RecyClass PET Technical Committee (TC) conducted a dedicated test campaign to assess the impact of common reheat additives used in transparent PET bottles. The objective was to evaluate their influence on colour development and visual appearance, simulating multiple recycling cycles. This work supports the continuous improvement of the Design for Recycling (DfR) Guidelines for PET packaging, by adding recommendations on the selection of the right reheat additives. The campaign included industrially relevant additives currently available on the market (Carbon Black (CB), Titanium Nitride (TiN), and Ferrous Phosphate (FeP)) as well as 3 more recent innovations, supplied by Avient and Repi. A non-additivated PET grade (RAMAPET N180) served as the control reference material.

The experimental programme followed a standardised approach to characterise colour evolution under thermal stress. Plaques were produced using pellets containing each of the additives and the control PET. Initial colour measurements were conducted before oven exposure to establish baseline Lab* values. Pellets were then placed in an oven at 220 °C and sampled after 1 h, 2 h, 3 h, and 4 h to generate plaques reflecting progressive heat history. All plaques were measured using reflectance mode (D65, 8–10°, SCI gloss setting), with the objective to determine how reheat additives influence the yellowing index (b*) and brightness (L*) under conditions mimicking high-temperature processing phases typical in bottle-to-bottle recycling. In addition to colour measurements, Near-Infrared (NIR) analysis was performed, focusing especially on the 1100 nm wavelength, to measure the reheat performances. Haze measurements at t = 0 h and t = 4 h were also included to refine the assessment of visual clarity. This dual optical characterisation enabled a more complete comparison of additive performance.

Across all samples, the control PET displayed stable and relatively neutral colour values, confirming its suitability as a baseline reference. In contrast, several reheat additives showed noticeable colour shifts even prior to heat exposure. CB, FeP and TiN, for instance, exhibited darker L* values from the start, demonstrating that their optical fingerprints may already affect the transparency of clear PET before reprocessing (see Annex I).

Throughout the oven exposure, CB expressed the strongest darkening, with L* values decreasing steadily from 85.9 at t = 0 h to 75.5 at t = 4 h, accompanied by high b* values reaching 15.2. This pattern confirms its significant yellowing and darkening effect under heat, making it a critical concern for the quality of recycled transparent PET. FeP showed a comparatively smaller but still notable decrease in brightness and an increase in yellowness, reinforcing earlier observations that FeP-based materials pose challenges to maintaining clear bottle appearance, in particular considering the low L* and high b* values before heat exposure. TiN demonstrated a more favourable profile. Despite being slightly darker than the control in terms of L*, its L* and b* evolutions remained small and much lower than that of CB or FeP. One of the tested recent innovation showed the most stable behaviour overall among the alternative additives, with almost no variation of L* and b* values during oven exposure. NIR and haze analyses further confirmed these trends: TiN and the abovementioned innovation presented the lowest negative impact on clarity, whereas CB and FeP showed significant increases in haze and colour deviation after heat exposure.

The overall findings reveal significant differences in yellowing and darkening depending on the additive type. As anticipated, Carbon Black (CB) presented the most challenging performance, whereas Titanium Nitride (TiN) showed promising results, particularly in terms of b* stability.

Based on the overall outcomes, reheat additives exert very different levels of influence on the optical properties of PET, especially under high-temperature conditions relevant for recycling. Some formulations such as CB and FeP significantly increase yellowness and reduce brightness, while others like TiN show limited impact on colour development and can therefore be considered more compatible with maintaining clear transparency in recycled PET streams. These insights directly support the following updates to the existing Design for Recycling Guidelines, as agreed by the RecyClass PET TC:

For clear & light-blue transparent PET bottles:

- Full compatibility: No reheat additives
- Limited compatibility: Titanium Nitride (TiN)
- Low compatibility: Ferrous Phosphate (FeP); Carbon Black (CB)

For coloured transparent PET bottles:

- Full compatibility: No reheat additives; Titanium Nitride (TiN)
- Limited compatibility: -
- Low compatibility: Ferrous Phosphate (FeP); Carbon Black (CB)

This categorisation considers both initial colour properties and the trends observed after thermal exposure. For clear and light-blue transparent PET bottles, TiN appears to be an acceptable option despite slight darkening in L*.

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This test campaign highlights the need for a comprehensive understanding of how reheat additives, and additives in general, behave throughout the recycling loop. Although this test campaign provides a first comparison of the most common reheat additives, more work will be requested to evaluate the impact of oxidation on the colouration of rPET. RecyClass PET TC invites additives producers to also test alternative additive chemistries to offer more circular solutions and secure high quality clear transparent rPET.

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

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Annex I

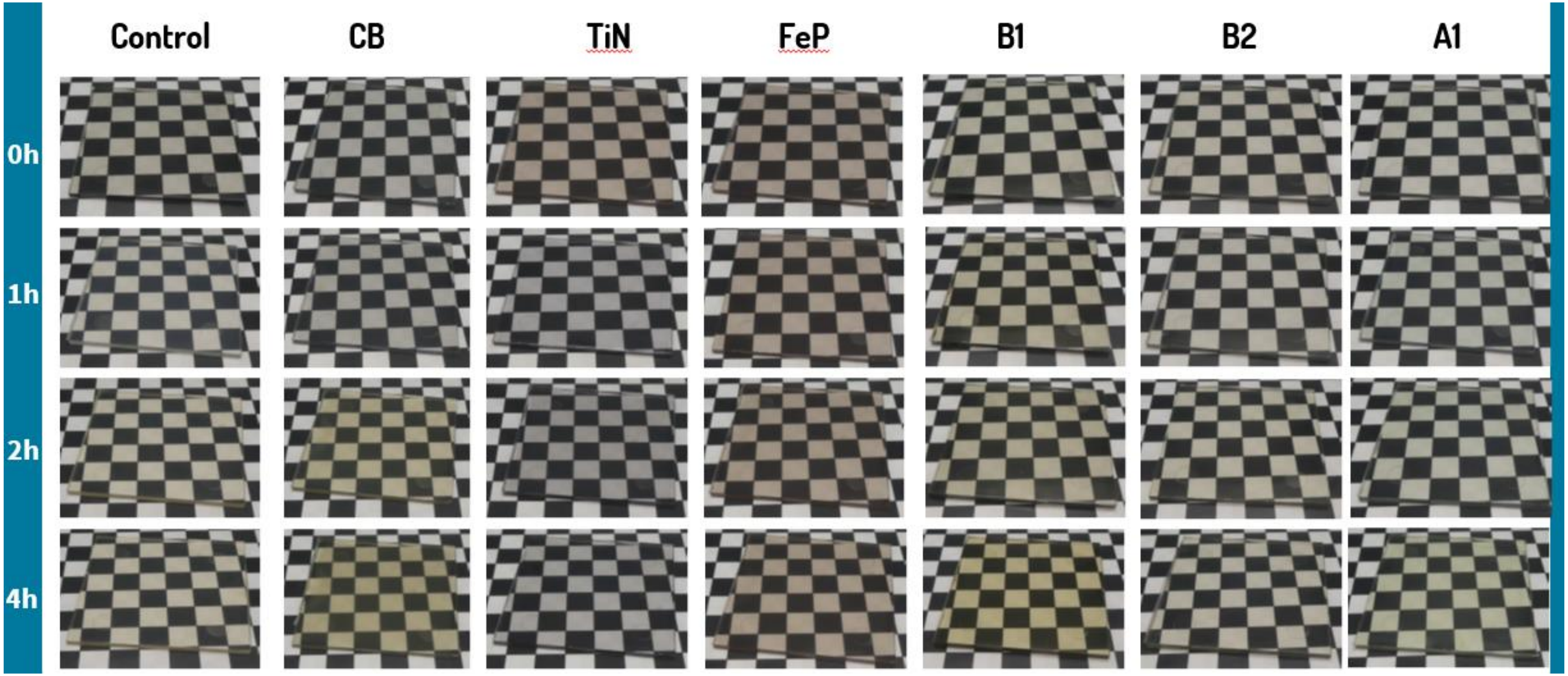

Figure 1: Pictures of produced plaques, before and after pellets heat exposure.