Tuning the pore size of polyurethane rigid foams via controlled bubble entrainment

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The interest in polyurethane rigid (PUR) foams as thermally insulating materials continues to grow due to the urge to minimize CO_2 emission. Controlling the thermal insulation efficiency of PUR foams, however, starts with the control of their porous morphology. Although the presence of micrometer-sized air bubbles entrained during the initial blending of the reactive PUR foam mixture (premix) has been shown to influence the final PUR foam morphology[1], detailed experimental investigation on how exactly the number of pre-dispersed air bubbles in the liquid premix affects the final PUR foam pore size is still lacking. To fill this gap, we developed a double-syringe blending process which allows to control the air bubble density of the premix and to strictly decouple air bubble entrainment and mixing of the reactive compounds. Employing this process, we can trace back changes in final PUR foam morphology exclusively to changes of the air bubble density in the initial state of the reactive premix. Our results confirm recent findings which suggest the presence of two different regimes of bubble nucleation and growth depending on the abundance of pre-dispersed air bubbles in the premix.[2] Furthermore, we demonstrate an inverse correlation between the air bubble density in the premix and the final pore size of PUR foams. For a single PUR foam formulation, we were therefore able to tune the mean pore size in the range of 300-1000 µm only by controlling the amount of pre-dispersed air bubbles within the initially liquid premix.

References:

[1] B. Kanner, T.G. Decker, *J.Cell. Plast.*, **1979**, *8*, 304 – 310.
[2] C. Brondi, E. Di Maio, *Polymer*, **2021**, *228*, 123877.