

1. Context and Summary of the Test Campaign

RecyClass Polystyrene Technical Committee (PS TC) conducted a test campaign to assess the behaviour of PS/EVOH/PE multilayer structures in both sorting and recycling conditions. These multilayer packaging formats are commonly used for high-moisture or long-shelf-life foods and typically contain approximately 90 % polystyrene (PS), around 2 % EVOH as an oxygen barrier, roughly 7 % polyethylene (PE) as a water barrier, and less than 1 % EVA tie layers. Their overall presence on the European market is estimated at around 10 % of PS food packaging.

The campaign was based on samples supplied by a brand owner (sorting tests) and in reel format by an industrial converter (recyclability tests), accompanied by additional insights previously shared by RecyClass PS TC members. The overarching objective was to verify the compatibility of such structures with sorting and recycling processes.

Overall, the multilayer structures demonstrated good detectability as PS in several sorting facilities and showed generally good processability during recycling trials. However, some deviations were observed in mechanical properties of the recycle, particularly flexural modulus and Charpy impact strength.

2. Design of Experiment and Tested Samples

The test plan combined sorting assessments and recyclability trials, conducted across multiple European facilities to capture a representative range of real-world performance.

Sorting tests were carried out at CROK, at Interzero (both static and dynamic conditions), and in a Belgian PMD sorting facility with the support of Fostplus. Recyclability trials followed the full PS Recyclability Evaluation Protocol (REP-PS-01) and were performed at AIMPLAS.

For sorting tests, a market-ready PS/EVOH/PE pudding pot was used. Tests at CROK included a compaction step in a real collection truck and testing in an industrial and operative sorting plant. Tests by Interzero and Belgian PMD were also done to complement the results obtained by CROK.

Recyclability tests employed a multilayer sheet (PS/PE/EVOH/PE) containing approximately 9 % PE, 1 % EVA, and 1 % EVOH from a converter. Reprocessed STYRON A-Tech 1200 was used as control material

and the same virgin grade was used during the conversion. Blends were prepared at 0 %, 25 % and 50 % incorporation of the innovation material (A.0, A.25, A.50). Pre-treatment steps included grinding, flotation tests to verify density behaviour and air elutriation, while washing was omitted. Subsequent steps covered extrusion, injection moulding and sheet extrusion, allowing complete characterisation of the recyclate's performance. For sheet extrusion, blends B.0, B.25 and B.50 were utilized.

3. Summary of Results

Sorting trials showed consistently good NIR detectability of the PS/EVOH/PE samples. CROK reported accurate recognition as PS in 94 % of the cases during dynamic tests. Interzero static tests indicated good recognition of the pots as PS, as it was for the dynamic tests. Complementary results from a Belgian PMD confirmed detectability when the PS-rich outer surface faced upward, while warned that misclassification might occur when the internal PE-rich layer was exposed, underlining the importance of object orientation and testing on sorting lines.

Recyclability assessments demonstrated good processability of all blends. Flotation behaviour confirmed a density profile consistent with recovery in the PS stream.

Extrusion tests revealed clean filters with no significant buildup. Homogeneous pellets with slightly whiter colour for innovation blends were obtained. Injection moulding and sheet extrusion showed stable processing conditions across all materials, with no defects observed on moulded bars, plaques or sheets and no major deviations in melt pressure or torque during sheet extrusion.

Mechanical properties evaluation highlighted the primary deviations. Flexural modulus and Charpy impact strength were negatively impacted as the share of multilayer material increased, whereas other key parameters remained within acceptable ranges. Deviations outside of the recommended benchmarks was observed for Flexural modulus and Charpy for A.50 blends, whilst the first one was also deviating for the A.25 blend.

4. Conclusion and Guidelines Update

The PS/EVOH/PE structures tested demonstrate clear potential for recovery in the PS stream, supported by good sorting performance and by overall good recyclate processability and quality. However, mechanical property shifts observed for A.50, particularly for flexural modulus and impact strength, indicate a limited but non-negligible influence on final recyclate quality.

Based on these findings, RecyClass PS TC defined the following updates to the Design for Recycling Guidelines for PS packaging:

- PE in concentrations equal or below **4.5 wt%** in combination with **EVA tie layers** is **fully compatible** with PS recycling.
- PE in concentrations over **4.5 wt%** and below **9 wt%** in combination with **EVA tie layers** is **limited compatible** with PS recycling.

5. Outlook and Future Investigations

While this campaign provides essential evidence concerning PS/EVOH/PE packaging, further work is encouraged to strengthen understanding of multilayer behaviour in PS recycling systems. Additional dynamic sorting trials, as well as studies comparing different structures and tie-layer chemistries, would help refine compatibility assessments. It is crucial to emphasise the importance of monomaterial packaging, as it significantly enhances sorting efficiency and recyclability. Avoiding multilayer constructions wherever possible simplifies recycling processes, reduces the risk of misclassification, and results in higher quality recycle. By prioritising monomaterial designs, stakeholders can contribute to a more effective and sustainable recycling system, minimising complications and improving material recovery rates.

RecyClass will continue collaborating with industry partners, testing facilities and technology providers to ensure that guidelines remain up-to-date, supporting the development of recyclable packaging solutions that preserve performance while enabling circularity.

About RecyClass

RecyClass is a non-profit, cross-industry initiative advancing recyclability, bringing transparency to the origin of plastic waste, and establishing a harmonised approach toward recycled plastic calculation & traceability in Europe. RecyClass develops Recyclability Evaluation Protocols and scientific testing methods for innovative plastic materials, which serve as the base for the Design for Recycling Guidelines and the RecyClass Online Tool. RecyClass established Recyclability Certifications for plastic packaging, Sorting Process, Recycling Process, and Recycled Plastics Traceability Certifications for plastic products.

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Annex I

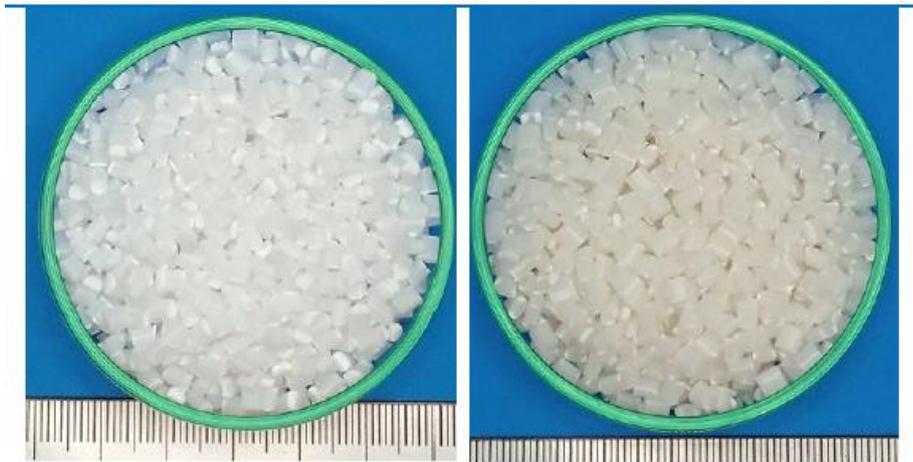


FIGURE 1. STYRON A-TECH 1200, VIRGIN (LEFT) AND CONTROL (RIGHT)

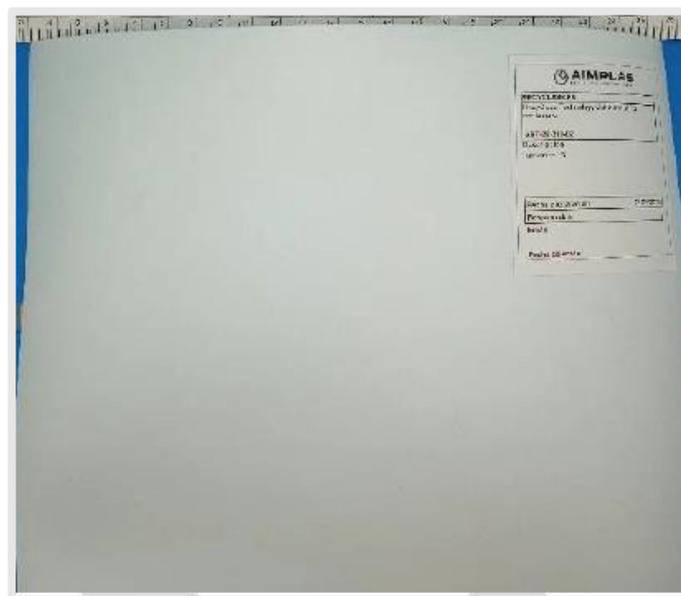


FIGURE 2. INNOVATION MATERIAL (PS/EVOH/PE SHEET)



FIGURE 3. EXTRUDED PELLETS

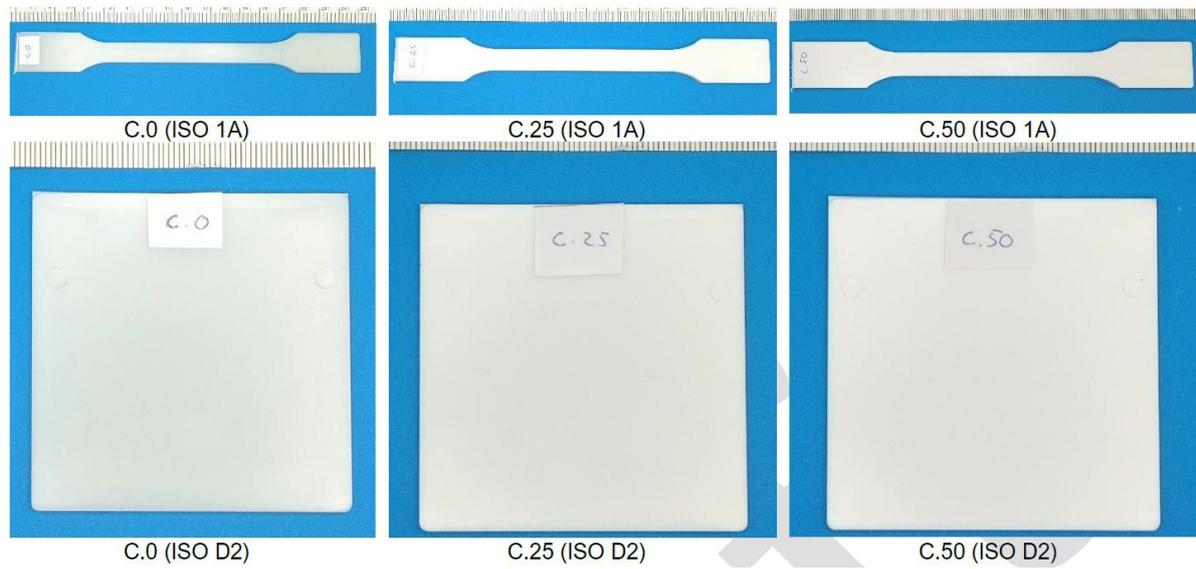


FIGURE 4. INJECTED SAMPLES

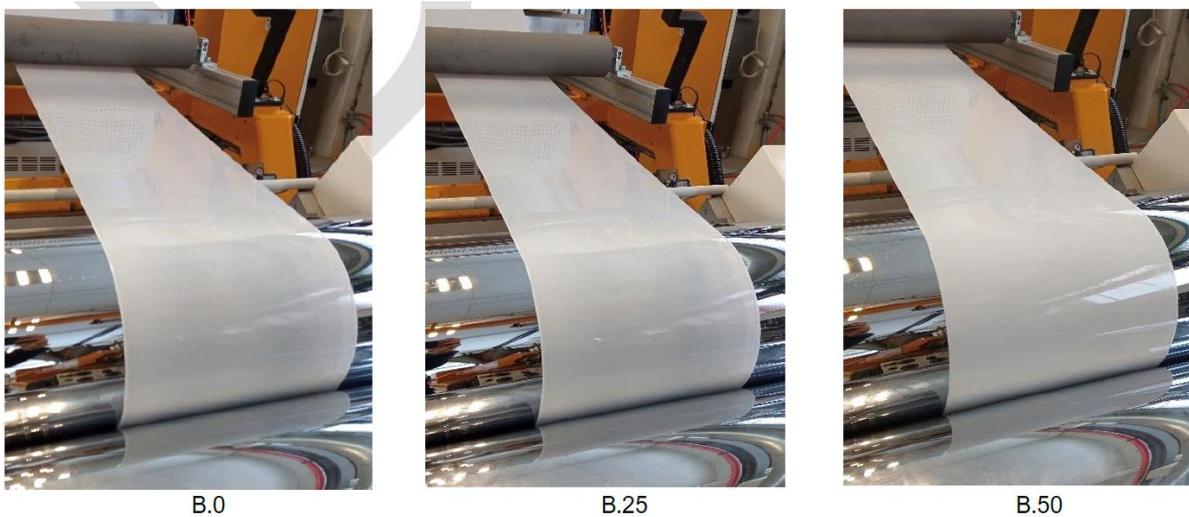


FIGURE 5. EXTRUDED SHEETS.