Abstract

In the view of the "green age" nano-cellular polymer materials are a key aspect for its realization as their ultra-low thermal conductivity offers extensive energy saving potential. To reap even greater economic and ecological benefits it is advisable to use super- or near-critical CO_2 as propellant, as it is incombustible, eco-friendly and cheap. Regarding the foaming itself the Principle of Supercritical Microemulsion Expansion (POSME) is a promising technique, because it utilizes a super-critical microemulsion in which the blowing agent is dispersed in nanoscopic micelles within a continuous polymerizable phase. A simultaneous expansion and fixation of the structure should lead to nanofoams. However, application of initial model systems such as propane-in-sugar solution microemulsions only lead to foams with micron-sized pores. Systematic investigation of the phase behavior and the microstructure by means of small angle neutron scattering (SANS) showed that instead of starting from a micellar structured microemulsion (POSME condition) these experiments were performed based on a bicontinuous L_3-phase. Furthermore, periodic pressure cycles in combination with time resolved SANS measurements indicate that an early stage demixing during the expansion causes a loss of the nanostructure. Nevertheless, the obtained sugar microfoams represent an innovative low calorie product for the food industry. To transfer this procedure to a continuous extrusion process, all non-edible components were systematically replaced and propane was substituted by CO_2 concluding in new and tasty sugar foams. In parallel, to allow for the general large scale production of polymeric nanofoams, the *Nano-Foam by Gel Acetone Foam Formation via Expansion Locking* (NF-GAFFEL) approach was developed. Here, a gel that consists of a polymer (e.g. polystyrene) and a plasticizer (e.g. acetone) is brought into a CO_2 atmosphere at high pressure before the solvent is extracted by expansion allowing for its recycling. The resulting polymer foams feature pore sizes in the range of 100 to 200 nanometers at densities between $\rho = 0.1$ and $0.4\ g/cm^3$. As those flexible polymer gels are easily extrudable the continuous production of polymer nanofoams is finally within reach.