Recycling Additives from Evonik

Evonik Interface & Performance
Specialty Additives
Technical Service

EVONIK
Leading Beyond Chemistry

That’s specialty chemicals.
And that’s where we’re among the best in class.

€15.3 billion
sales*

€1.66 billion
adjusted EBITDA*

€1.17
dividend per share**

10.8 %
adjusted EBITDA margin*

~43%
of sales from
Next Generation Solutions

€793 million
investment in intangible assets,
plants & equipment

>33,000
employees

109
nationalities

€0.79
adjusted earnings
per share*

* Financial Report 2023

** Proposal for the Annual Shareholder's Meeting June 4, 2024

EVONIK
Leading Beyond Chemistry

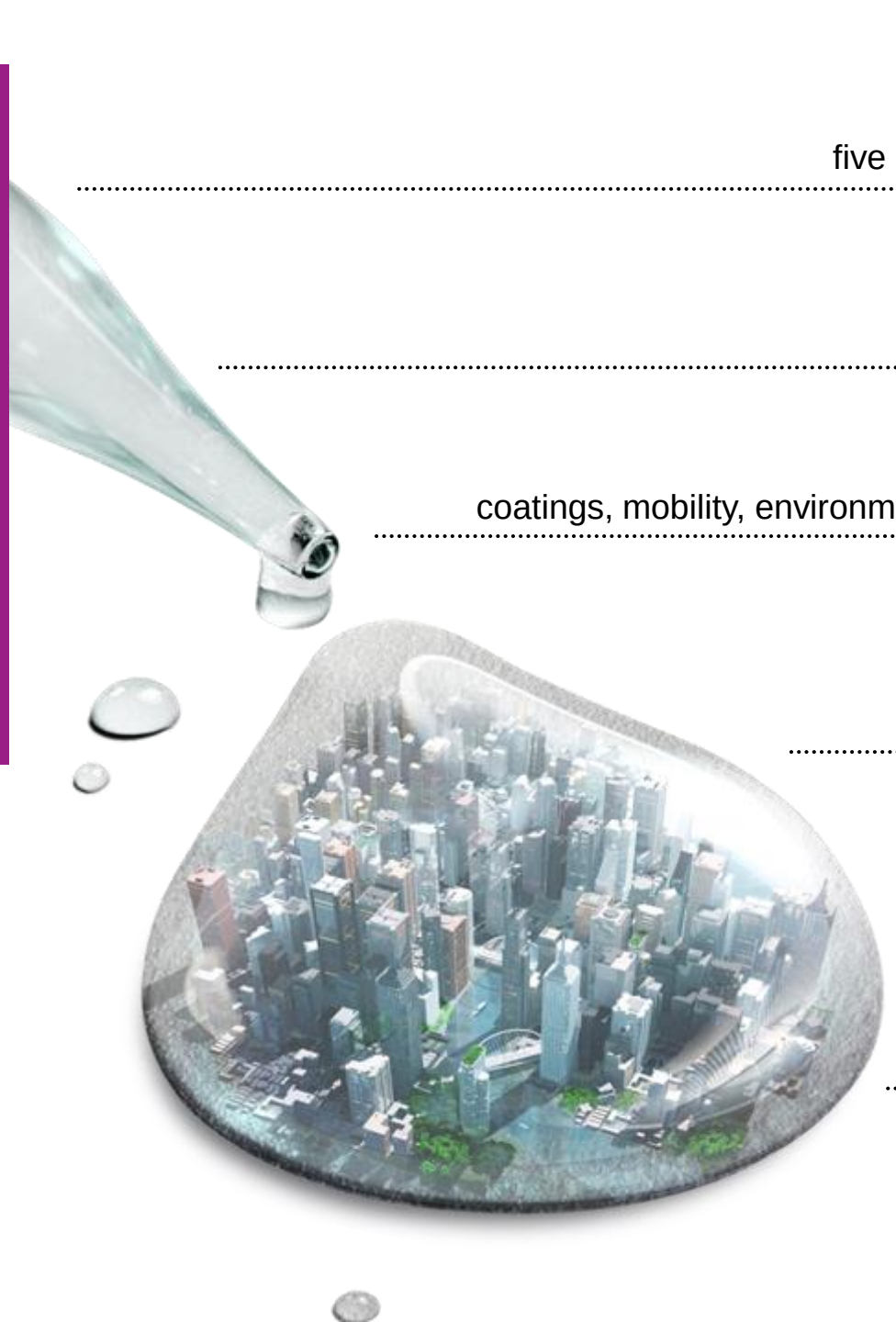
Our five divisions with their diverse business lines drive our innovation and success

EVONIK

- Specialty Additives
- Nutrition & Care
- Smart Materials
- Performance Materials
- Technology & Infrastructure

EVONIK
Leading Beyond Chemistry

Our specialty additives get the maximum performance out of our customers' products



One partner, many experts
five leading and versatile business lines

€ 673 m
adjusted EBITDA in 2023

Industries and applications
coatings, mobility, environment, infrastructure, consumer goods

Major effects
more durability, more protection, less energy, less maintenance

€ 3,520 m
sales generated in 2023

3,500
employees

EVONIK
Leading Beyond Chemistry

Strong Technical Competence to support Customer Needs for Compounding at Evonik Interface & Performance

Compounding

- Extrusion 35mm Leistritz
- Extrusion 27mm Leistritz
- Labextrusion 25 mm Collin

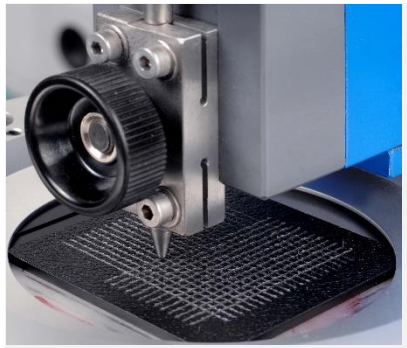
Processing

- Injection molding machine
- Bars and Plates

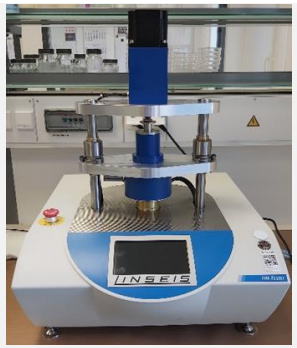
- Filter pressure equipment
- Flow spiral
- Melt Flow Path & MFI

- Brabender Lab Station
- Blown / Cast Film

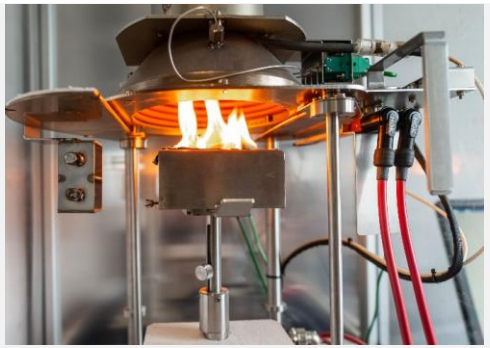
Testing



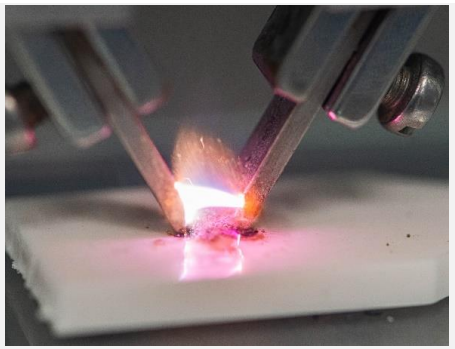
- Erichsen Scratch Tester
- Five Finger Scratch Tester
- Crockmaster



- Electrical and thermal conductive measurements



- Lowest oxygen index (LOI)
- UL 94 flame chamber
- Cone calorimeter

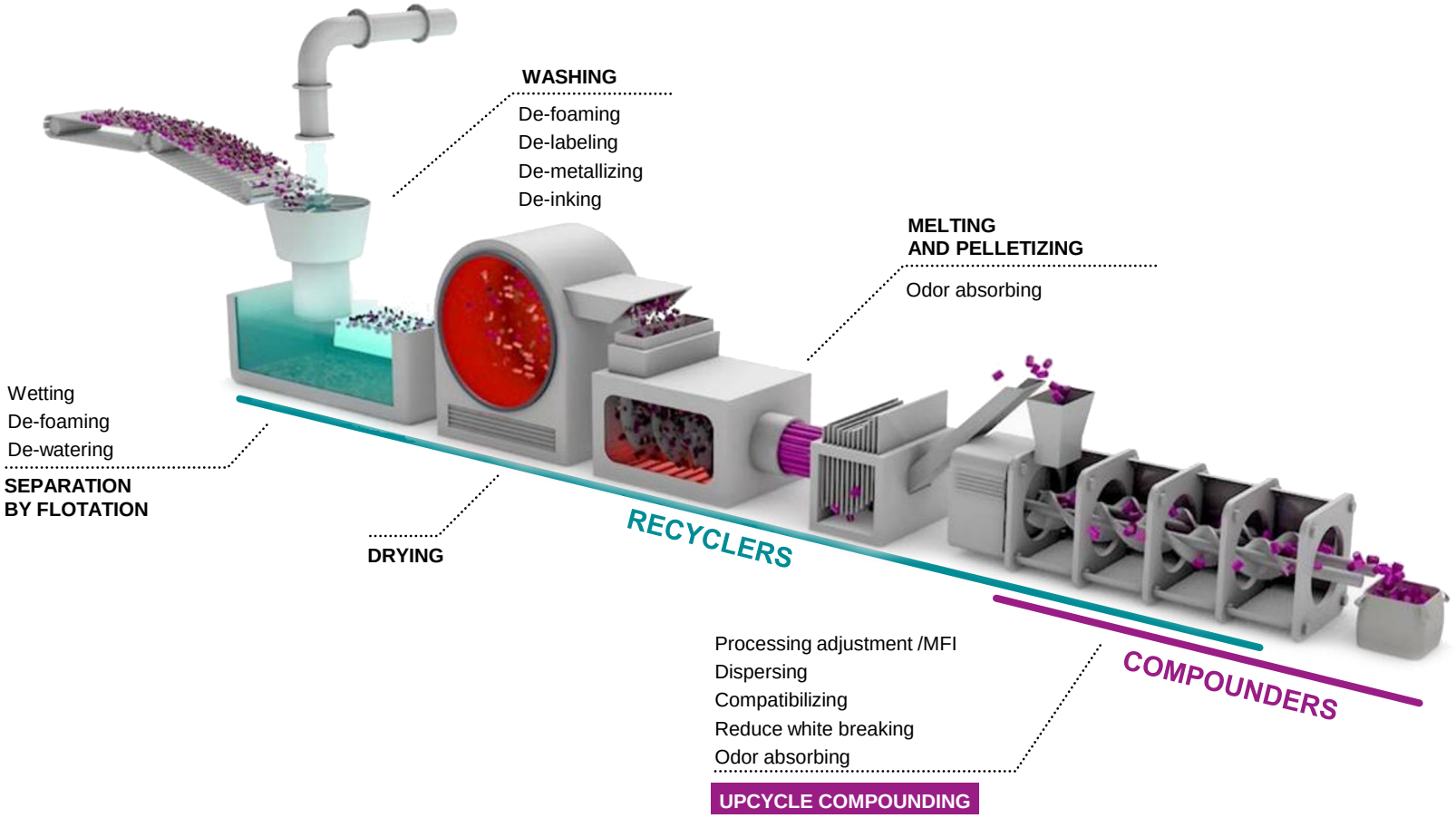


- CTI measuring device

- Mechanical Tests

EVONIK
Leading Beyond Chemistry

Evonik additives help along the entire process to convert plastic waste into plastic goods



Mechanical Recycling

Higher Efficiency & Yield

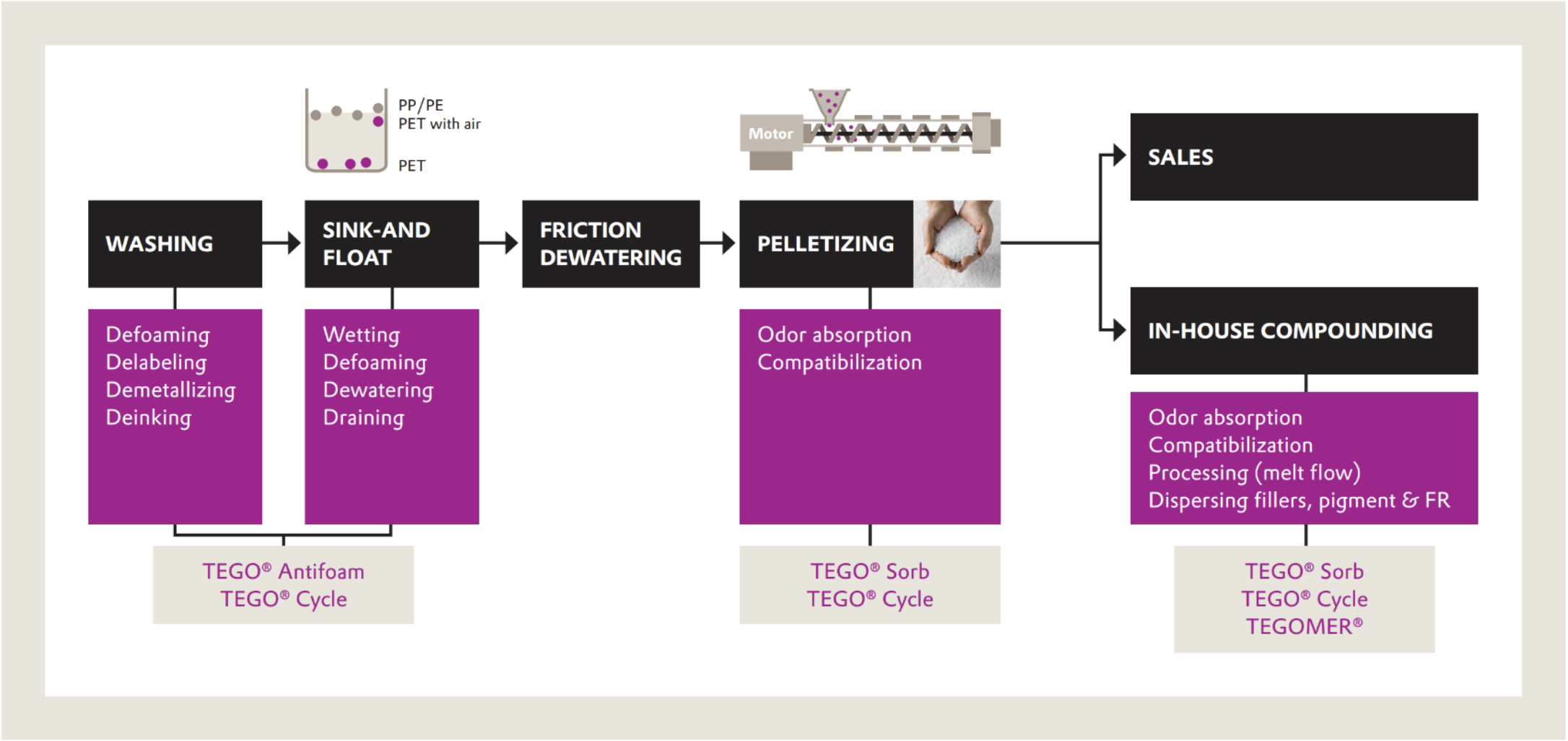
During separation/washing we can help to make recycling processes more efficient resulting in higher quality and yield of recyclates

Better Processing, Quality and higher up-take

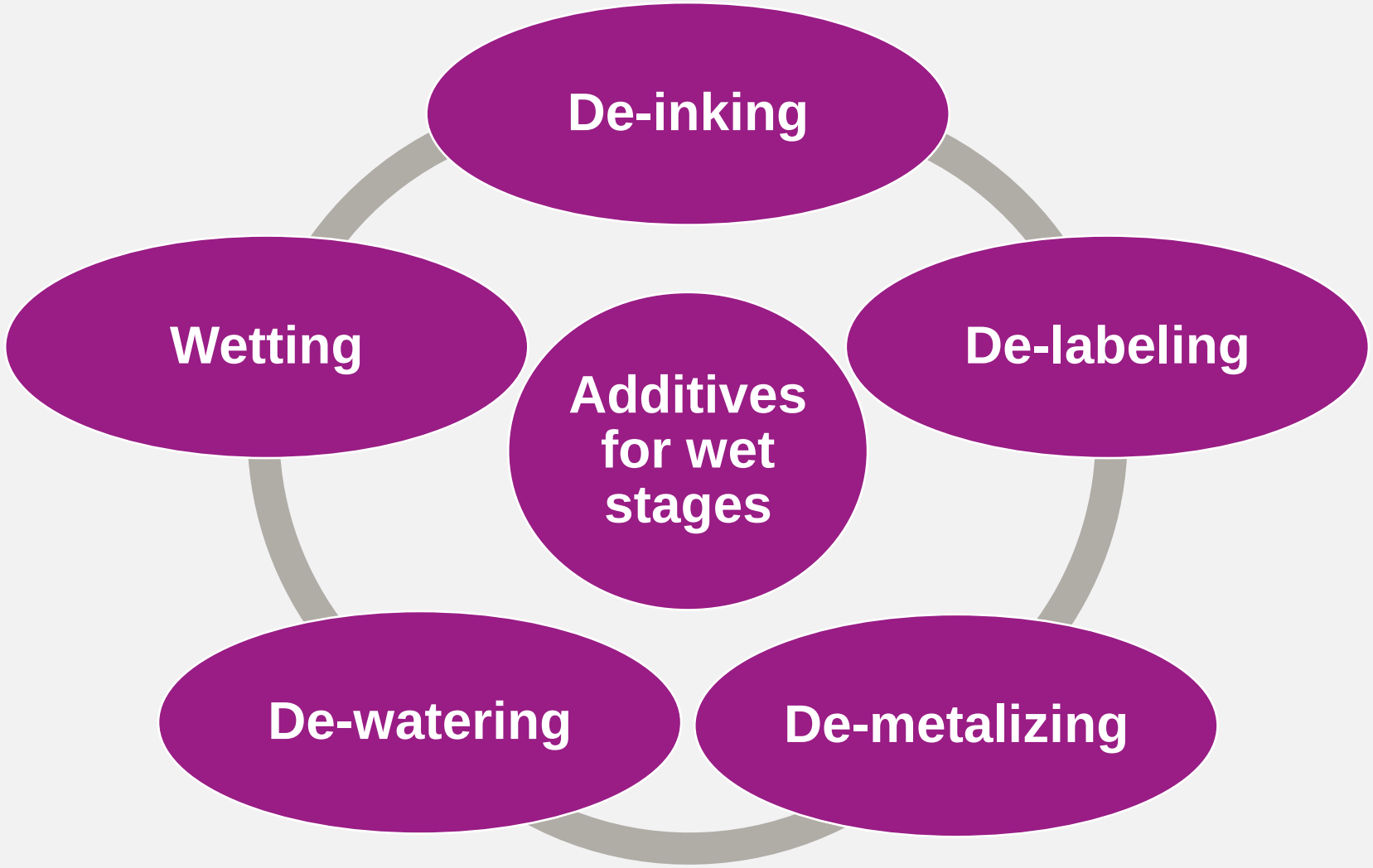
During compounding we improve processing and properties leading to competitive costs & quality, and enabling higher recycled contents

Evonik Additives for Recycling

Additive Portfolio for Wet Stage, Granulation and Compounding



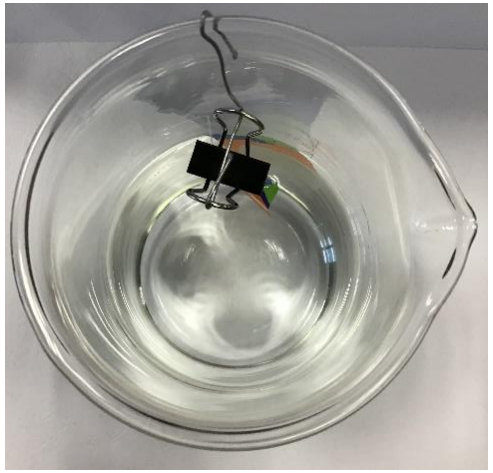
EVONIK
Leading Beyond Chemistry

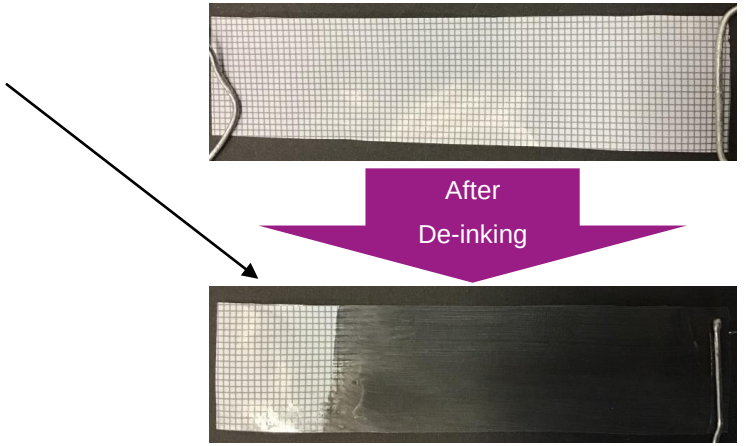


De-inking & De-metalizing Method

- The cut-out samples (6 x 2 cm) are hooked inside the solution (250 ml) with a magnet stirrer
- Each solution contains water and the additives
- At timeslots 5 min - 24h the samples are taken out of the solution
- The additive is applied to the samples at either room temperature (RT) and/ or higher temperature at 80°C
- Evaluation starts with pH 7, if a higher temperature shows no improvement, pH is increased to pH 12
- The print is wiped with a white paper towel

6	not possible
5	with intensely scrubbing/rubbing possible in small amounts
4	with intensely scrubbing/rubbing possible
3	with normal scrubbing/rubbing possible
2	with easily scrubbing/rubbing possible
1	no scrubbing/rubbing is needed





EVONIK
Leading Beyond Chemistry

Evonik Additives for Wet Stage Recycling
De-inking

	Before De-inking	After De-inking		Before De-inking	After De-inking		Before De-inking	After De-inking
PP rigid IML			BOPP flexible			PP rigid		

TEGO® Cycle WA products enable de-inking of different kinds of products.
TEGO® Cycle WA 111 (+ DA 850) works best in most cases.

EVONIK
Leading Beyond Chemistry

Evonik Additives for Wet Stage Recycling

Separation of layers – De-inking and De-lamination

Before	After De-inking and De-lamination

Before	After De-inking and De-lamination

Printing ink is located between two film layers on the back of the transparent front layer

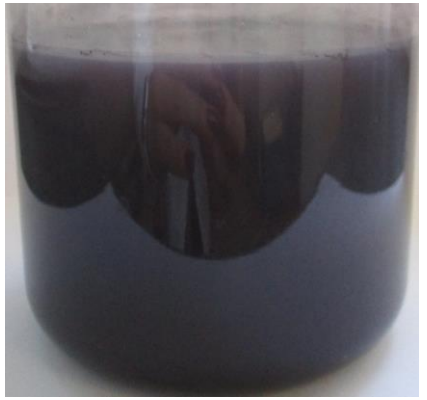
First step is delamination, second step is de-inking between the layers

TEGO® Cycle WA products enable layer separation and de-inking of different kinds of products.

TEGO® Cycle WA 111 (+ DA 850) works best in most cases.

EVONIK Leading Beyond Chemistry

De-Inking Effect in Combination with TEGOMER DA 850

Before de-inking shredded flakes	0.5% TEGO® CYCLE WA 111, 80°C	0.5% TEGO® CYCLE WA 111 + 0.1% TEGOMER ® DA 850, 80°C
		
		

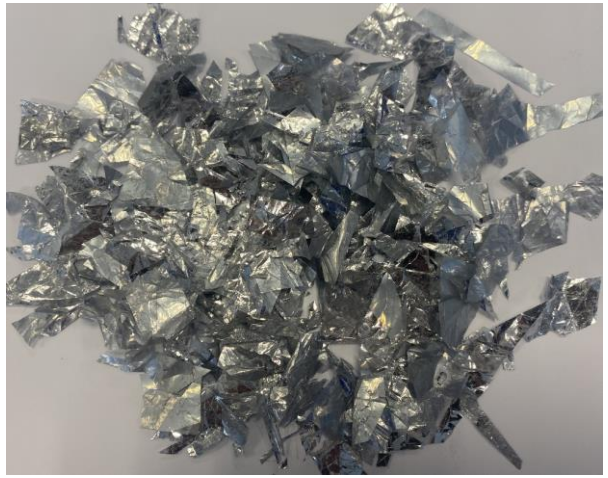
EVONIK
Leading Beyond Chemistry

De-inking
CASE – Rigid PP-Yoghurt Cups from PIW

yoghurt cup flakes with ink	yoghurt cup flakes with ink compounded	yoghurt cup flakes De-inked with 0.5% TEGO® Cycle WA 111 0.1% TEGOMER® DA 850 compounded

EVONIK
Leading Beyond Chemistry

Evonik Additives for Wet Stage Recycling
De-metallizing, De-labeling

	Before De-metallizing	After De-metallizing	Before De-labeling		After De-labeling	
PET						
		0,5% TEGO® Cycle WA 111	Paper	Coated Paper	Paper	Coated Paper

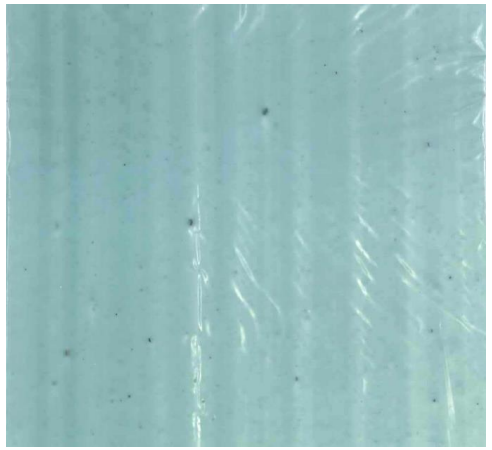
TEGO® Cycle WA products enable de-metallizing and de-labeling of different kinds of products.

TEGO® Cycle WA 111 & WA 120 works best in most cases.

EVONIK Leading Beyond Chemistry

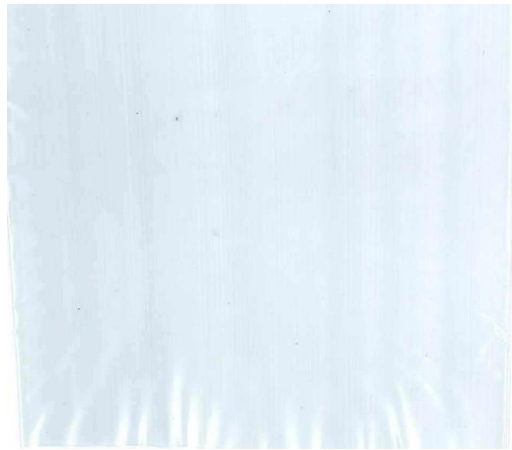
Evonik Additives for Wet Stage Recycling

De-inking LDPE flexible – **Pilot Plant**

	without De-inking	after De-inking
LDPE material 1		

De-inking conditions

- 0.5% WA 111 + 0.2% DA 850
- **80 °C, pH 12**
- PCR material

	without De-inking	after De-inking
LDPE material 2		

De-inking conditions

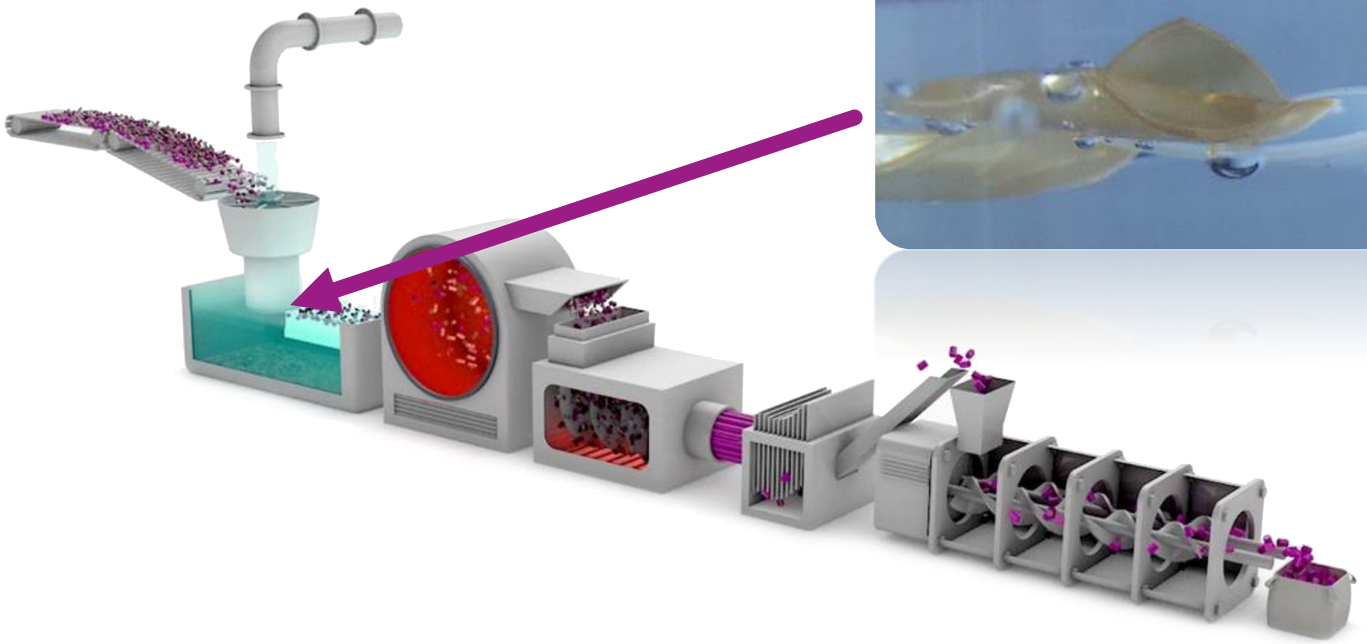
- 0.5% WA 111 + 0.2% DA 850
- **30 °C, neutral**
- PCR material

New film made from r-LDPE de-inked with **TEGO® Cycle WA 111**

Less specs/colour; less malodor; better mechanics and processing

Evonik Additives for Wet Stage Recycling
Wetting Agents

Sink float separation

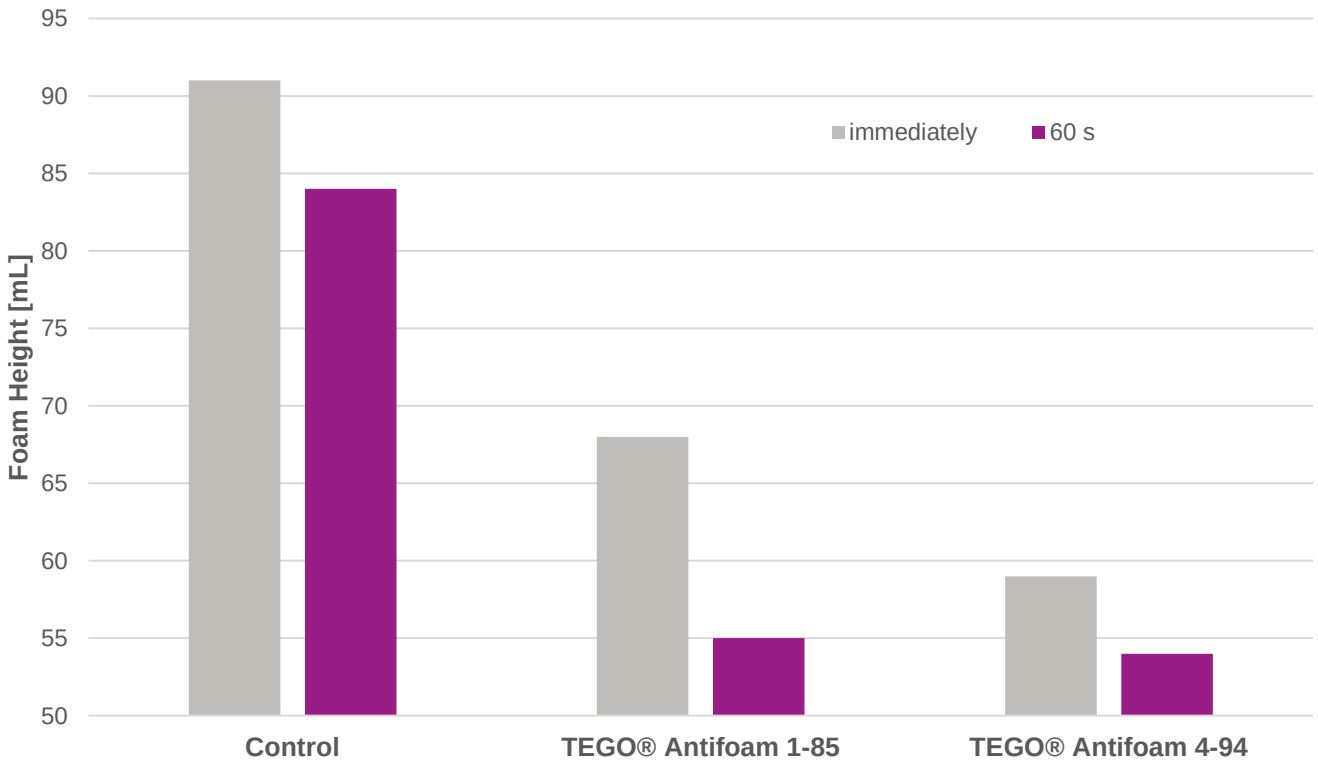


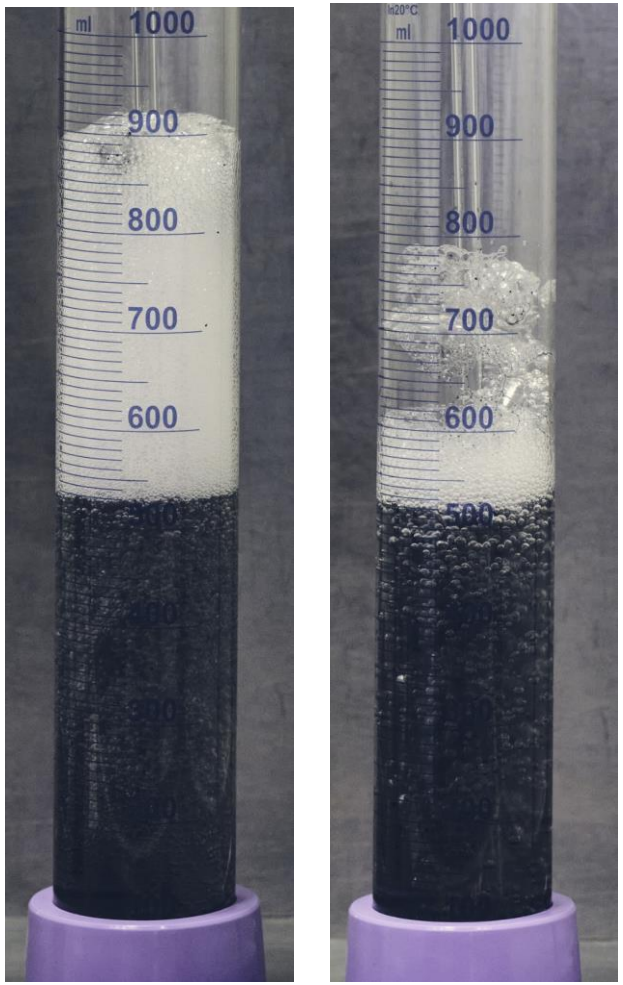
TEGO® Cycle WA products prevent air bubbles from sticking on flake surfaces. Wet **separation** processes are **enhanced**.

Dense plastics (e.g. PET, PS) sink faster and separate from floating plastics (e.g. PE, PP).

Evonik Additives for the Wet Stage – Antifoams and Wetting Agents

Case – Foam Problems during Washing Process of r-HDPE out of PCR





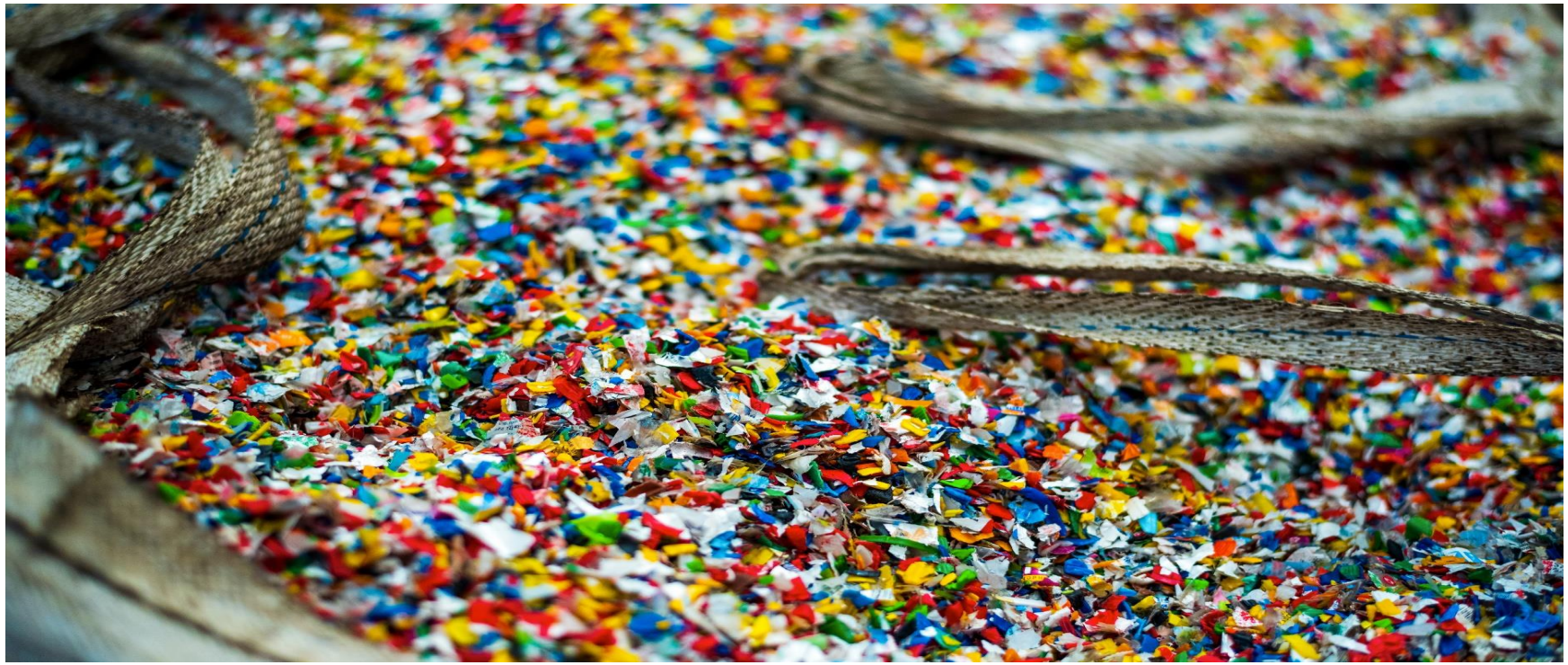
TEGO® Antifoams prevent foam, e.g. in washing processes efficiently. For additional wetting properties **TEGO® Antifoams** can be combined with non-foaming wetting agents such as **TEGO® Cycle WA 120**.

EVONIK
Leading Beyond Chemistry

De-watering and Draining Aid

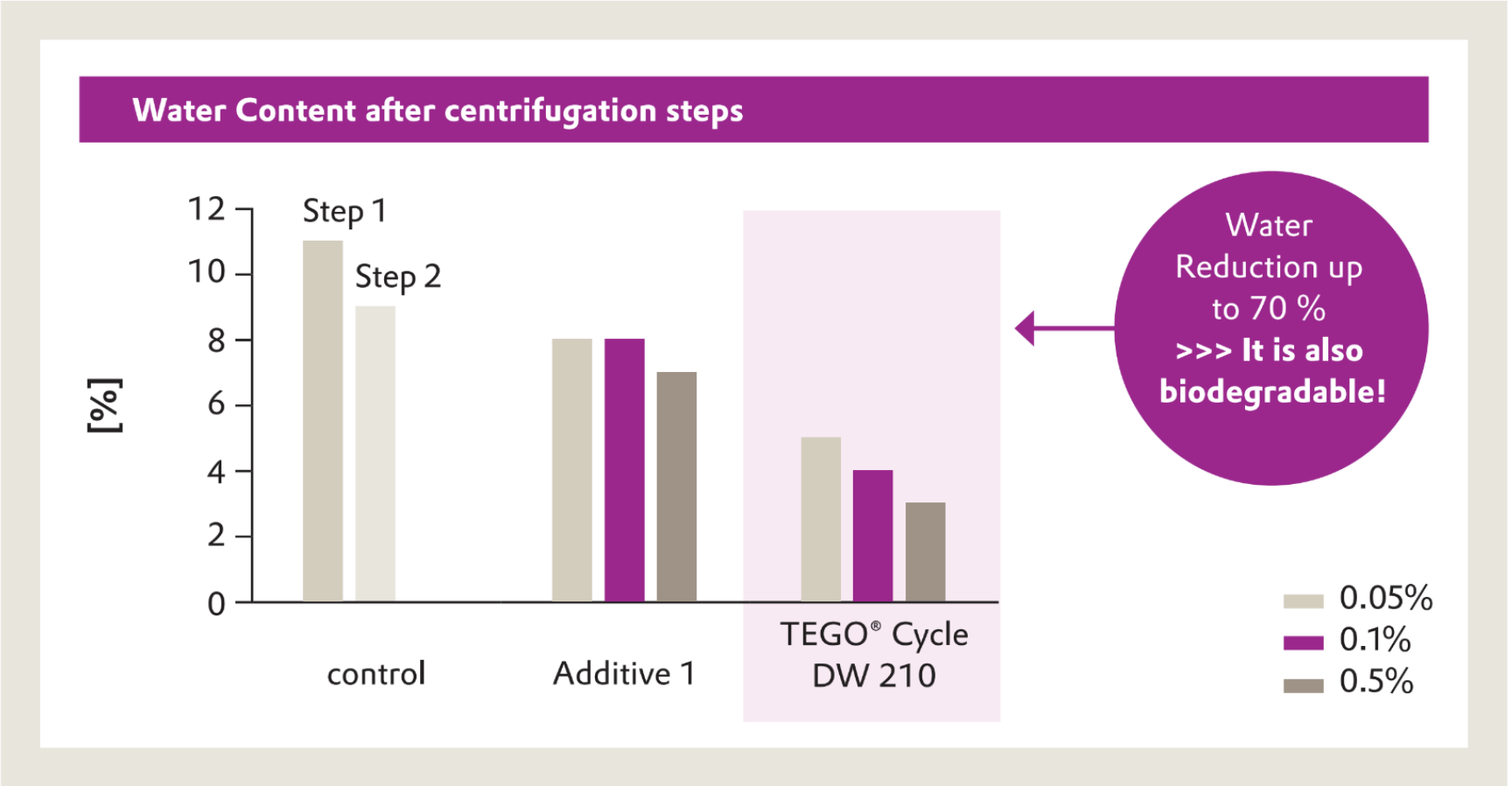
TEGO® Cycle DW 210

Evonik Additives for the Wet Stage – De-watering
relative water content of shredded plastics



	r-LDPE	r-PET	r-HDPE / r-PP
moisture after mechanical drying	10-15 %	0.5-2 %	5-10%

Evonik Additives for the Wet Stage – De-watering
Flakes of r-HDPE out of PCW or PIW

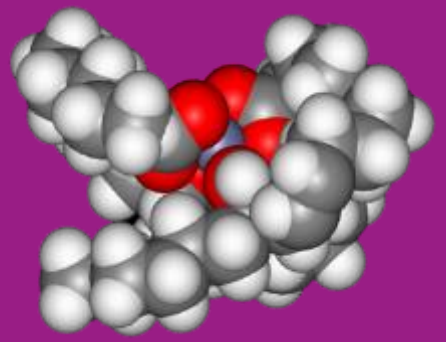


Less energy use for thermal driers or less capex invest for advanced drying methods by the addition of 0.05% **TEGO® Cycle DW 210**

EVONIK Leading Beyond Chemistry

Additives for Dry Stage

1. Odor Absorption



2. Compatibilization

How to Determine Odor of Plastics according to VDA 270

The VDA 270 standard test method is used to analyze interior parts of cars in Germany.

The material is evaluated in a 1l or 3l vessel

First tempered at room temperature, 50°C or 80°C or a certain time (24h or 2h)

Evaluate regarding malodor by minimum three independent test persons

The smell intensity is rated on a scale from 1-6.
Lowest determined odor is rated by 1 and heavy malodor is rated by 6.

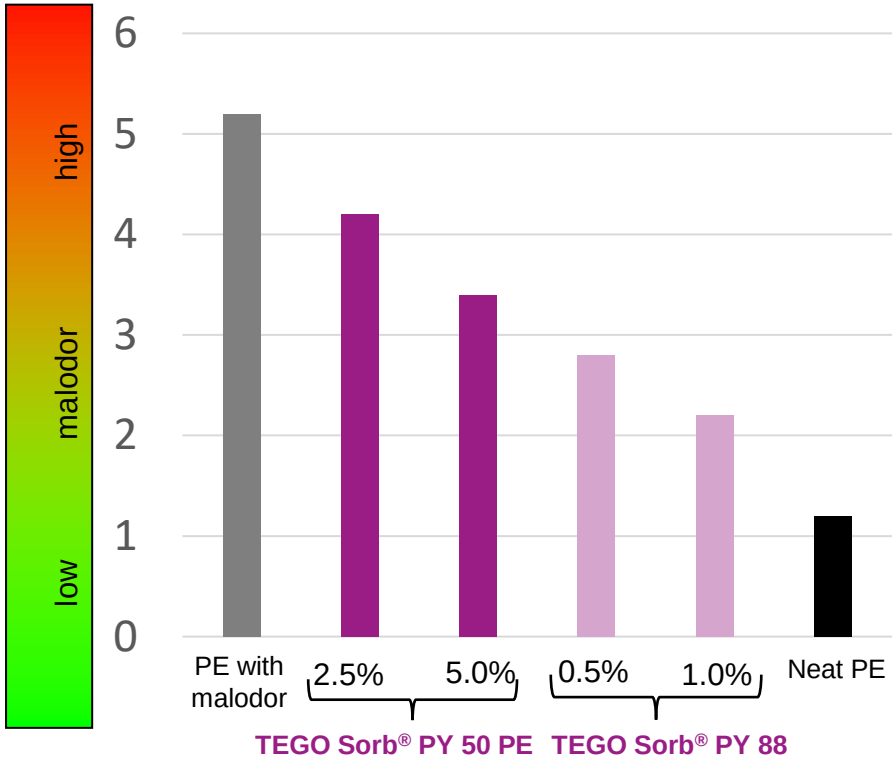
Result: Odor test VDA270 xy-grade a,b

no smell malodor

Evaluation Scale	
Grade 1	not perceptible
Grade 2	perceptible, not disturbing
Grade 3	clearly perceptible, but not disturbing
Grade 4	disturbing
Grade 5	strongly disturbing
Grade 6	not acceptable

Evonik Additives for Regranulation and Compounding – Malodor Absorption

Case – Agricultural Films collected to gain r-PE



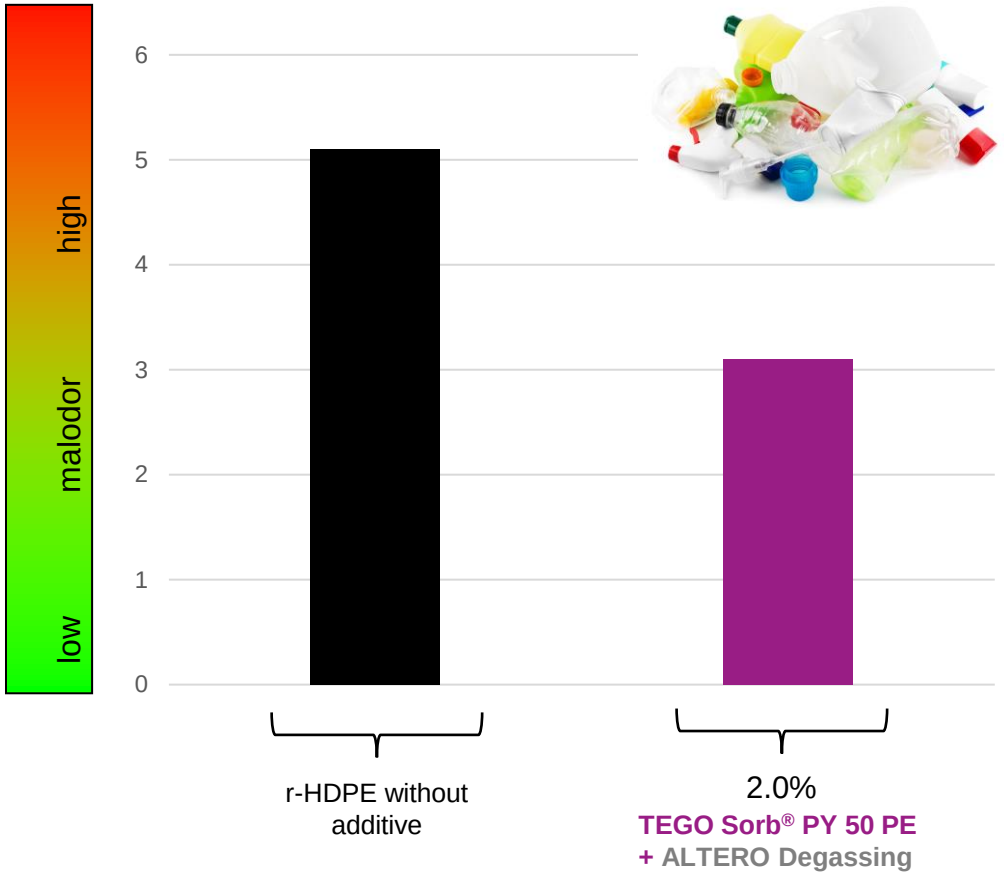
TEGO Sorb® reduces the smell in recycled polyolefins.

TEGO Sorb® PY 50 PE and **TEGO Sorb® PY 50 PP** are even suitable for single screw applications.

EVONIK
Leading Beyond Chemistry

Evonik Additives for Regranulation and Compounding – Malodor Absorption

Case – Trial at ALTERO Recycling Machinery S.L.



2 % TEGO Sorb® PY 50 PE + ALTERO Recycling Line with Double Degassing System allow to reduce the malodor of PCR to a pleasant level

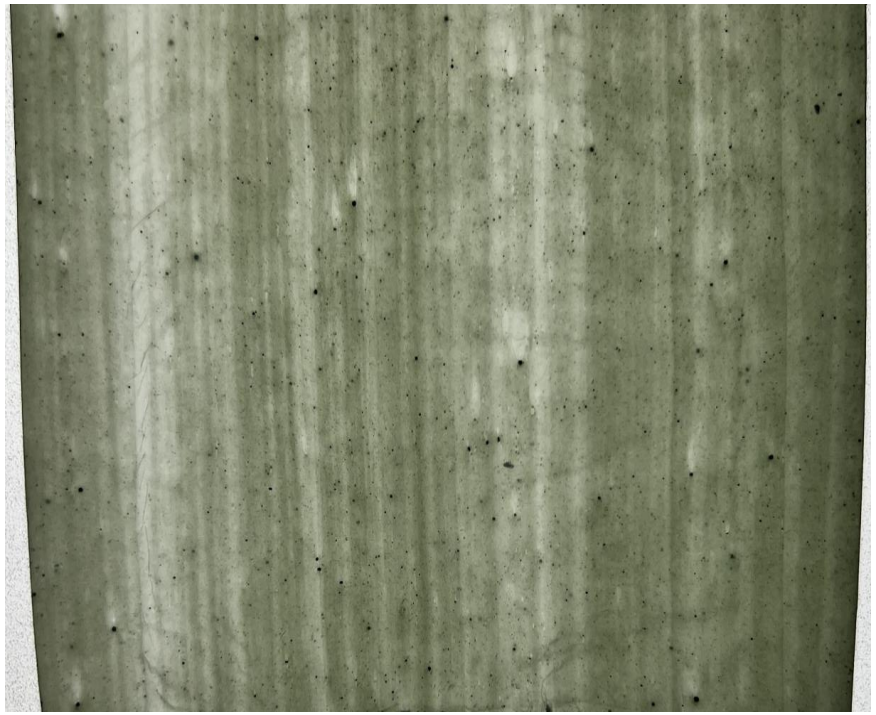
ALTERO VELOX 80 Post Consumer Recycling Line

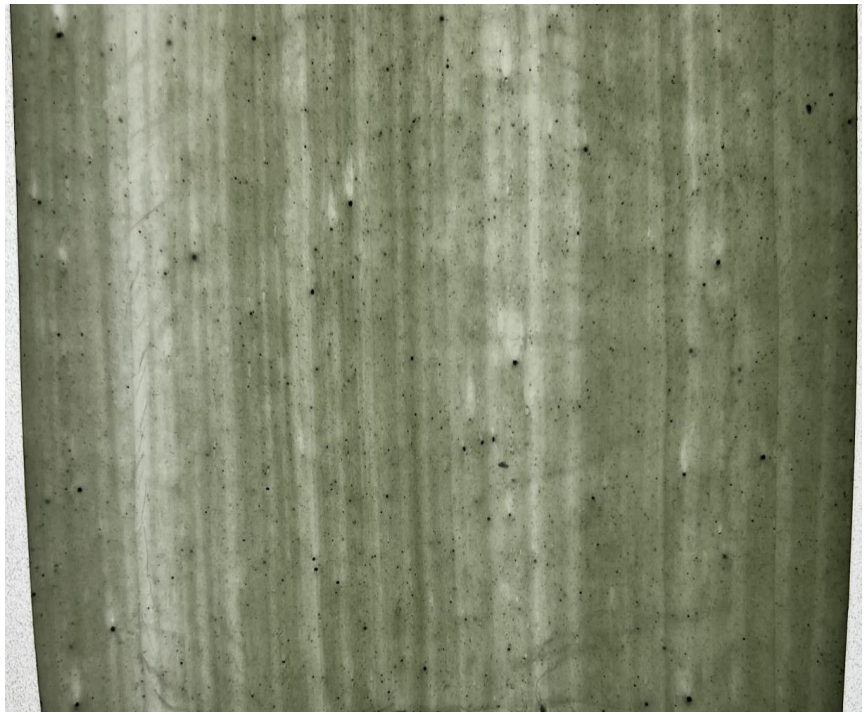
- Double degassing system with up to 2mbar of absolute pressure (high vacuum)
- Throughput up to 300 kg/h
- 2 % TEGO Sorb PY 50 PE

EVONIK Leading Beyond Chemistry

Processing of demanding PCR waste
Blown Film Samples

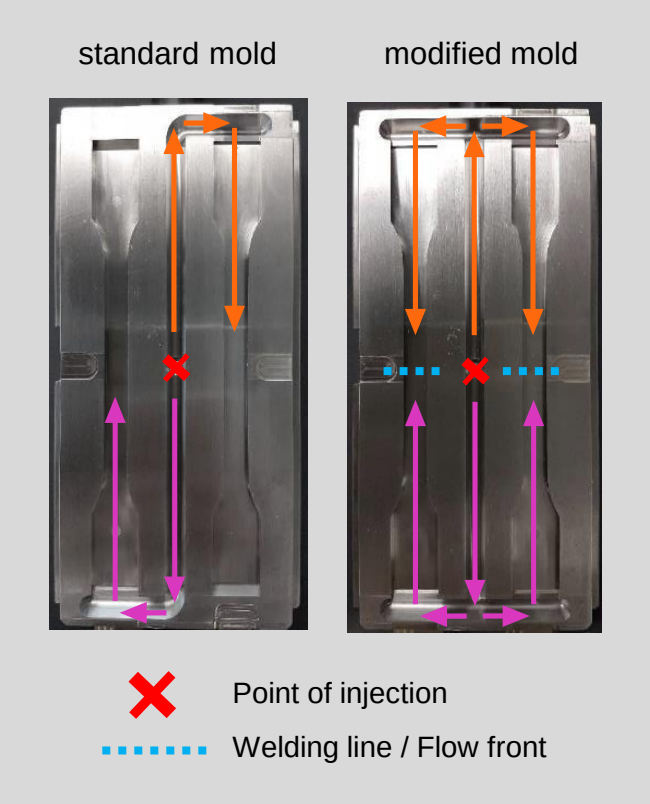
Without additive	1% TEGOMER 6810	6% TEGO Sorb PY 50 PE

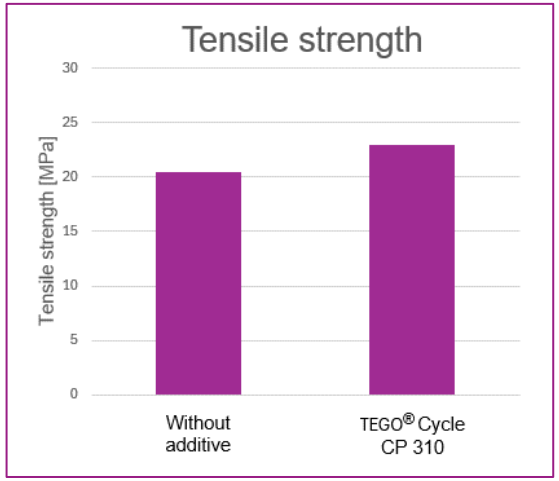


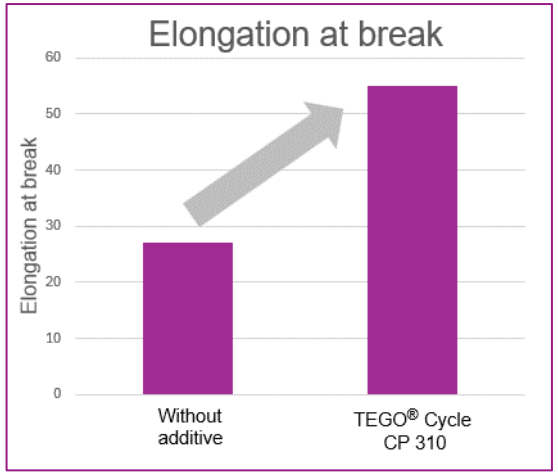


Evonik **TEGOMER® 6810, TEGO® Sorb PY 50 PE** additives enable film manufacturing

Compatibilisation of PP in HDPE
Improved welding line strength





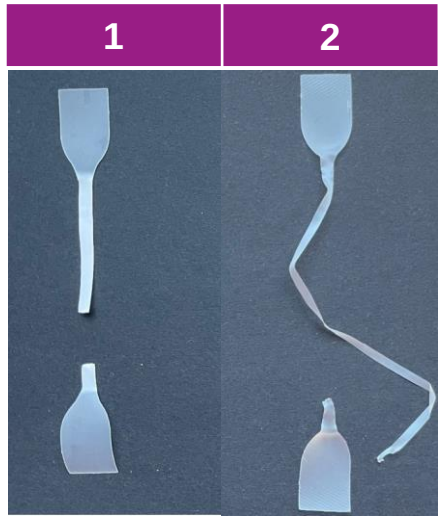


Evonik **TEGO Cycle CP 310** improve elongation at break at the welding line while maintaing the tensile strength

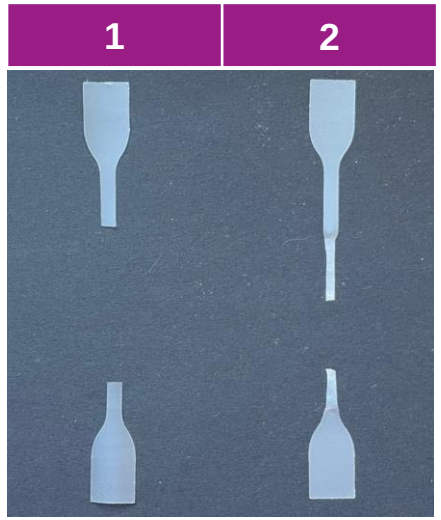
EVONIK Leading Beyond Chemistry

Compatibilisation of PA or EVOH in Polyolefines

Cast Film Samples from multilayer multipolymer films using compatibilizer - PIW



in machine direction



transvers to the machine direction

1 – recycled multilayer compound (PE, ~50%PA, EVOH, PP)

2 – (…) with addition of **TEGO Cycle CP 320**

Evonik **TEGO Cycle CP 320** improve elongation at break transverse to the machine direction in recycled mixed material compounds.

EVONIK
Leading Beyond Chemistry

Evonik Additives for Recycling

	Antifoams	Wetting agents	De-inking / De-labeling De-metallizing / De-watering
WET	▪ TEGO® Antifoam KS 53 ▪ TEGO® Antifoam 2290 ▪ TEGO® Antifoam 4-94 ▪ TEGO® Antifoam 1-85	▪ TEGO® Cycle WA 120 ▪ TEGO® Cycle WA 111	▪ TEGO® Cycle WA 111 ▪ TEGO® Cycle DW 210
	Odor absorber	**Dispersants**	**Processing aids / Compatibilizer / Performance enhancer**
DRY	▪ TEGO Sorb® PY 88 ▪ TEGO Sorb® PY 50 PE & PP	▪ TEGOMER® P 121 ▪ TEGOMER® E 525	▪ TEGOMER® H-Si 6441 P ▪ TEGO® Cycle CP 310 & 320 ▪ TEGOMER® 6810 & 6850

Technical Plant View to see how Evonik supports their CUSTOMERS

EVONIK
Leading Beyond Chemistry


EVONIK
Leading Beyond Chemistry