Innovations in food grade recycled plastics packaging

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nextek

NEXTLOOPP
CLOSING THE LOOP ON FOOD GRADE PP

NEXTEK LTD

WHAT WE DO

Recycling plant design and Feasibility studies.

Strategic advice to Multi-National Corporations and Recycling Co's.

Food-grade recycling of post consumer plastics – process development.

Research and development of novel materials and processes including plastics and bioplastics.

Business support, productivity improvement and problem solving.

Ground breaking projects for governments and major commercial organisations in the EU, UK, India, Malaysia, USA, South America, Middle East, North Africa and Australia/NZ.

Strong ties to Universities and Scientific Centres of Excellence in the UK and Europe.

AWARDS

Circular Economy: Targets and Blockages

- **The Circular Economy = USE "WASTE" to make NEW MATERIALS (BUT DON'T CALL IT WASTE) and put it back into products,……. preferably the same products**
- The majority of materials have been designed to be processed once only. **Recycling friendly formulations are needed. CHANGE NEEDED**
- In the circular economy, you can only recycle what is put out by the retailers. **Printing and pigmentation limit re-use. CHANGE NEEDED**
- **Not all packaging is recyclable**. Mono materials are more widely recyclable to high value. In many countries around 25% of packaging has poor recyclability.
- **Food grade recycling** is possible but difficult to achieve unless sorting of food/non-food and powerful decontamination is available
- Odour removal from LDPE, HDPE and PP is often necessary
- Polyolefins are oxidised by the thermal recycling processes which will be problematic at high recycling rates such as >50%
- **Potential recovery of plastics for recycling and CO2e benefits.**

75% **collection** x 95% **sorting** x 85% **recycling** = **60% Recovery**

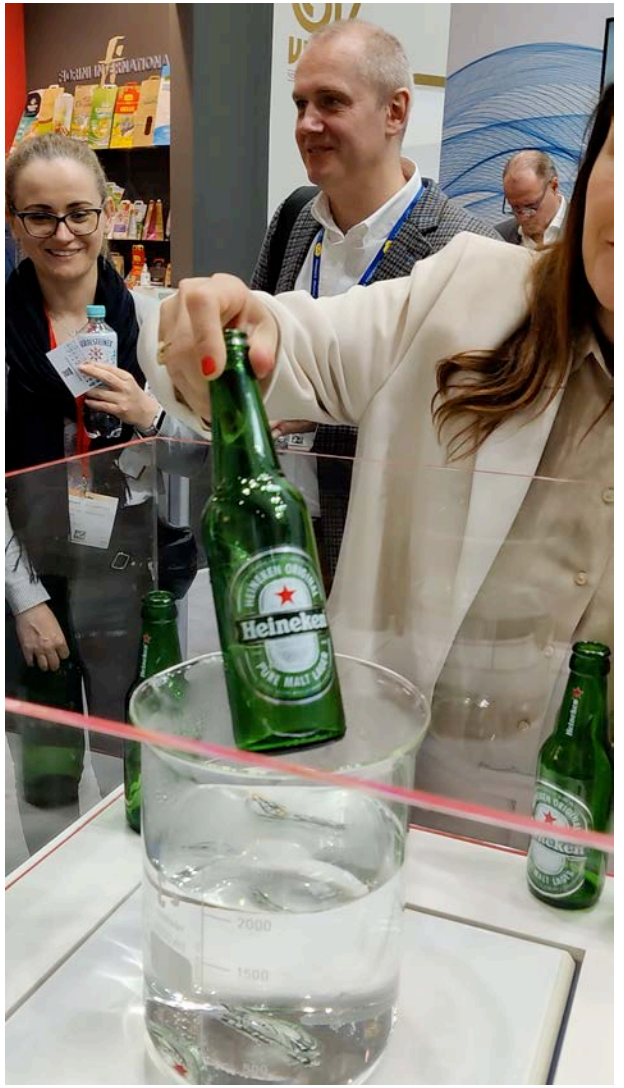
Each tonne of rPlastic will save around 1.5 tonnes of CO2e

Circularity = Design for Recycling back to (same) products

- **Especially important for food products**
- **RESIN** - ideally unpigmented, stabilised for multi-cycles
- **Printing inks and labels**
  - The label should be recycling compatible and separable or self-peeling from the bottle
  - Inks must not come off during hot washing
  - Direct printing with unstable inks should be avoided
- **Adhesives/Glue**
  - Stay with the label when they peel off
  - Ideally do not leach plasticisers
- **CAPS**
  - Many colours are used and affect final colour of the resin
  - Ideally should be colourless and stay with the bottle
  - Should be recycling compatible
  - Made of one polymer per packaging type

Adhesives

- Adhesives with phthalate plasticisers
  - Many endocrine disrupting / toxic to reproduction
  - Conflicts - some permitted use with FDA indirect use but excluded from 10/2011
  - MEHP / BEHP / DOTP frequently observed in labels
  - Some alternatives available i.e. adipates (see 10/2011)
- Label removal
  - One long term study finds an average of 2.2 % of HDPE flakes with labels attached after conventional hotwash process
  - Poor delamination = carry over of glues and inks
  - Glues causing gels and black speck impurities
  - Label carry over causing issues with genotoxic activity and circularity
- Should stay with the label when they peel off
- Ideally do not leach plasticisers



Design to Recycle: NextCycle IML from MCC Verstraete

- Removable IMLs - Verstraete's NextCycle IML
- Fully printed (non-bleeding inks) without adhesives.
- These labels are designed to be removed prior to extrusion at the grinding steps or air elutriation stage and separated from the rigid flakes

IML and Print removal: Mechanical Cleaning during wet washing

Recycling with IML labels left on

Recycling with IML labels removed through innovative recycling approach

CASE STUDY: Competitive INTELLIGENT SORTING into food use packaging

Globally, Near Infra Red (NIR) and visible signatures are used to identify the polymer type and colour at very high speeds.

No markers are needed for sorting into polymer types such as PET, HDPE, PP, LLDPE etc

The important technologies of marker sorting (Spectroscopic, Neural network (Artificial Intelligence) and Digital product markings will deliver more precise separation for recycling.

No.1 Priority is FOOD-GRADE Prior Use

No.2 Priority is Non-Food Grade Prior Use

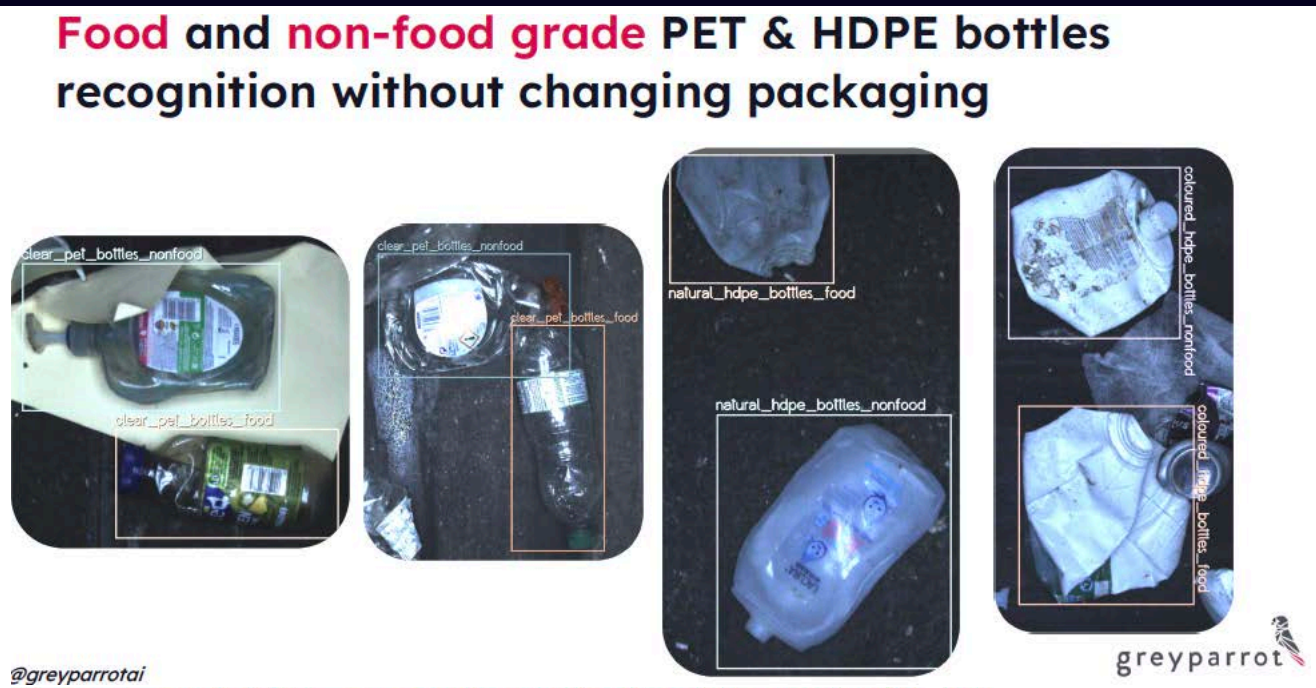
No.3 Priority is Toxic products

No.4 Priority is Difficult to Recycle packaging

Digital watermarks Filigrade and Digimark

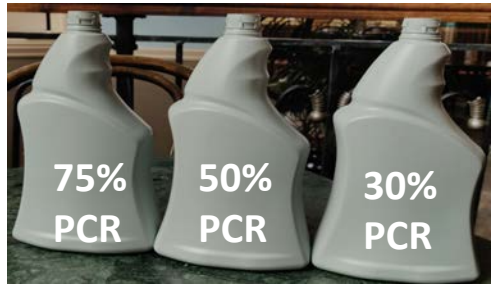
Fluorescent markers on labels

CASE STUDY: Artificial Intelligence (e.g. Grey Parrot) SORTING for plastics packaging



DESIGN FOR FOOD-GRADE CIRCULAR ECONOMY RECYCLING.
REMOVING AND CONTROLLING COLOUR TO BOOST RECYCLING

- The key challenges for food grade recycling are twofold:
  - 1. Recovering the food grade fraction of packaging for recycling
  - 2. Boosting the yield of the most favoured colours (natural and white) to improve economics
- The controlled use of pigmentation could be used to improve food grade sorting and increase yield.
- All food products should be preferably free of of pigment where possible; otherwise if opacity is needed, pigmented white.
- Non-food products would be in light pastel colours – thereby using smaller concentrations of pigments.
- Hazardous products would be pigmented in black (either carbon black or detectable black pigments).
- Sorting by transparent/pastel/black colouration of packaging is very simply achieved by the use of well-established, accurate and relatively low-cost automatic sorting technology using the visible light spectrum and cameras for detection.



POLYPROPYLENE

Growth of the "do everything" plastic

2018

56MMT

USD$ 97 Billion

+50% GLOBAL GROWTH

2025

83MMT

USD$ 147 Billion

Europe

10MMT

2018

NEXTLOOPP Project

48 participants in PP supply chain

Highest stiffness to weight ratio, insoluble, strong, super-tough, transparent, fibres, sheet, mouldings, furniture, appliances, automotive, packaging.

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NEXTLOOPP UNIQUE TECHNOLOGIES

PolyPrism

Sorting food-grade packaging

PPristine

Decontamination technology

Our unique technology has taken 8 years of intense research and commercial trials to achieve and is now **plug and play ready for use**.

This technology has been designed to be implemented **with current technologies, staffing and infrastructure**.

Sorting with markers requires only one layer of ink on a label and UV light

Mechanical recycling offers the most cost and carbon efficient option for recycling plastics

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How it works: Fluorescent markers and labels

Ink – Clear UV free radical flexographic ink

White backed PP pressure sensitive label printed using ‘flexo’ print process

Labels in daylight

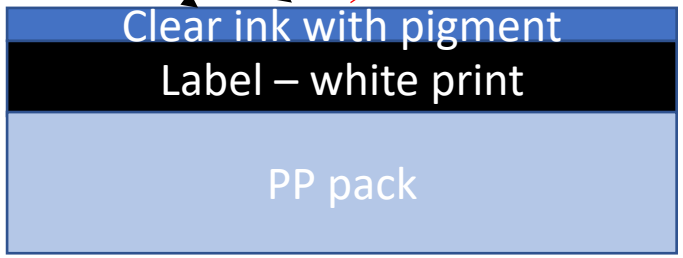
What the sorting machine camera sees

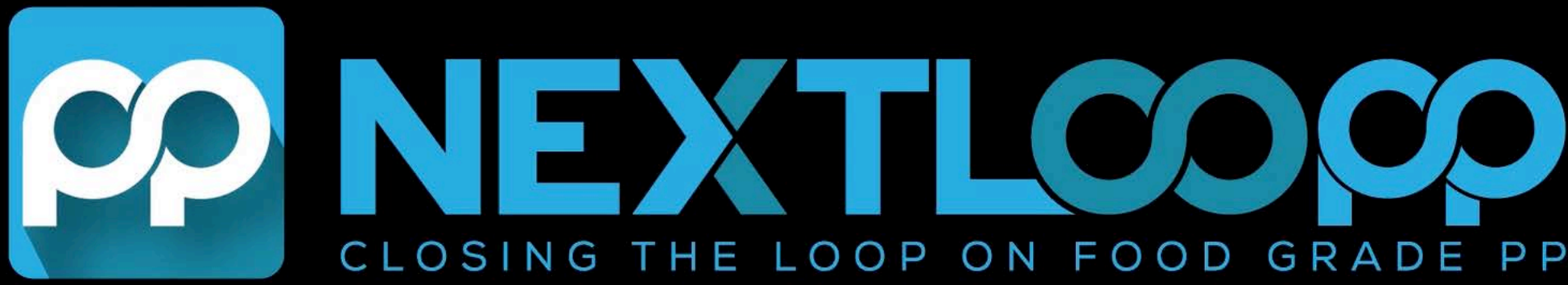
UV_{365nm}

Excitation light

Red 618nm

Detected light

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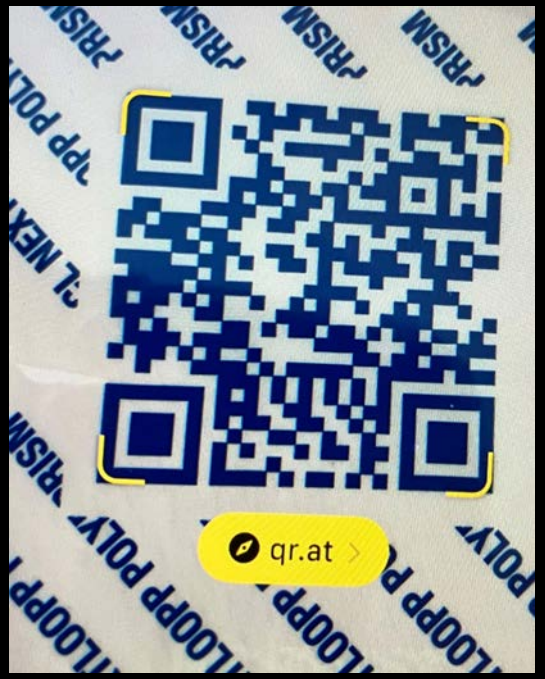
‘BRAND QR CODES’ AND ‘RECYCLING QR CODES’ ON LABELS

iPhone recognition of UV visible QR code at HY pigment concentration 0.35% w/w



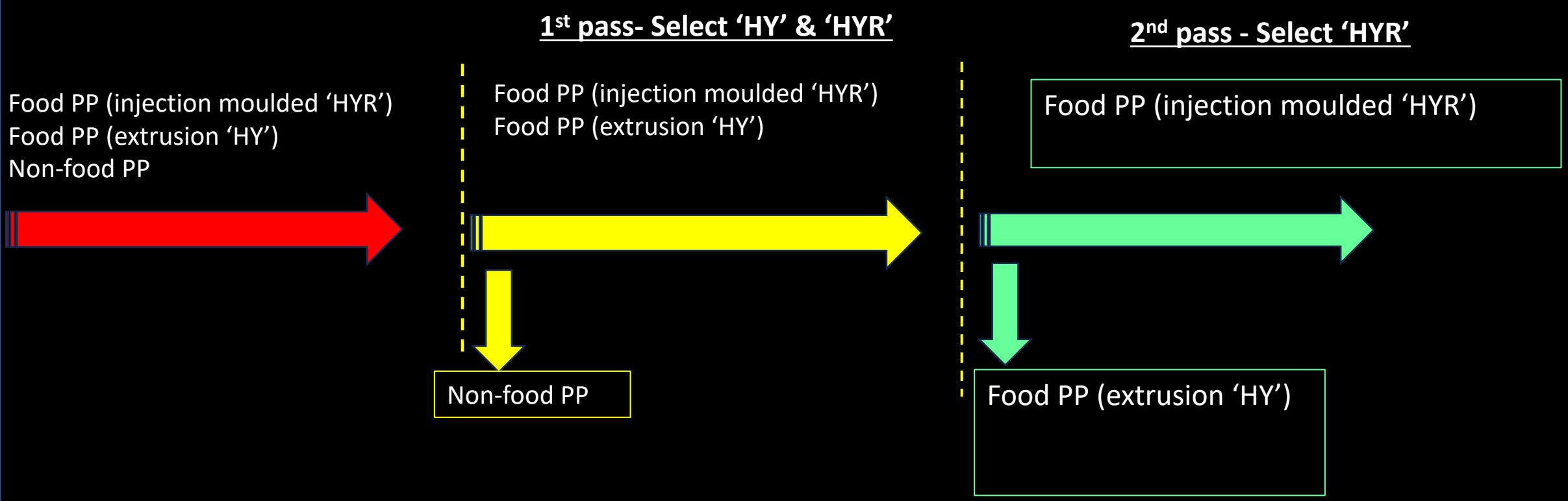
‘Brand QR code’

Prizes to drive brand loyalty
Social media engagement
Customer service information
Customer feedback
Food recipes
Food track and trace
Food nutritional value
Food allergy information
Supply chain transparency
Sustainability and disclosures

‘Recycling QR code’

Polymer traceability
Recycled content and verification
Polymer properties eg MFI
Approval for contact with food

SEPARATING FOOD GRADE INJECTION MOULDED PP AND EXTRUSION GRADE PP USING UV VISIBLE MARKERS



98% SEPARATION
INJECTION-MOULDED AND EXTRUSION GRADE PP

Without UV
zero packs selected
(Control test)

With UV - select ‘HY and HYR’
(All selected- 100% yield)

With UV – select INJ packs
(Yield 97%, purity 97%)
Extrusion packs not selected
(Yield 98%, purity 98%)

Three essential stages in Food Grade PP recycling

A. Sorting into PP is the first step
B. Sorting into Food Grade PP is next
C. Extrusion and decontamination rate > 95% - 100%

Input for Food Grade PP needs to be >95% prior food grade

NEXTLOOPP RESINS

rPP MATERIAL

NEXTLOOPP PPRISTINE™ NATURAL FG IM

NEXTLOOPP PPRISTINE™ NATURAL FG

NEXTLOOPP PPRISTINE™ WHITE FG

NEXTLOOPP PPRISTINE™ COLOUR FG

NEXTLOOPP PPRISTINE™ NATURAL INRT

NEXTLOOPP PPRISTINE™ WHITE INRT

NEXTLOOPP PPRISTINE™ COLOUR INRT

NEXTLOOPP PPRISTINE™ MIXED INRT

EFSA/USFDA/FSA SUBMISSION UPDATE

- FDA submitted
- FSA submitted
- EFSA registration as novel tech application

Dear Mr. Kosior:

Attached is an acknowledgement letter for your recent submission to the U.S. Food and Drug Administration. Your request will be assigned to a Regulatory Review Officer for review and response.

Regards,

Center for Food Safety and Applied Nutrition
Office of Food Additive Safety
U.S. Food and Drug Administration
Tel: 240-402-1175
sylvia.dodson-proctor@fda.hhs.gov

FDA U.S. FOOD & DRUG ADMINISTRATION

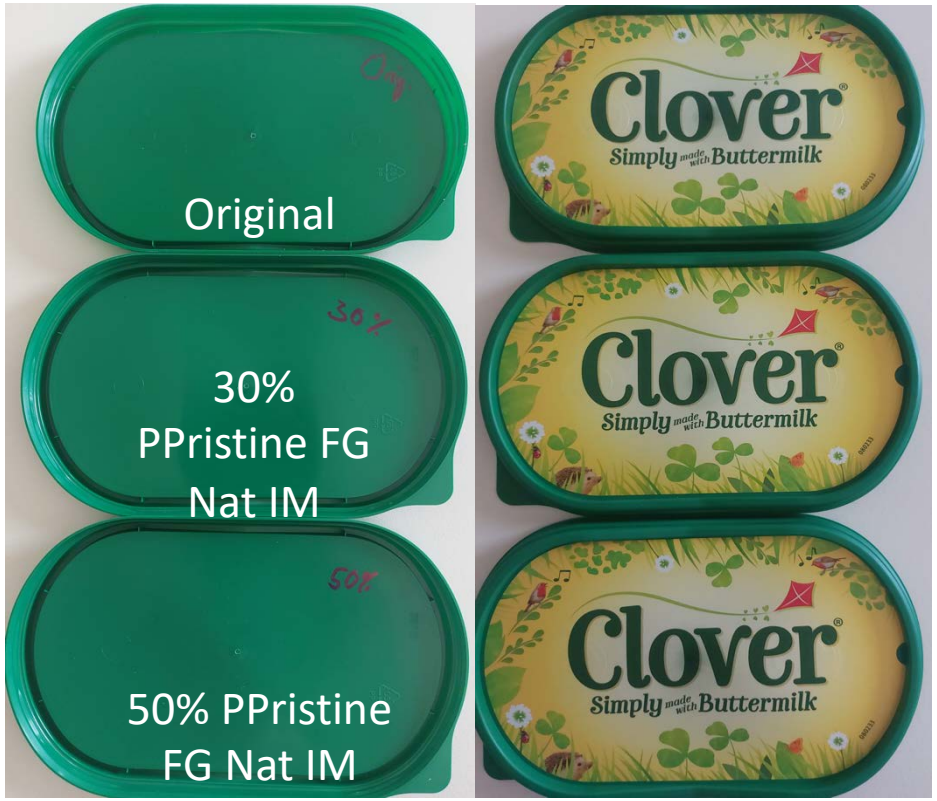
Asiantaeth Safonau Bwyd
food.gov.uk
Food Standards Agency

Food Standards Scotland
foodstandards.gov.scot

Dear Paul Marshall,

Your application for approval of PPristine was received on 07/11/2022 and has been assigned the following application number RP 1793. We shall now check the information you have provided to ensure that it complies with the requirements of Article 9(1)(a) of retained Regulation (EC) No 1935/2004 on materials and articles intended to come into contact with food.

COMMERCIALISATION TRIALS with project participants



CO_{TOO}CLEAN

Cleaning Plastic Film To Food-Grade Standards using super critical CO_2

Creating food-grade destinations for films.

Alliance Prize
Solutions to Address Flexible Plastics in Household Waste
NY Stock Exchange
29th November 2022

CO$_{TOO}$CLEAN Project Partners

- **Four key innovation partners** providing plastics recycling, process development and material science expertise
- **Four commercial partners** to exploit the technology across the flexible film supply chain for successful commercialisation.

Our joint vision is to deliver a revolutionary commercial process that can efficiently and effectively clean and decontaminate post-consumer polyolefin films to a food-grade material.

The global market size for food flexibles is vast at 21.7 Million tpa (AMI 2022)

At 25% PCR content = 4.4 Million tpa – many opportunities for global recycling enterprises.

COTOOCLEAN Decontamination of Plastic Films

COTOOCLEAN Decontamination using supercritical CO_2 as an extraction solvent

Decontaminates LLDPE, HDPE & PP films >99% of oils and chemical contamination in USFDA and EFSA challenge tests

CO_2e savings of 65% compared to virgin PE (1.3t/t vPE)

Deodorises films – no smell

De-inks with green co-solvents - improves colour and quality

De-lamination & de-metallise multi layer films – boosts yields

No water

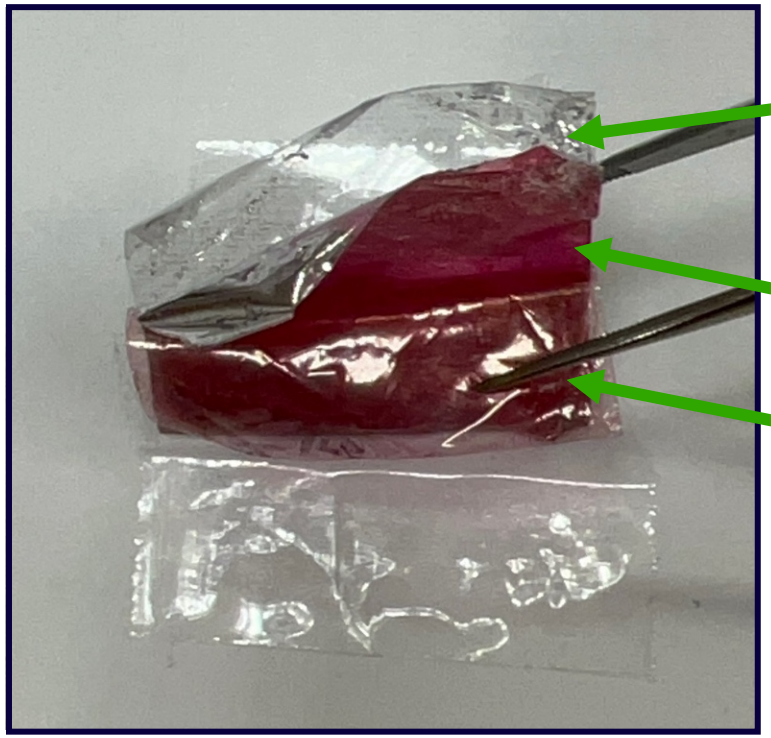
No drying

No toxic or corrosive chemicals – CO_2 and green solvents

No diluted residues or wastes

CO$_{TOO}$CLEAN Delamination of multilayer films

The images shown demonstrate the delamination of a 3-layer metallised multilayer films after treatment.

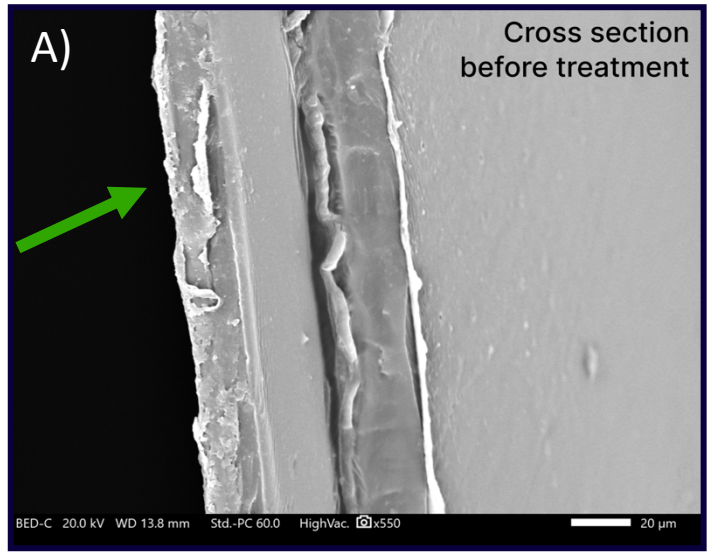


PP inner Layer
De-metallised

LLDPE Layer with metallising and ink

PP Outer Print Layer
- now clear

SEM Images (A and B) of 3-layer metallised film before and after treatment.
The top layer of clear PP is indicated by the green arrows.



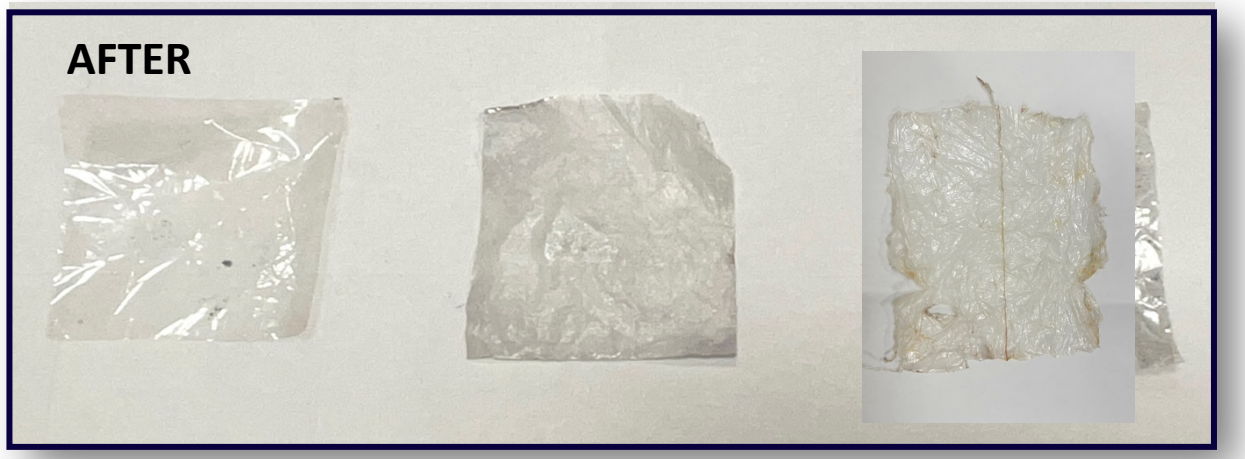
CO_{TOO}CLEAN De-Inking and Oil removal

De-Inking

Crisp pack, reverse print outer layer

Crisp pack, reverse print mid layer

Surface printed bread bag



Oil Removal

BEFORE

Oil saturated film sample, simulation of surface contamination from food.

AFTER

After CO_2 cleaning >99% oil was removed.

How do we accelerate a Circular Economy for Plastics?

1. Infrastructure

- Create greater MRF resources to sort Recyclables and Post-Consumer Household "Waste"

2. Recycled Content in Packaging

- Every product should be designed to be circular
- Recycled plastics should be manufactured locally NOT imported or exported

3. Innovation in the Circular Economy

Many challenges remain for innovation

- Sorting food grade from non-food grade packaging to implement food-grade recycling technologies
- Recovery of plastics from waste before landfill
- High performance plastics properties in closed loops in existing and new applications

What will help to Make a Difference

- A shared vision in Chemical-Waste-Recycling Industry Associations and buy-in by Brands and Convertors
- Big recycling operations for high quality plastics in every major population centre
- Research that focuses on greater efficiency and participation in the circular economy
- Large Petro-chemical operations that scale up "Chemical Recycling" for difficult-to-recycle plastics.
- Bans on oxo-degradable plastics that distract or damage circularity
- Government taxes on packaging without recycled content to stimulate the timelines