Microcellular Polystyrene Foam Preparation Using High Pressure CO2

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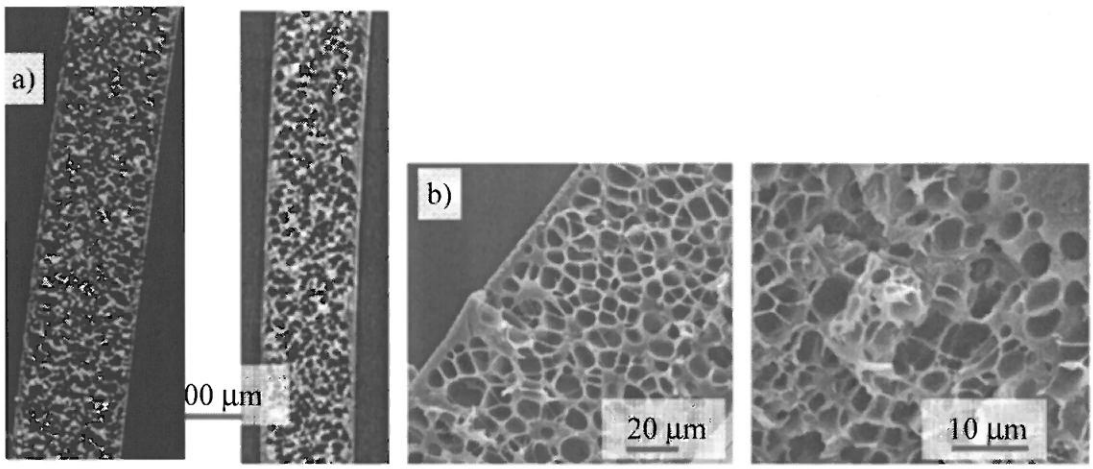
In the polymer foam industry, emphasis is placed on improving foam properties and making the production process more sustainable and ecological. Polymer foams are mainly used for their heat insulation properties. According to mathematical modeling, heat insulation properties can be improved by (i) ballistic (Knudsen) effect for average cell sizes smaller than several microns, (ii) reduced heat radiation in foams with cell sizes smaller than approximately 100 μm and (iii) additives. Conventional polystyrene (PS) and polyurethane foams have the average cell size larger than 100 μm. By reducing the average cell size below 10 μm, we would obtain improved products with superior heat insulation properties.

We prepared PS microcellular foams from PS films using high pressure CO_2 as the blowing and nucleating agent. The PS film samples were prepared by a custom-built dip-coating apparatus using toluene as the solvent. We studied the influence of the foaming conditions (pressure, temperature, pressure release rate) on the resulting foam structure, which was analysed by X-ray micro-computed tomography (micro-CT), SEM and AFM. From the foam images (Fig. 1) we evaluated the average cell size, cell size distribution, cell density and porosity. By optimizing the process conditions, we produced microcellular foams with average cell sizes below 10 μm. We also observed a great influence of residual solvent (toluene) on the resulting foam structure. Our aim is to prepare microcellular foams with cell sizes below 1 μm, high cell density, high porosity and uniform structure.

Figure 1: Images of microcellular polystyrene foams taken by a) micro-CT and b) SEM.



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