Preparation and Characterization of Micro- and Nanocellular Polystyrene Foams

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Micro- and nanocellular polymer foams are defined as foams with the cell sizes smaller than 10 μm or 100 nm, respectively. The range of the average cell size is comparable to the mean free path of gas molecules. Therefore, the nano-scale transport effects start to play an important role. Based on the simulations of heat transfer and sound propagation in foams [1,2], the heat and sound insulation properties strongly depend on the foam porosity and cell size. As a consequence of the nano-scale transport effects, micro- and nanocellular foams have improved heat and acoustic insulation properties in comparison with conventional foams.

We prepared and characterized the morphology of open and closed-cell polystyrene micro- and nanocellular foams. Polystyrene foams with closed cells were prepared using supercritical CO_2 as the blowing agent (Figure 1a). On the other hand, polystyrene foams with open cells were prepared via temperature induced phase separation, namely by the spinodal decomposition (Figure 1b). In both cases, we systematically studied the influence of the foaming conditions (focusing especially on nucleation and coalescence) on the final foam morphology. The influence of solvent residua on foaming was discussed in [3]. By carefully optimizing the foaming conditions we prepared foams with an average cell size below 1 μm. Furthermore, we studied the heat insulation properties of the prepared foams and compared them with the results of heat transport simulation in foams.

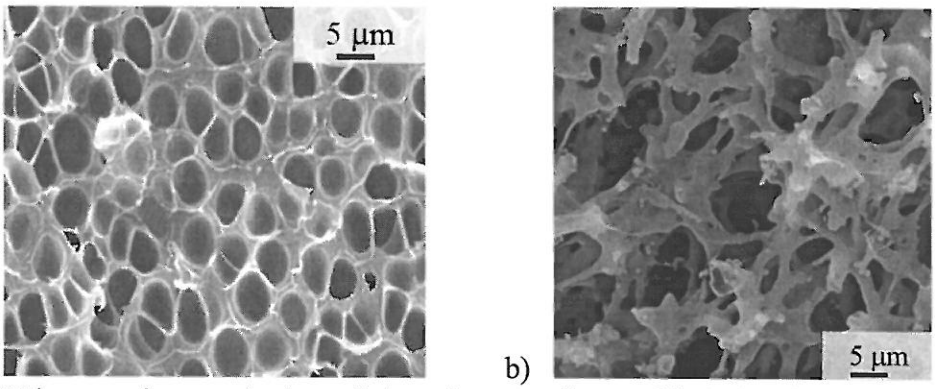

Figure 1: SEM images of prepared microcellular polystyrene foams with a) closed and b) open cells.

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[3] Nistor A., Rygl A., Bobák M., Sajfrtová M., Kosek J. Micro-cellular polystyrene foam preparation using high pressure CO_2: The influence of solvent residua. *Macromolecular Symposia* 333, 266-272 (2013).