowing agent and therefore the requirement of high pressure is a matter of expense. To this end an alternative route for preparation of nanoporous materials without blowing agent was developed - which we called blowing agent free foam formation (BAFFF). Polymer beads are swollen in a mixture of at least two solvents which lead to nanoporous beads by sequential evaporation. The generated structures with an average pore size smaller than 100 nm show morphologies similar to NF-CID materials.