

One-step reactive extrusion foaming of starch for lightweight biobased materials

From
Knowledge
to Competitiveness
Portugal-US Partnerships 2026 Summit

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1. Framework and hypothesis

Starch foams are promising candidates to replace fossil-based foams.

However, native starch lacks the **melt strength** required to prevent **cell collapse** during expansion.

This study proposes a processing approach that aims to overcome **starch foamability limitations**.

2. Objectives

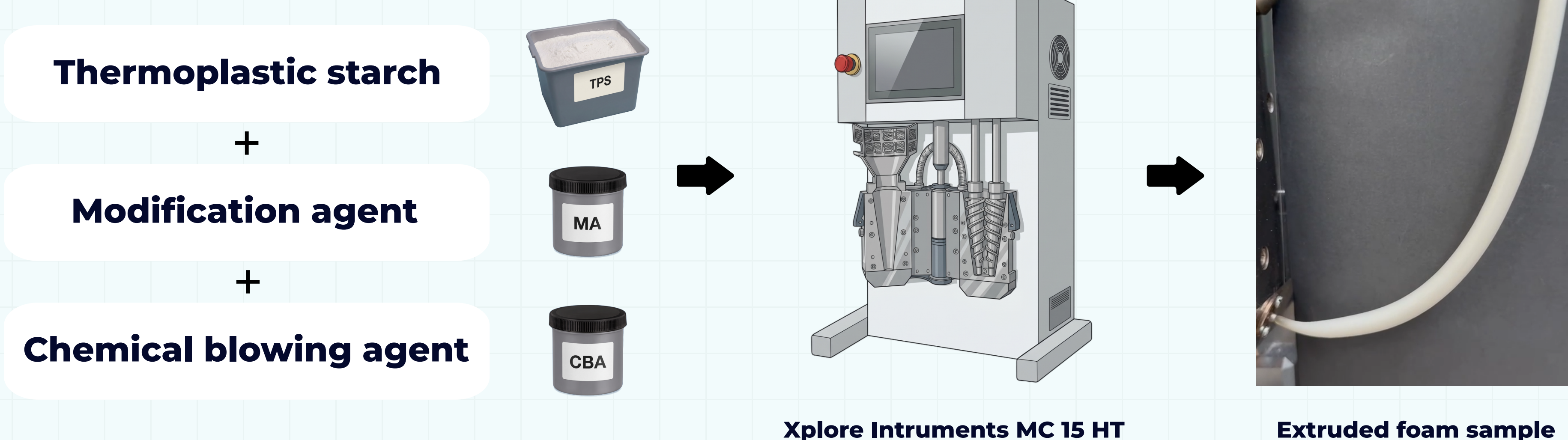
Evaluate the feasibility of promoting starch modification and foaming in a **single step process**.

Investigate the underlying chemical and physical processes through the analysis of the **structural** and **chemical evolution**.

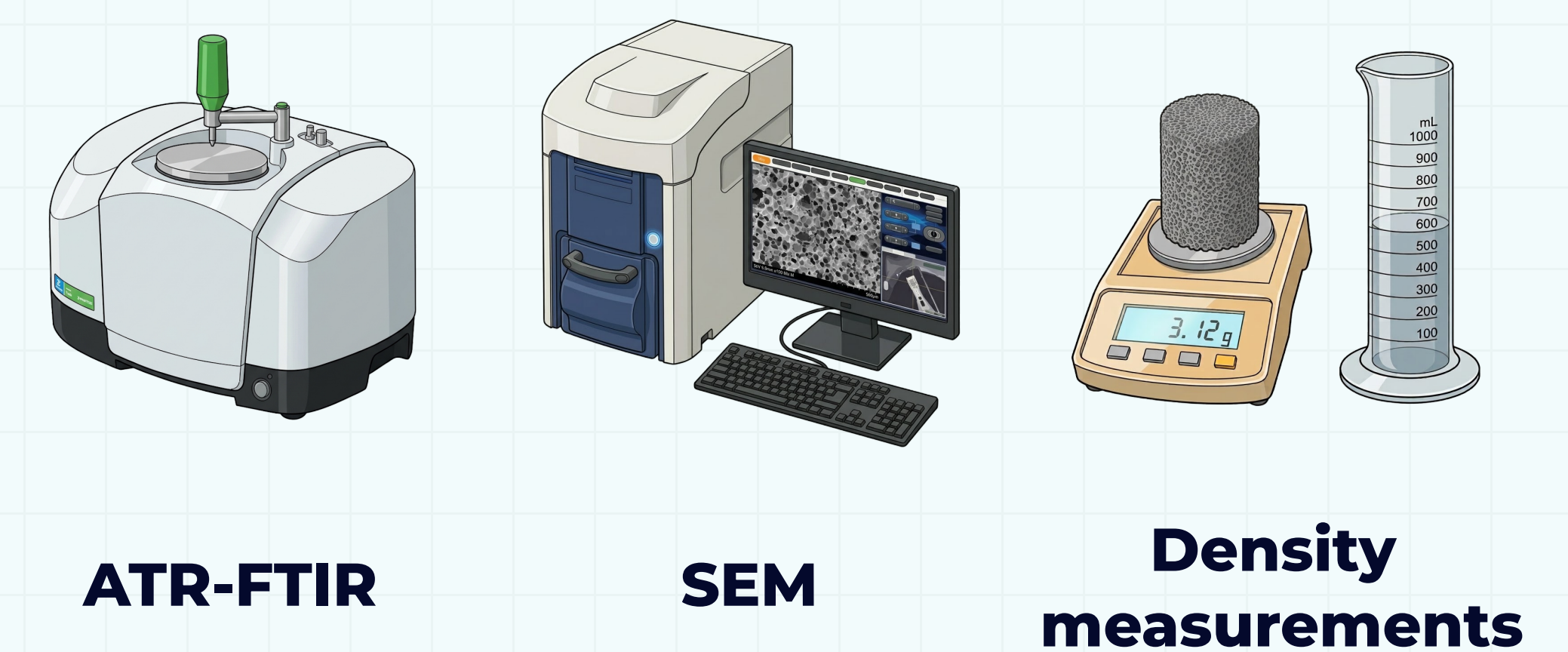
Contribute to the development of **sustainable** and **circular materials**.

3. Methodology

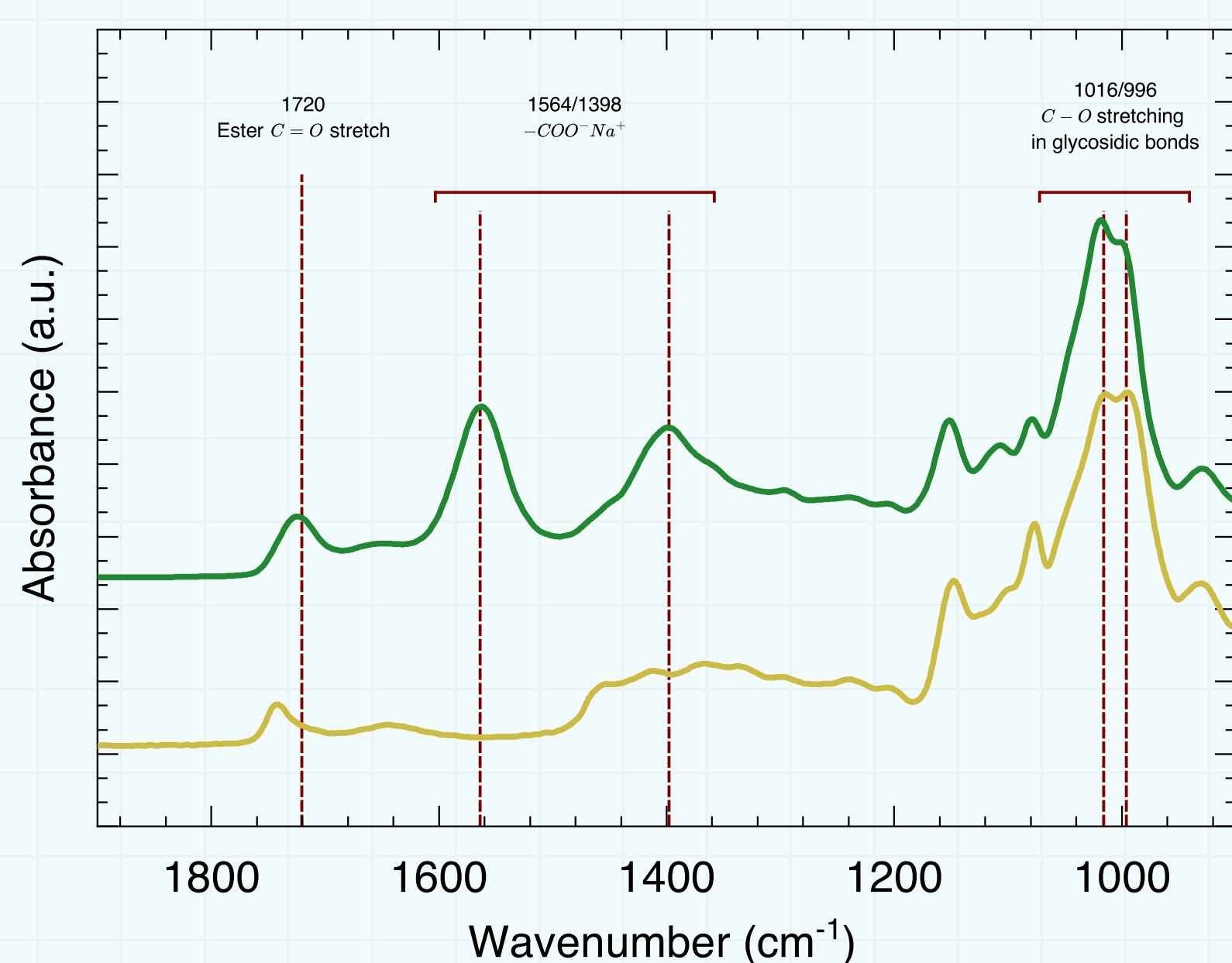
Reactive extrusion foaming



Characterization

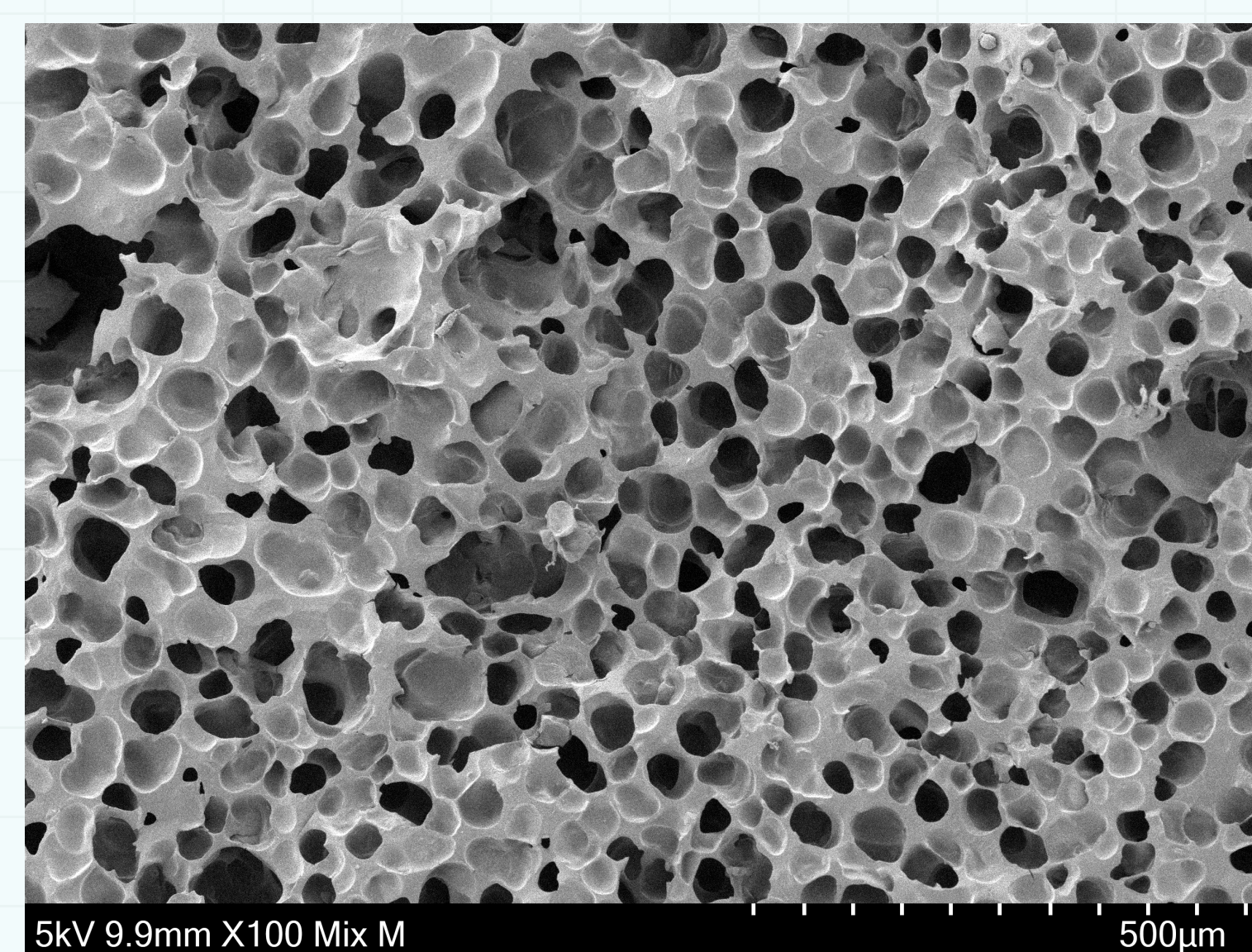


4. Results



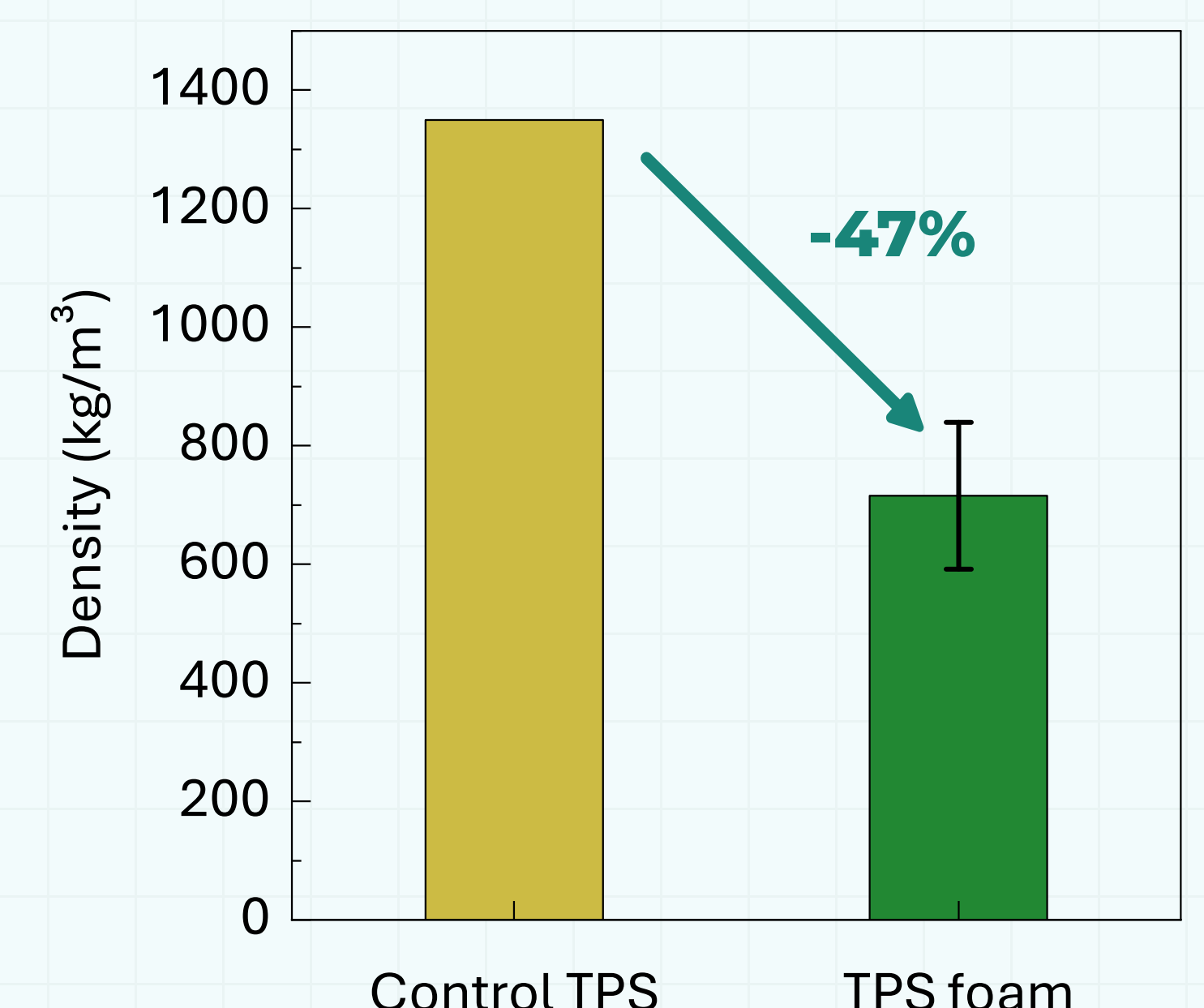
FTIR spectra displays new peaks attributed to **starch esterification** and **new functional groups**.

This observation supports that **TPS was modified** during the short residence time of the extruder.



SEM micrographs show a stable **porous network** composed of small and uniform cells, with limited evidence of **cell collapse**.

This confirms that reactive foam extrusion is able to combine starch modification and expansion in a **single process**.



The foamed extrudate exhibited a **density reduction** of around 50% compared with the unfoamed matrix.

However, the obtained density is still not comparable to conventional polystyrene foams (10-50 kg/m³).

5. Conclusions

Starch modification and foaming were successfully integrated into a **single continuous processing step**.

Significant density reduction and a **uniform cellular structure** were achieved without severe cell collapse.

Further process optimization is required to obtain comparable densities to conventional foam materials.

Acknowledgements

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