

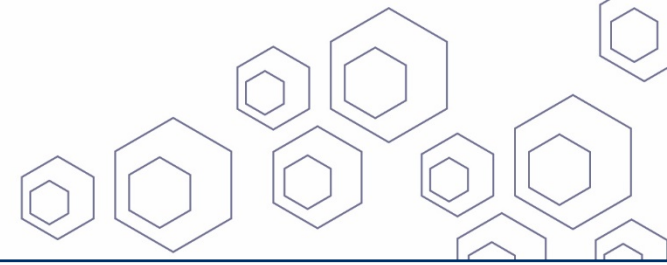


New level of precision in sorting

Detect and sort plastics and other materials simultaneously by fluorescence tracer, color, NIR and AI

Polysecure in a nutshell

Growth through vision, passion and innovation!



Young technology company growing by positive cash flow and guided by the claim
“Preserving Resources by Innovation”



~30 patent families, exclusive cooperation with Karlsruhe Institute of Technology (KIT), Institute Charles Sadron (ICS), Carl Zeiss AG, Röchling ...



Interdisciplinary team

scientists, engineers, technicians, business developers, business managers, customer service managers, IP managers, regulatory affairs manager...



Industrial Advisory Board with representatives from: e.g. EU Commission, Henkel, Carl Zeiss, Trumpf, Der Grüne Punkt, BDE, GKV, TUHH, Wuppertal Institute, HSPF ...



One stop approach “Marker & Devices”

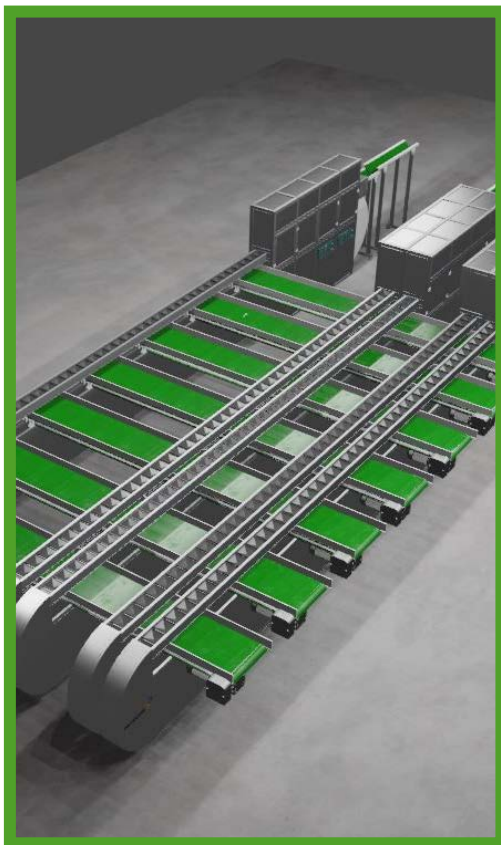
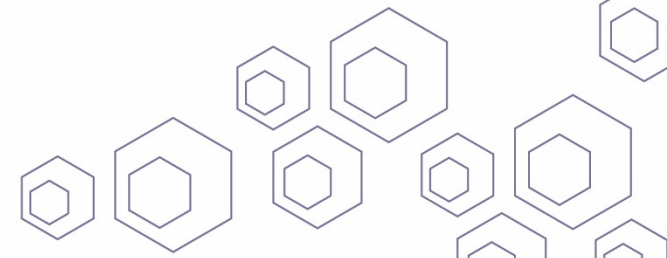
(chemistry, optical physics, plastics technology, automation, electronics, **pilot sorting plant**)
New building with offices, labs, pilot plant, production planned.



Joint developments and projects with **strong partners**: Rehau, Siemens, Continental, Suez, Nestlé, Amcor, Siegwerk, Hahn-Schickard, Spindiag, Renolit, iPoint, CEPAC, BASF, Cyient, Menshen ...

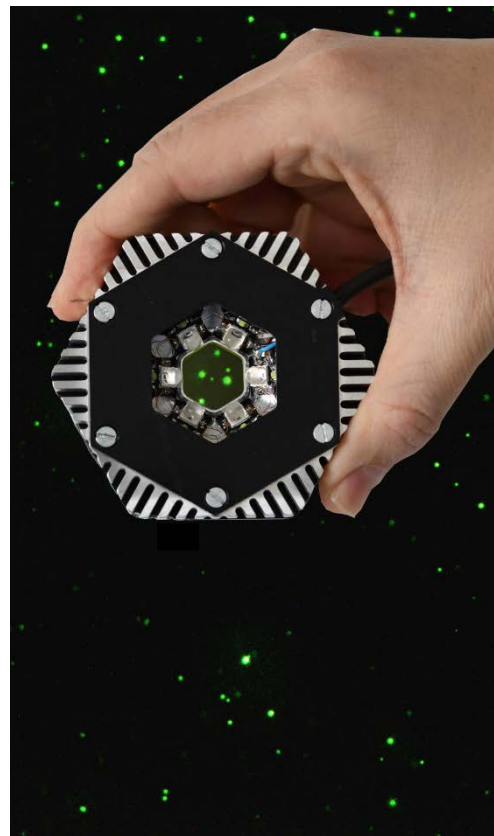
Overview on Polysecure's technology

We develop & produce marker solutions for four application segments



SORT4CIRCLE®

First complete & efficient sorting technology for the Circular Economy



Particle-Fingerprints

Most robust & forgery-proof individual product tracking technology



POLTAG®

First precise material tracking by innovative macromolecules



BRANDPROOF®

Mobile, fast and reliable product authentication

SORT4CIRCLE®

Precise, flexible and technology-open sorting technology



↑
Increase of throughput

←
Increase of sorting fractions

Conventional front part
&
Singulation

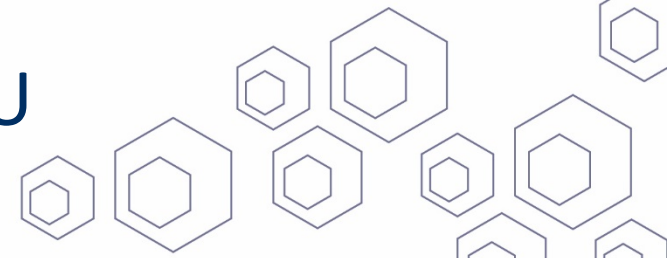
Combined detector for:
tracer, NIR, color, image /
AI, optionally watermark

Strategic collaboration



Recycling of consumer plastic packaging in the EU

Meeting the recycling targets requires major improvements in sorting



EU-Targets for 2025:

Min. 55 % recycling rate of plastic packaging

10 Mio. t of recyclates produced



~ 20 % recycling rate of plastic packaging in EU

Only ~ 4.6 Mio. t of recyclates produced (EU27+3, 2019)

Best-in-class sorters with newest stepwise NIR sorting equipment reach ~38%

In order to increase recycling rates, **more plastic waste needs to be identified properly and then sorted into purer & better specified fractions**

→ this is exactly what Polysecure's sorting technology can deliver

Average status today in EU

Packaging Collection

From separate and mixed waste streams (all types of materials)

First Sorting at MRF / LWP sorting plant by material type

Landfill and / or incineration ~ 70%

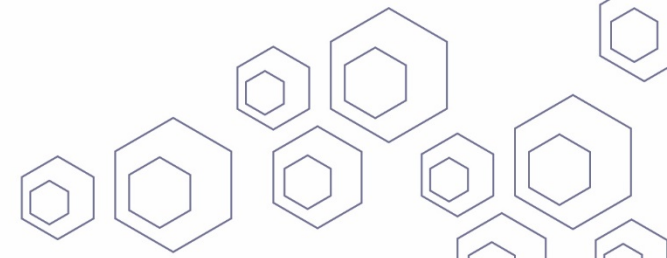
Pre-sorted bales going to recyclers ~30%

Recyclates for use in new products ~20%



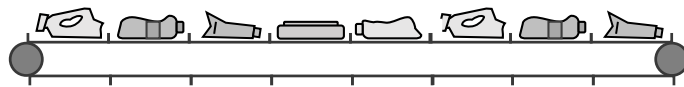
Why Polysecure?

Three innovations to enable more quality & higher recycling rates



Innovation #1 – Single step sorting

All waste items are singulated, detected and then sorted to their defined fraction in **only one step** – comparable to letter sorting.

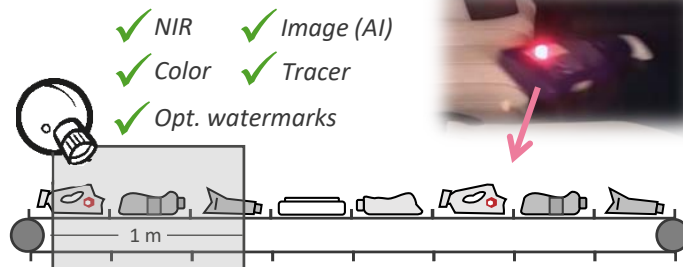


Singulation

Polysecure provides **automatic singulation**. Alternatively singulation and deposit into the tray belt can also be done **manually**.

Innovation #2 – Combined detection

Each waste item is identified by the **combined detection** of tracer, NIR, color, image (AI) and optionally watermarks -> best possible sorting decision.

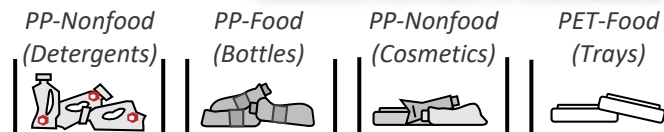


Combined detection

Provides **technology-openness** since all today's and future detection technologies are applied -> allows recycling companies to be future-proof.

Innovation #3 – Tracers

The tracers are not needed per se, but are a **flexible tool to allow defined fractions, closed-loops and very high detection & purity rates (>99%)**.

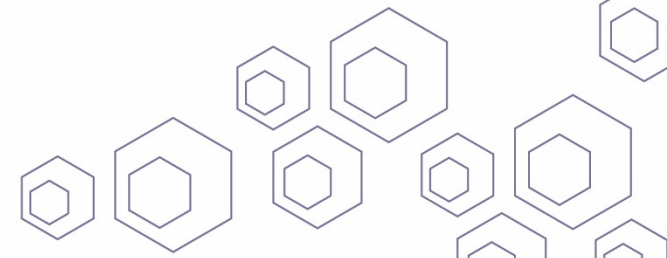


Sorting into fractions

Flexible set of sorting fractions. Additional fractions (e.g. specific packaging of a brand) can be added at **marginal costs**, based on Circular Economy needs.

SORT4CIRCLE®

Technology development and validation in our technical centre



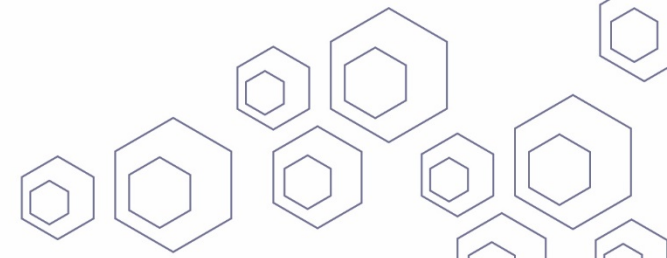
First SORT4CIRCLE® Prototype to precisely sort closure caps



SORT4CIRCLE® applied to sort rigid plastic packaging

Tracers

A flexible tool for definable fractions and high detection & purity rates



Favorable properties



Crystalline particles with strong, characteristic fluorescence

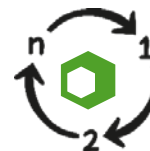


High thermal, physical, mechanical and chemical **stability** and **low solubility**



Compliance with EU chemical & material regulations

Relevant success factors for technical solutions



Robustly available over many use cycles and years



Good biocompatibility, very good results in toxicological tests

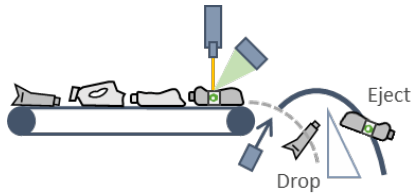
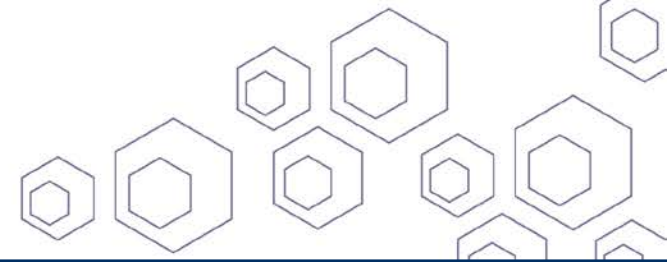


Fast and reliable detection (even at very low concentration)

Our Tracers - luminous under excitation

Reliable and precise tracer detection

TBS-light – Cost-efficient addition to conventional NIR sorters



TBS-light enables reliable and precise detection of marked packaging

- Inexpensive addition to existing NIR sorters (~10 k Euro per 1 m belt widths)
- Sorting system with 40 codes



Bottles with and without tracer under ambient light (left) and in laser curtain (right)

Experiments on the detection rate of marked PP bottles (10 ppm Tracer)

- Trials with 2 Tracer-Batches (MB-A, MB-B), each 1000 measurements at 3 m/s

Tracer-Batch	Correct-positive	False-positive	Rejected	Purity
MB-A	99,8%	0%	0,2%	100%
MB-B	100,0%	0%	0%	100%

Industry-typical sorting trials

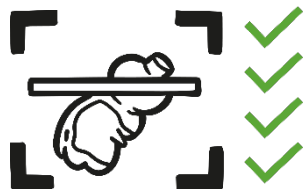
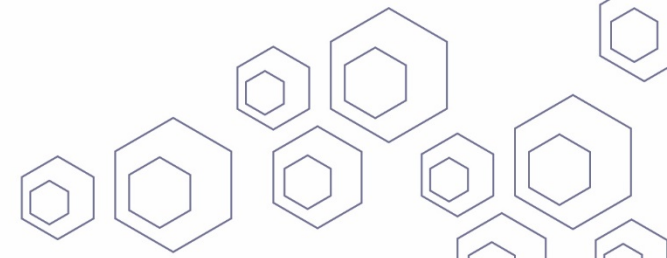
- NIR-sorter modified with TBS-light
 - Belt speed 4 m/s
 - Belt coverage 30 %
 - Throughput 1.4 t/h per m belt widths (650 kg sorted at ~1:1 ratio)
 - Tracer amount 50 µg per pack on 2cm² (white ink)
 - **Purity 97.4 %**
- Sorting errors: imperfect air jets due to overlapping objects
- Solution: S4C (singulation and combined detection)



Sorting trials with industrially relevant and typical conditions

Problems solved...

by SORT4CIRLCE® (S4C) plus tracers



Sorting into definable fractions:
applications (e.g. Food vs. Non-Food),
polymer specifications (e.g. PP homo
vs. PP copo; technical polymers),
Specific recycling pathways, brands etc.



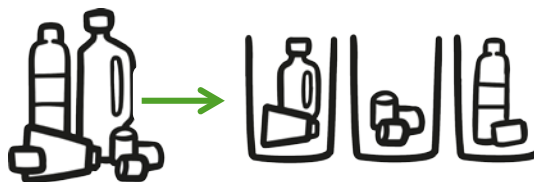
Higher purity of sorted fractions:
For packaging with tracer: larger than
98%, close to 100%
For all other packaging: larger than
sorted by conventional NIR sorters



Larger number of sorting fractions:
Single-step sorting allows larger and
scalable number of fractions (e.g.
50) without exploding costs and
footprint of sorting plant



Monitoring of compounds:
Tracers can be applied to assure
quality in circular streams



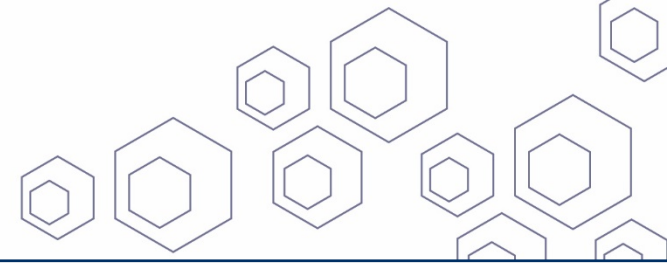
Several waste segments in one step:
One sorting process for e.g. plastic
and paper based packaging



Sorting of flexibles:
Current promising development of
S4C to handle also flexibles

Market introduction considerations

with SORT4CIRCLE® (S4C) plus tracers



Technology-openness:

With the S4C process every packaging or object passes the combined detector which is employing all relevant detection technologies (NIR, tracer, image / AI and possibly watermarks)

- Allows smooth transition to new sorting standards
- Future proof investment in dynamic technology landscape

Market introduction of S4C:

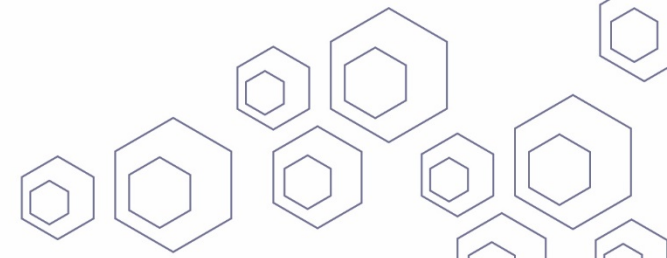
- » Use of S4C for the plastic sorting part of **future** packaging sorting plants to better pre-sort on article level
- » Use of S4C at **recycling factories** to improve purity and specification of pre-sorted bails

Market introduction of Tracer application and detection:

- » **Existing NIR** sorters can be adopted for tracer detection by adding a specific tracer excitation source (~10k Euros per meter band width), no integration or alteration of sorter controlling system needed

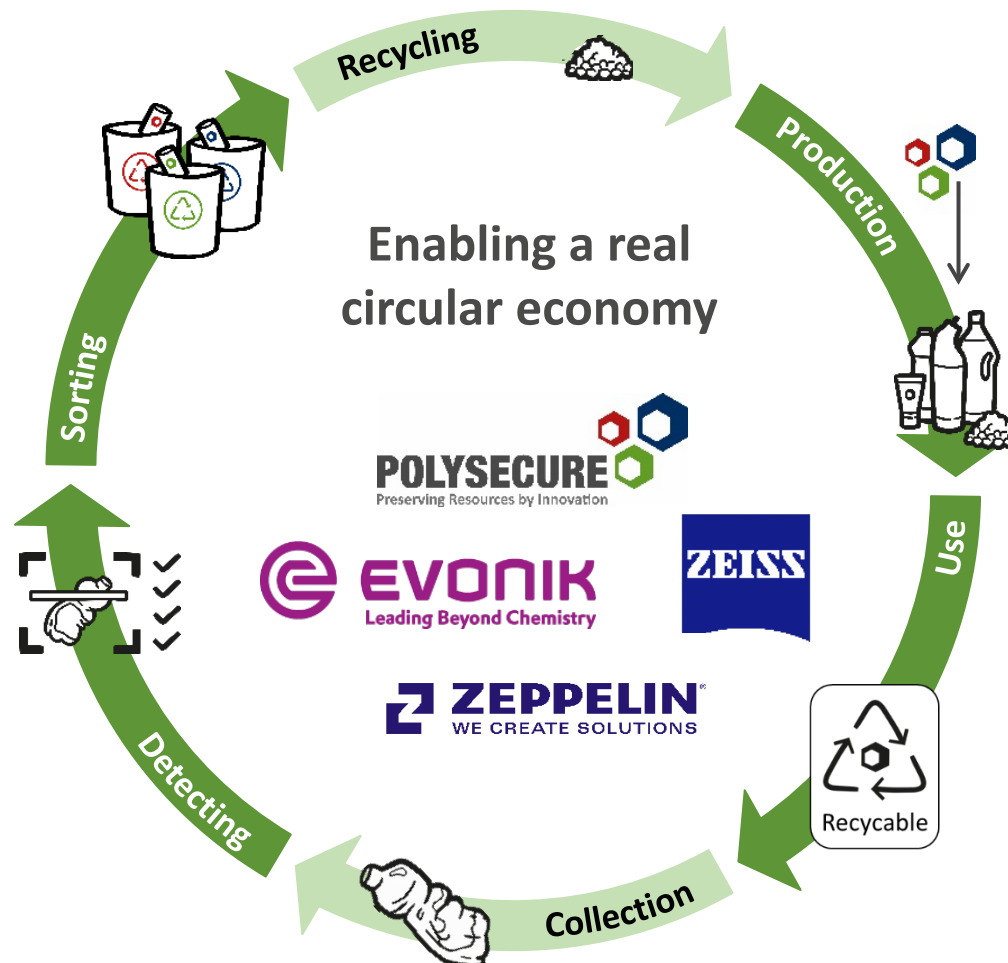
Branding for Circularity

Booster for the Circular Economy



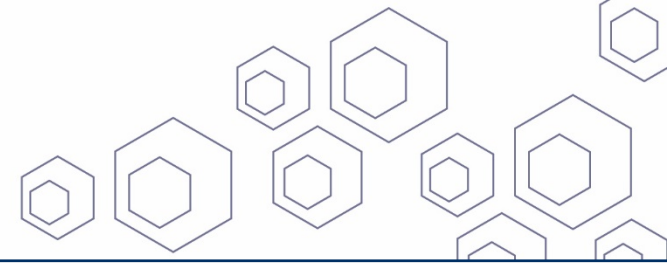
Detecting & Sorting

- » New **SORT4CIRCLE®** single step sorting process enables **reliable and efficient sorting of all objects in just one step**. The process is scalable, flexible and economical even with numerous fractions.
- » **Combined detection of Tracer, NIR, color, Artificial Intelligence (AI)** and optional watermarks) creates the best possible detection and for the first a **technology-open sorting process** that allows future-proof investments for MRFs, utilities and recyclers.



Marking & Branding

- » **Marking with innovative fluorescent tracers.** They represent a **sorting code** that reflects important properties such as polymer subclass (material specification), food contact (application) or brand that cannot be detected by existing sorting technologies.
- » Increased recyclability of marked product is made visible by a "recycling label". A **branding for circularity** that creates transparency, awareness, and trust.



Thank you for your interest!

Of course there is more to say and see.
We look forward to further discussions
and your visit!

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