

Recyclability Scoring and Screening of Papers with Food-Contact Grade Barrier Coatings

Arne Derluyn, Patrick Cosemans, Bram Bamps, Roos Peeters, Pieter Samyn*

*contact: pieter.samyn@sirris.be

SIRIS – Department of Innovations in Circular Economy, Belgium

HASSELT UNIVERSITY - Materials and Packaging Research & Services, Belgium

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Introduction

- Motivation:** EU Directive 2018/852 “Green Deal”: Preventing packaging waste, boosting reuse and refill, and making all packaging fully recyclable by 2030: (i) decrease the need for virgin materials, (ii) boosting Europe's recycling capacity and (iii) making Europe less dependent on primary resources and external suppliers; FEVIA (Belgium): all food packaging 100% reusable, recyclable or compostable by 2025.
- Status:** Barrier-coated papers are desired for food packaging (Figure 1), with required high overall recycling rates of paper and board products (Figure 2).

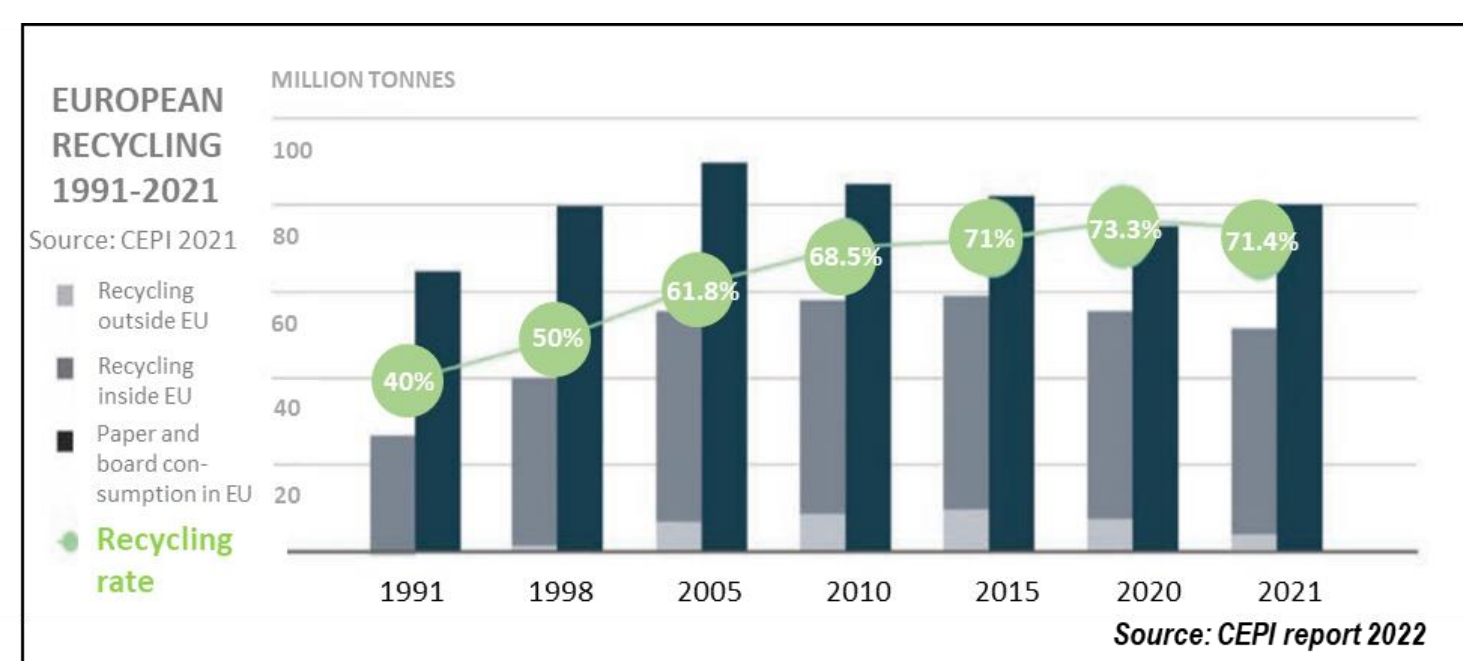


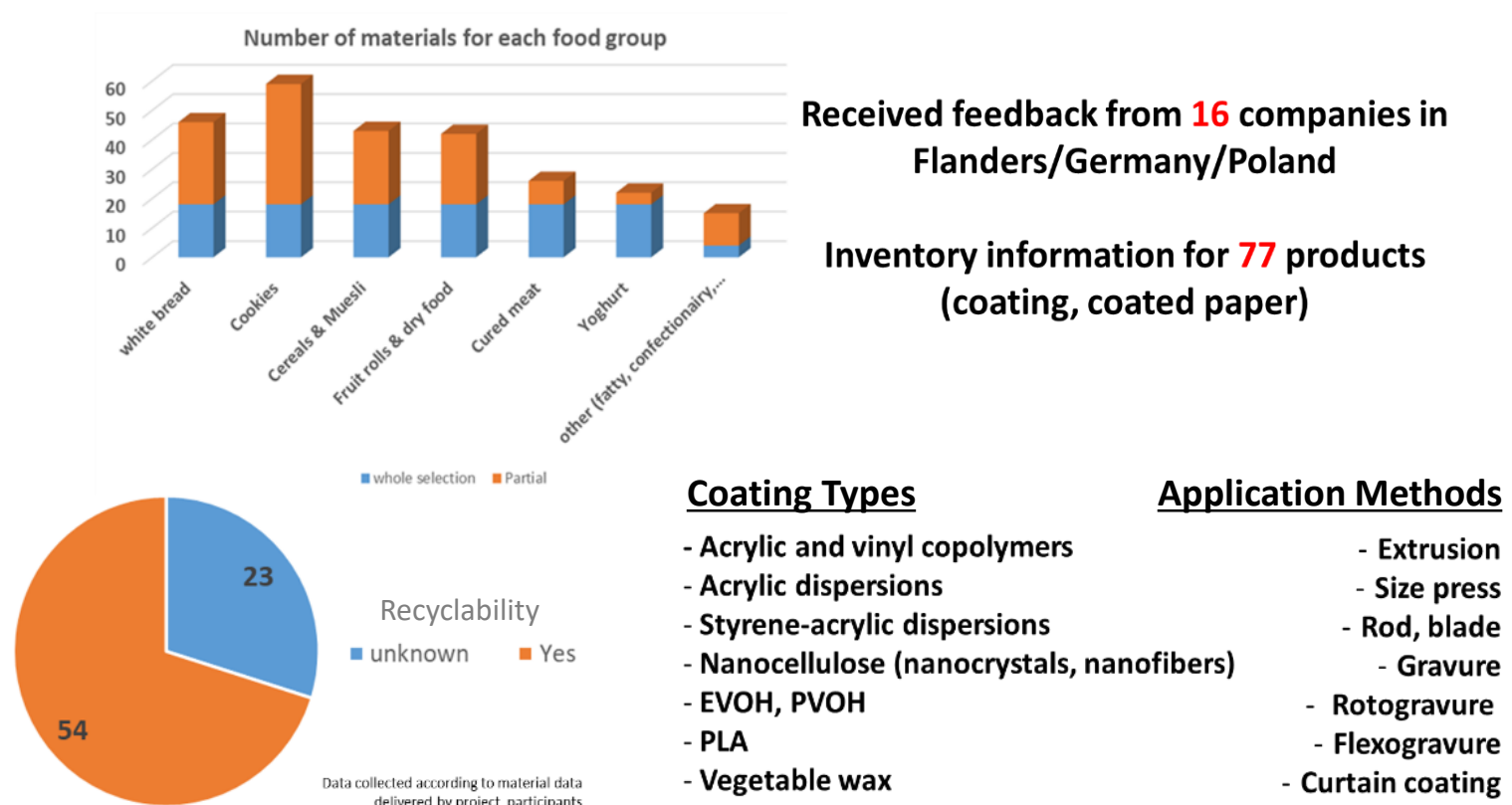
Figure 1: Coated paper products for food-grade packaging applications

Figure 2: Recycling rate is defined as the ratio between the recycling of used paper and consumption of new paper and board.

Materials

- Selection of industrially available coated paper grades suited for food packaging, including different food types.
- Creating a database of coatings for paper packaging and coated paper approved for packaging of various food types, resulting in a shortlist of materials that will be selected for detailed analysis

https://www.sirris.be/en/database_coated_paper



CEPI Harmonized European Laboratory Test Method to Generate Parameters for Assessment of Recyclability in Standard Mills

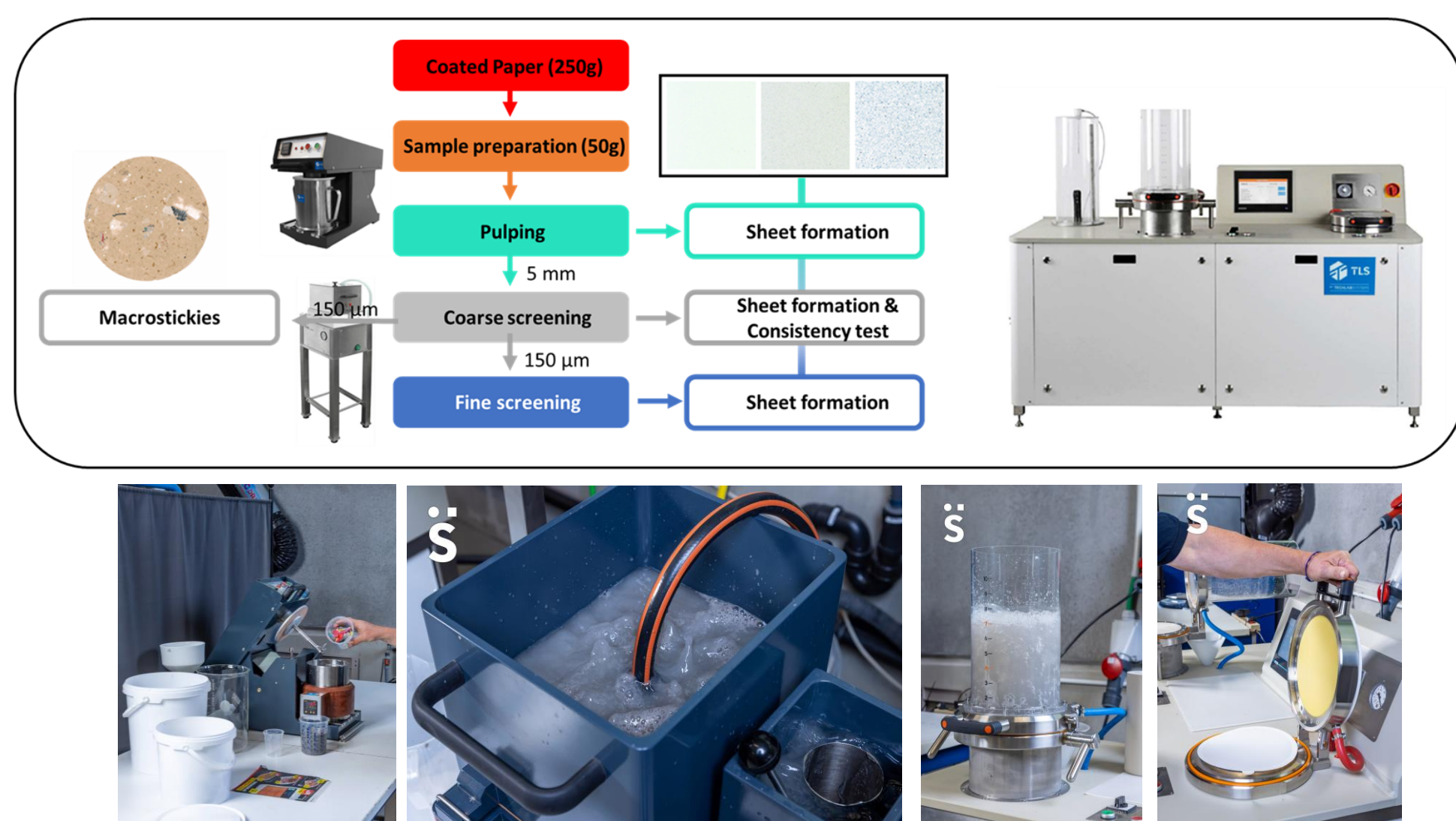


Figure 3: Testing protocol for recyclability testing according to CEPI Testing method

Most recent guidelines according to the European harmonized laboratory protocol for recyclability testing in standard mills were implemented including different processing steps (Figure 3), for the evaluation and assessment of recyclability of coated papers, based on determination of different evaluation scores, i.e. **Y**, **VI**, **SA** (Figure 4).

$$Total\ Score = \frac{(Y + VI + SA - 100) + |Y + VI + SA + 100|}{2}$$

Y = Yield Score
 VI = Visual Impurity Score
 SA = Sheet Adhesion Score

Total score	Standard Mill Recyclability	Score component breakdown					
		Yield		Visual Impurities		Sheet adhesion	
		Score	Description	Level	Score	Level	Description
/100	0 – 100 Suitable for Standard Mill recycling	90 – 100	The method indicates that the packaging is expected not to pose any repulability issues in the standard mill and is therefore considered Best in Class.	Level 1	0	Level 1	Posses no visual quality issues.
	< 0 Not suitable for Standard Mill recycling. Potentially recyclable in other mill types.	70 – 89	The method indicates that the packaging has minor repulability issues that could have limited impact on the recyclability in the standard mill.	Level 2	-5	Level 2	Posses minor visual quality issues that can be acceptable in the mix.
		50 – 69	The method indicates that the packaging has some repulability issues that affect the process in the standard mill and should therefore not be abundant.	Level 3	-15	Level 3	Posses some visual quality issues that can be acceptable in the mix for certain types of production.
		0 – 49	The method indicates that the packaging has significant repulability issues that have a significant impact on the process in the standard mill and should therefore be avoided when possible.	Level 4	-30 or KO	Level 3	KO Poses significant adhesion issues that can have a significant impact on the process in the standard mill
		< 0	The method indicates that the packaging has major repulability issues which could stop the process at a standard mill and therefore are not suitable for this mill. It is recommended to evaluate this product with either Part II or III.				

Figure 4: Evaluation parameters for assessment of recyclability for coated papers in standard mill

Test Results: Recycling Scores and Visual Observation of Paper Products from Recycled Pulp of Coated Papers

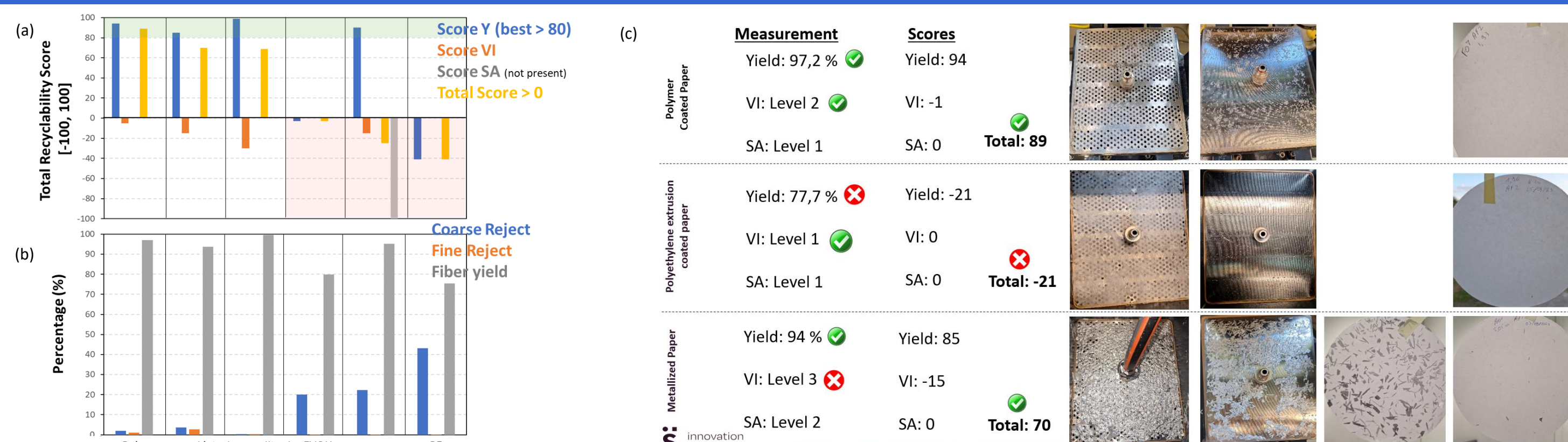


Figure 5: (a, b) Recyclability scores Y, VI, SA for a selection of coated papers, (c) with visual interpretation of coarse rejects (screen with holes) and fine rejects (screen with sleeves)

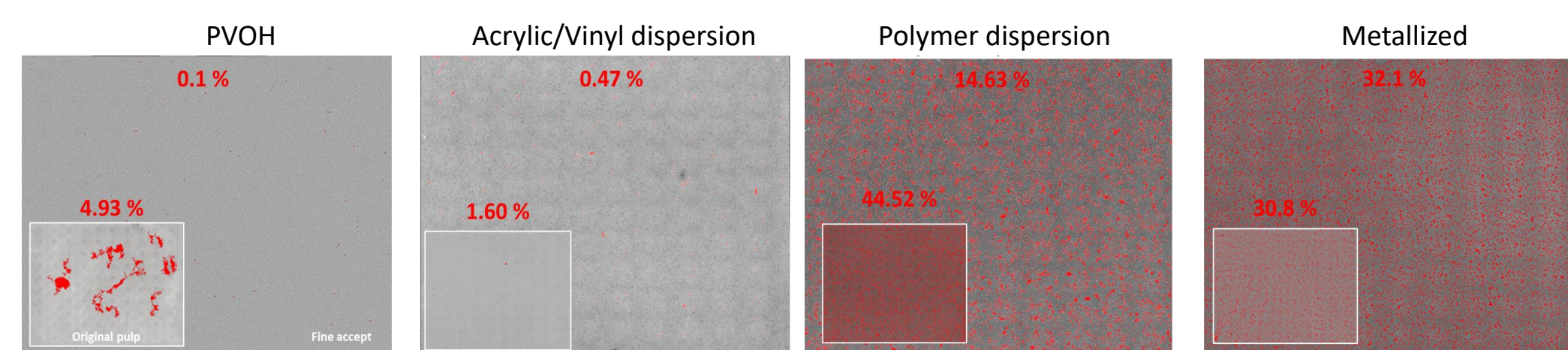


Figure 6: Optical visualization and quantification of polymeric inclusions in the handsheets made from original non-screened pulp (inset) and pulp of fine accepts (main picture), with indication of surface coverage of foreign coating inclusions



Figure 7: Near-infrared spectroscopy (NIR) of remaining coating inclusions in handsheets from recycled pulp

- Based on the calculated yield score (**Y**), clear discrepancy between dispersion and extrusion coatings are identified. If yield score is low ($Y < 80$), the total score is reduced and the sample is not acceptable in standard paper mills (Figure 5a).
- Significant variations in amount of coarse rejects (CR) and fine rejects (FR) depend on coating type for eventual same yield score $Y = CR + FR$ (Figure 5).
- The visual impurity score (**VI**) may significantly jeopardize the acceptance for recyclability as, e.g., the metalized papers provide a high fiber yield but inferior visual aspect (Figure 5c).
- Polymer inclusions in recycled handsheets can be quantified by optical microscopy and image processing (Figure 6), or identified through NIR spectroscopy (Figure 7), including eventual glue and coating remainants that influence sheet adhesion (**SA**).

Conclusions

- First estimates for recyclable packaging can be based on design-for-recycling guidelines, but practical testing is needed for explicit demonstration of recyclability and quality of recycled fiber fraction. Harmonized laboratory guidelines to be followed for recycling in standard mills are available and readily applicable for practical testing.
- Clear evaluation criteria determined for recyclability assessment (**Y**, **VI**, **SA**), depending on scoring grid with levels 1 to 4. However, additional optical evaluation is needed for better quantification and qualification of remaining coating inclusions.

Acknowledgments

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