Chemical blowing agent-assisted foam extrusion: from processing to morphology and mechanical efficacy

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1. Framework and hypothesis

Density gradation of foam structures allow to improve the mechanical efficacy of thermoplastic foamed materials in several applications based on nature evidence of effectiveness.

At large scale, pentane-containing polystyrene (PS) processed by thermoldation, a **multi-step process**, is often used to achieve density-graded structures. In this PhD study, it is hypothesized that **continuous foam extrusion** can be used to develop **density-graded PS foams** in a single process.

2. Objectives

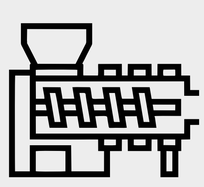
In a first approach, the feasibility of extruding pentane-containing PS was studied. Further, the addition of 1 wt.% of a **chemical blowing agent** (CBA) to the material formulation was investigated.

Parameter optimization was conducted by attesting the influence of **die temperature** on the physical, morphological, and mechanical properties of the extruded PS foams.

3. Methodology

01

Adaptation of a laboratory-scale twin srew extruder.

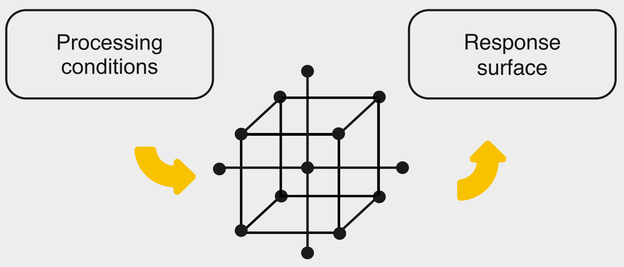


Feedstocks

Gas-tight isolation and dynamic sealing

02

Parameter optimization based on design of experiments and analysis of response surfaces.

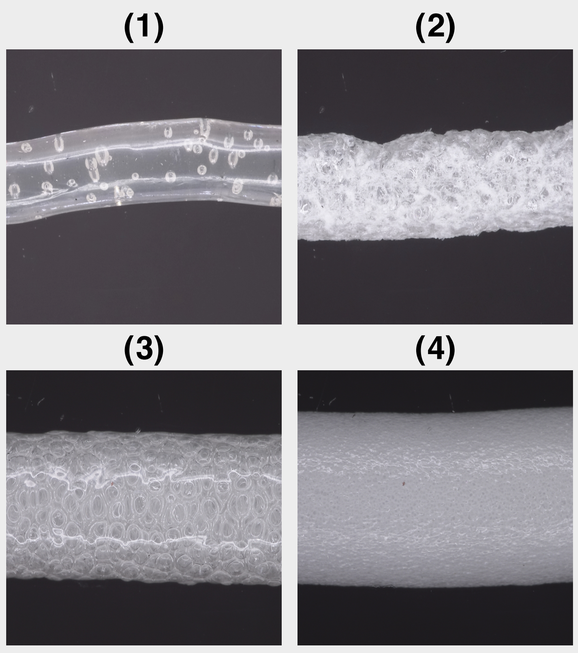


03

Characterization of physical, mechanical, and morphological properties of extruded foams.



4. Results

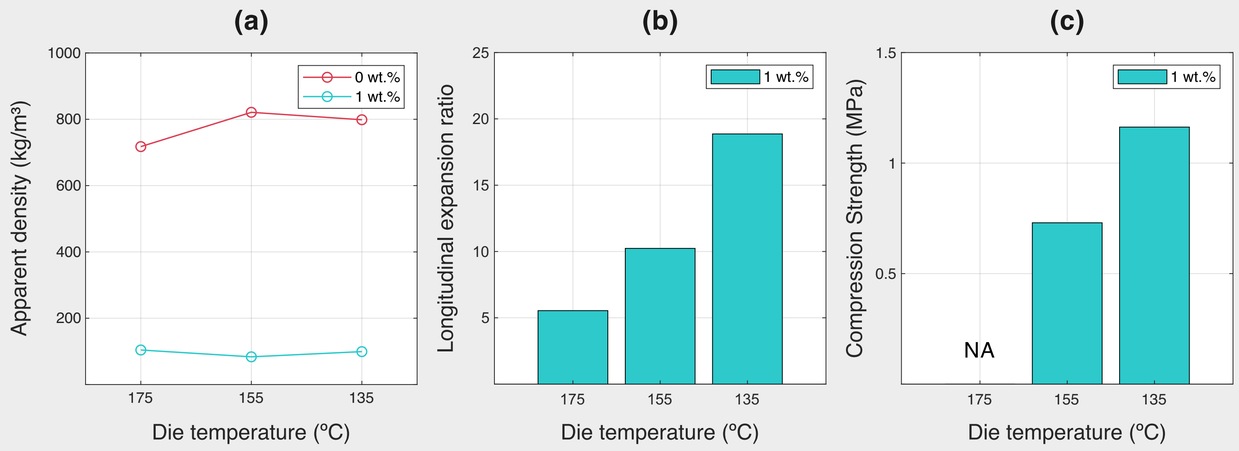


(1) Extrusion without gas-tight isolation and 0 wt.% CBA - no expansion, appearance of few, scattered cells.

(2) Extrusion without gas-tight isolation and 1 wt.% CBA - no expansion, signs of cell collapse

(3) Extrusion with gas-tight isolation and 0 wt.% CBA - moderate expansion, appearance of large cells.

(4) Extrusion with gas-tight isolation and 1 wt.% CBA - good expansion, appearance of small, uniform cells.



- 1 wt.% CBA decreased in -85% the apparent density in relation to neat PS and independently of the die temperature.
- Decreasing the die temperature significantly increased the longitudinal expansion ratio and compression strength of extruded PS foams.

5. Conclusions

This study demonstrated that continuous foam extrusion allows to achieve materials with distinct properties, which is crucial for the production of density-graded structures in a single process.

Future perspectives of this work will be focused on using the gathered data from the material characterization on the design of density-graded foam structures that can provide enhanced mechanical efficacy in comparision with their uniform counterparts.

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