CENTEXBEL-VKC

INFO

2021-06 | plastics

Verantwoordelijke uitgever | Éditeur responsable | Responsible editor: Jan Laperre, directeur generaal
Redactiecomité | Comité de rédaction | Redation Committee: Jan Laperre, Stijn Devaere, Eline Robin
Tekstredactie en lay-out | Rédaction et mise en pages | Editing and graphics : Eline Robin
Fotografie | Photographie | Photography : Marc Van Hove

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PLASTICS PRODUCTION AND TRENDS

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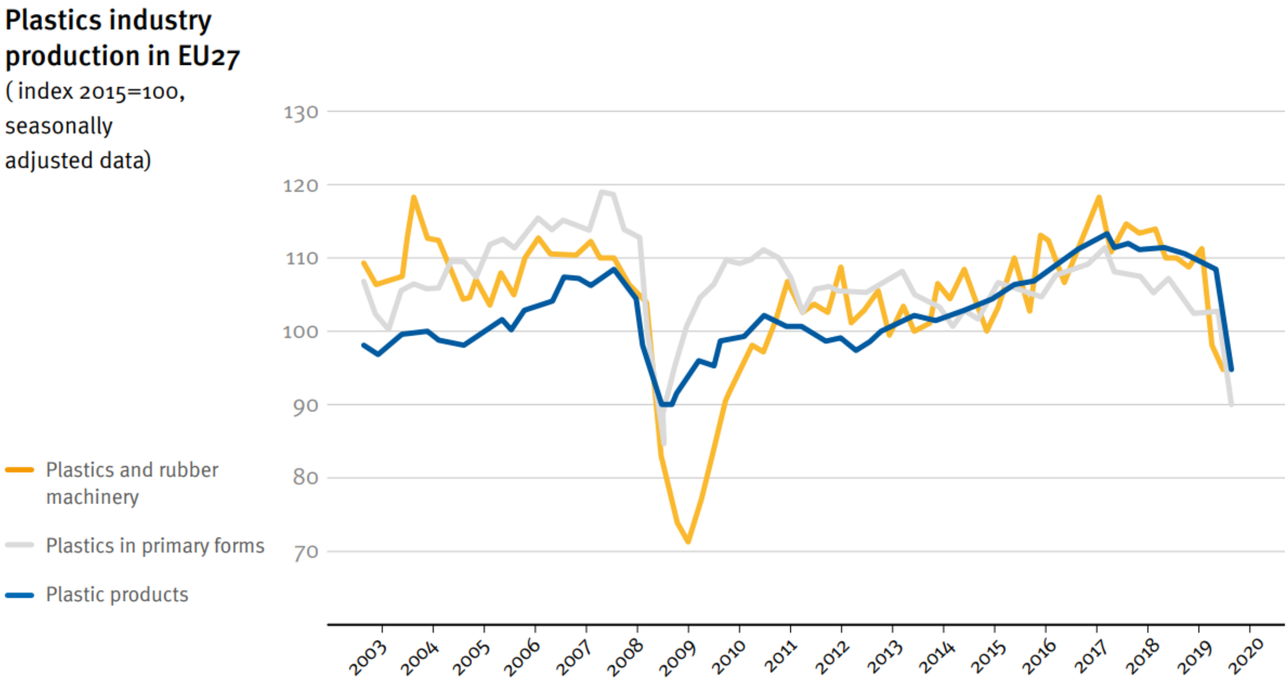
THE PLASTIC RAW MATERIALS PRODUCERS, plastics converters, plastics recyclers, and machinery manufacturers, represent a value-chain that **employs over 1.5 million people** in Europe, through more than **55,000 companies**, most of the them SMEs, operating in all European countries. In 2019, these companies created a turnover of over **350 billion euros**.

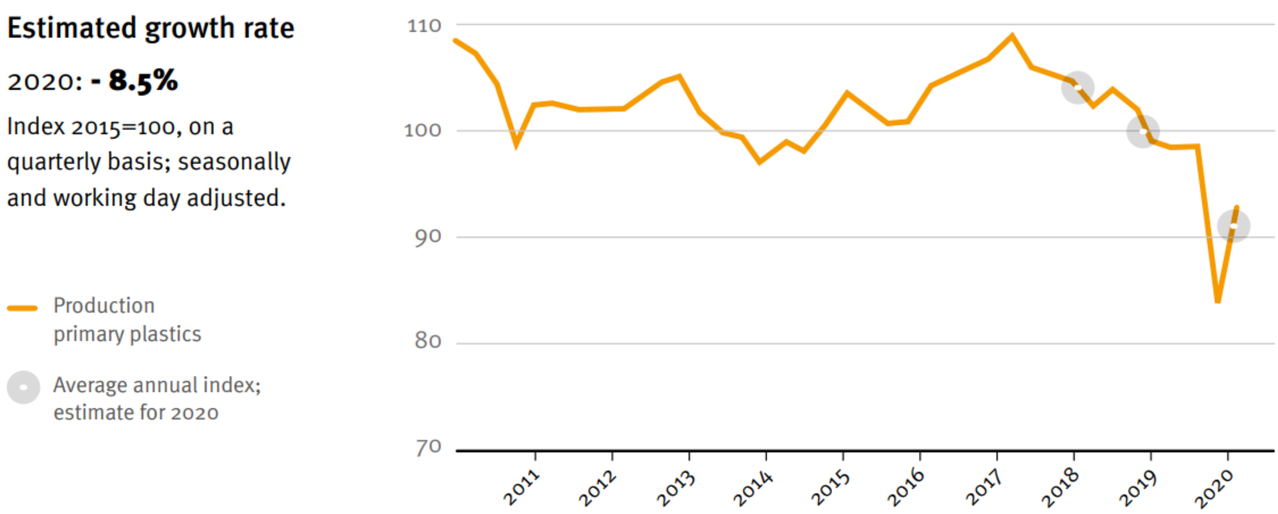
Since 2018, the data provided by EUROSTAT show a decline of the european plastics industry production, which has been clearly intensified by the covid-19 pandemic. A similar decline was noticed in the aftermath of the 2008 financial crisis, from which the industry completely recovered as from 2009-2010, leading to a peak in 2017.



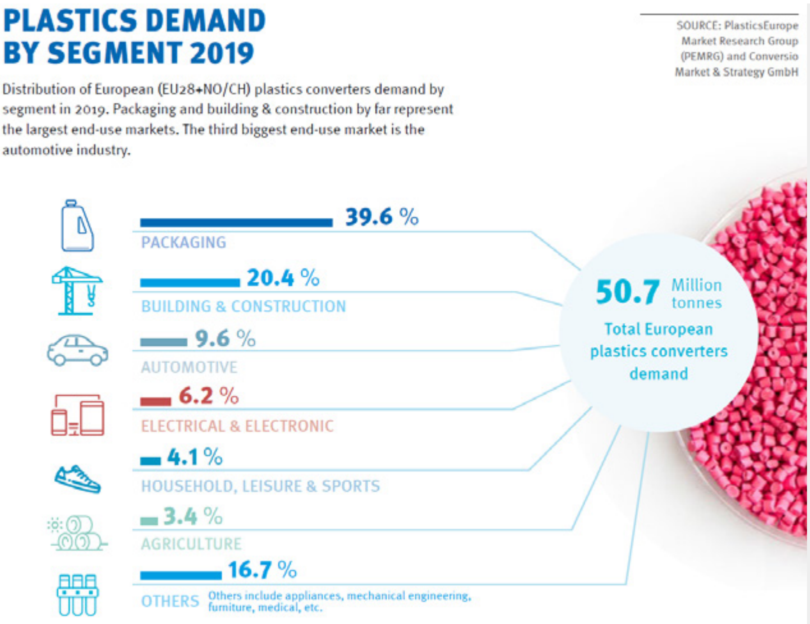
After a sharp drop in production due to COVID-19 in the first half of the year 2020, the production of plastics in primary forms in the EU27 started to recover in June 2020.

The recovery is estimated to continue in the last quarter of 2020 and in 2021. However, the speed of recovery depends on the impact of the COVID-19 and on the demand for plastics from important customer industries like automotive or building and construction sectors.

The production level before the COVID-19 pandemic will not be reached before 2022.



Source EUROSTAT - Plastics - The Facts: https://www.plasticseurope.org/en/resources/publications/4312-plastics-facts-2020



With a market share of almost 40%, **packaging** represents the largest end-use market in the EU, closely followed by and building & construction (more than 20%). The third biggest end-use market is the automotive industry.

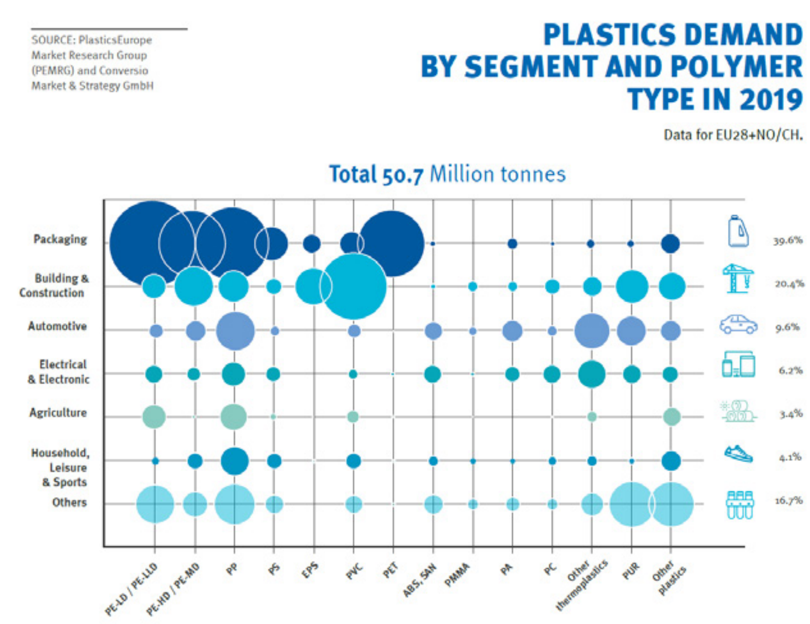
The leading polymers are the **polyolefins** (PE & PP).

The global market for **bio-polylactic acid** is expected to grow by 14.96% during t2021-2026*. The major factor driving the growth is favorable government policies toward bio-plastics. On the flip side, the high cost of PLA and the negative economic impacts of COVID-19 are expected to hinder the growth of the market studied.

* Source: https://www.researchandmarkets.com/reports/4536244/bio-polylactic-acid-pla-market-growth

The packaging industry dominated the global market share of PLA, owing to its usage in fruit and vegetable packaging in the supermarkets, for bread bags and bakery boxes, bottles, envelopes and display carton windows, and shopping or carrier bags, among others.

The growing production of genetically modified corn and the growing usage of bio-PLA in 3D printing are likely to act as opportunities in the future.



TRENDS IN THE PLASTICS INDUSTRY

Internet of Things and connectivity: more and more products are connected to each other or gather data to share.

Advances in polymers and additives: new materials with specific characteristics are being developed for explicit purposes.

Industry 4.0: machines are interconnected (inside and outside the factory) allowing to achieve an even higher level of efficiency.

Global plastic production continues to grow: The demand for plastic products continues to grow on an annual basis. With innovative solutions in design and materials, it is possible to replace all kinds of metals in more and more finished products with plastic.

Lightweight plastics: major industries such as the automotive industry are moving from steel to plastic for certain applications. That also improves sustainability, because lighter cars use less fuel.

Automation improves reliability when managing production and assembly processes. The use of robots results in a faster, more accurate and more agile production process, which in turn leads to an increased production output and more efficiency.

Recycle-proof design: the circular economy is becoming a major factor in the plastics industry. When designing a new product, it is therefore increasingly common to consider the use of recycled bioplastics, the recyclability of the design and the option of making the design recycle-proof.

Local: A growing number of organisations look for local solutions to reduce transport costs and increase their flexibility in the supply chain. Producers build smaller production sites that can operate in a more flexible manner, which allows them to meet buyers' demands locally.

CIRCULARITY FOR PLASTICS

IN 2018, THE EUROPEAN UNION adopted a *European strategy for plastics in a circular economy*[1] as a part of their action plan for a circular economy. Sustainability is the underlying motivation behind the plastics strategy with a goal of addressing how plastics are designed, used and recycled in the EU. According to the Commission, this proposal is an ambitious step in making the European plastics system more resource-efficient and drive the change from a linear to a circular system.

One of the strategies is that by 2030, all plastic packaging placed on the EU market is either **reusable** or can be **recycled in a cost-effective manner**. In this context, the Commission will look into ways of maximising the impact of new rules on **Extended Producers Responsibility (EPR)**[2], and support the development of economic incentives to reward the most sustainable design choices. It will also assess the potential for setting a new recycling target for plastic packaging, similar to those put forward in 2015 for other packaging materials.

PLASTICS IS MORE THAN ITS WASTE!

With their inherent versatility and capacity for innovation, plastics play a crucial role in a sustainable and resource-efficient economy. In the transport sector, their light weight makes them more fuel-efficient and helps reduce CO_2 emissions. In the building and construction sector, they are used to manufacture high-performance and long-lasting insulation products, window frames and piping systems that save energy and water. Plastic packaging plays an important role in ensuring food safety and reducing food waste.

However, it is crucial to address the many challenges relating to littering and the end-of-life options for plastic waste – particularly packaging waste.

Closing the loop of the circular economy for plastics will boost European competitiveness, help tackle climate change and reach the **United Nations Sustainable Development Goals**[3].

CIRCULARITY FOR PLASTICS STARTS WITH ECODESIGN

Ecodesign is defined by the **European Environment Agency**[4] as *"the integration of environmental aspects into the product development process, by balancing ecological and economic requirements. Ecodesign considers environmental aspects at all stages of the product development process, striving for products which make the lowest possible environmental impact throughout the product life cycle."*

Ecodesign means producing goods and services that meet your customers' needs while:

- using the minimum levels of resources
- having a minimum impact on the environment and society

Ecodesign involves designing or redesigning products, services, processes or systems to avoid or repair damage to the environment, society and the economy.

The environmental considerations of ecodesign:

- using materials with less environmental impact
- using fewer materials overall in the manufacture of products
- using fewer resources during the manufacturing process
- producing less pollution and waste
- reducing the environmental impacts of distributing products
- ensuring that products use fewer resources when they are used by end customers
- ensuring that products cause less waste and pollution when in use
- optimising the function of products and ensuring the most suitable service life
- making reuse and recycling easier
- reducing the environmental impact of disposal

Source: Ellen MacArthur Foundation (2016)

In the above mentioned European strategy for plastics in a circular economy, we read that design improvements could reduce the cost of recycling plastic packaging waste by as much as 50%.

1 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN
DOWNLOAD: https://www.europarc.org/wp-content/uploads/2018/01/Eu-plastics-strategy-brochure.pdf
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3 **DOWNLOAD:** https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf
4 https://www.eea.europa.eu/help/glossary/eea-glossary/eco-design

MORE MASKS THAN JELLYFISH!

Source: The Guardian[1]

CONSERVATIONISTS have warned that the coronavirus pandemic could spark a surge in ocean pollution – adding to a glut of plastic waste that already threatens marine life – after finding disposable masks floating like jellyfish and waterlogged latex gloves scattered across seabeds.

Divers had found dozens of gloves, masks and bottles of hand sanitiser beneath the waves of the Mediterranean, mixed in with the usual litter of disposable cups and aluminium cans. The quantities of masks and gloves found were far from enormous, but hint at a new kind of pollution, one set to become ubiquitous after millions around the world turned to single-use plastics to combat the coronavirus.

In the years leading up to the pandemic, environmentalists had warned of the threat posed to oceans and marine life by skyrocketing plastic pollution. As much as 13 million tonnes of plastic goes into oceans each year, according to a 2018 estimate by UN Environment. The Mediterranean sees 570,000 tonnes of plastic flow into it annually – an amount the WWF has described as equal to dumping 33,800 plastic bottles every minute into the sea.

These figures risk growing substantially as countries around the world confront the coronavirus pandemic. Masks often contain plastics such as polypropylene. With a lifespan of 450 years, these masks are an ecological timebomb given their lasting environmental consequences for our planet.

Gloves, masks and bottles of hand sanitiser have been collected around France's Côte d'Azur.

Photograph: Courtesy Operation Terre-Mer

On the next pages, we'll discuss the EU strategy for plastics in a circular economy, and several Centexbel-VKC research projects and investments in this field.

1 https://www.theguardian.com/environment/2020/jun/08/more-masks-than-jellyfish-coronavirus-waste-ends-up-in-ocean

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SAFE USE OF ANTIMONY TRIOXIDE

AS A FLAME-RETARDANT SYNERGIST IN POLYMERIC MATERIALS

MOST POLYMERS are combustible materials and therefore flame retardants (FRs) are indispensable in the protection of plastics used in electric devices, construction materials, or textiles. Conventional flame-retardant formulations are based on halogenated substances. They are effective in low doses, have a minimal impact on the physical properties of the polymer, and a good price / performance ratio. Flame retardancy of halogens can be boosted by the use of different synergists. Antimony trioxide (Sb_2O_3) is by far the most frequently used synergist.

Besides the flame-retardant standard to be reached, the selection of flame retardants involves different aspects: environmental issues, sustainability, and the safe use for producers as well as for end-users have become increasingly important.

Antimony trioxide has a potential carcinogenetic label, because it is categorized as a fine dust particle. The actual OEL[1] level is 0,5mg/m^3. In order to use ATO powder in production, producers (such as Campine in Belgium) offer safe user-formats which reduce and even completely avoid exposing workers to dust. These formats are respectively: wetted powders (using oils or plasticizers), dispersions in plasticizers or H_2O, sealed dosable bags, granules for thermoplastic polymers, or PVC µ-granules. All these formats allow to reduce the workplace exposure far below the actual OEL levels and are also fit for complying with the expected lower levels in the future.

In order to evaluate the safe-use for the end-user, the potential blooming of Sb_2O_3 for various FR systems out of different plastics (PE, PP, HIPS, PVC, PA6 and PBT) was evaluated (data Campine). Real life formulations have been used to determine potential exposure of end-users to Sb_2O_3 in different applications.

Results show that the **risk** a person runs in contact with Sb_2O_3 once it is encapsulated in a plastic matrix (e.g. television, cable, electrical connector, coated textiles, etc.) is **extremely small**.

Formulation	t_0 µg Sb_2O_3/cm^2	14 days µg Sb_2O_3/cm^2	35 days µg Sb_2O_3/cm^2
LDPE/DBDPE/Sb_2O_3	< 2	< 2	< 2
PPco/ BDDP of TBBA /Sb_2O_3	< 1	< 1	< 1
HIPS/ BDDP of TBBA /Sb_2O_3	< 1	< 1	< 1
PA6/Br Polystrene/Sb_2O_3	< 2	< 2,5	< 2
PBT/Br Polyacrylate/Sb_2O_3	< 1	< 1	< 1
PVC/Plasticiser/Sb_2O_3	< 1	< 1	< 1

The blooming has been studied at 70°C for 35 days. The maximum amount of blooming observed was 2.5 µg/cm2. Over a timeframe of 35 days, no migration of Sb_2O_3 was noted for any of the polymers and FR systems.

Translated to room temperature, these results correlate to a timeframe of 2.5 to 3 years. In this timeframe, the bloomed amount of Sb_2O_3 out of the back panel of a 55-inch television standing in a standard living room (10m on 6m) is 50.000 times smaller than the actual OEL level valid in EU.

1 Occupational exposure limits (OELs) are regulatory values which indicate levels of exposure that are considered to be safe (health based) for a chemical substance in the air of a workplace. – source: https://echa.europa.eu/oel

CREATOR
COLLECT • PURIFY • REUSE

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project website: https://www.creatorproject.eu/

FLAME RETARDANTS are chemicals added to materials to prevent the start or spread of a fire. They have been used in a myriad of consumer and construction products since the 1970s, but many have now been banned because they can remain in the environment for years, accumulating to toxic levels over time. Brominated flame retardants (BFRs), like HBCD, octa-BDE, deca-BDE are among these.

In this perspective, The European H2020 project **CREAToR** is developing a process to remove BFRs from polymer waste materials in the building, construction, electrical and electronic equipment and aviation sectors. Even more, CREAToR aims to create a circular economy, revalorising the purified materials for use in new insulation panels for buildings as well as for interior automotive and aerospace components.

To achieve this aim, CREAToR focuses on process development including a demonstration to identify and sort (via LIBS-based techniques) hazardous, already banned brominated flame-retardant waste streams and to subsequently remove these flame retardants using continuous purification technologies: supercritical-CO_2 and cost-effective solvent-based processes using natural deep eutectic solvents (NADES) in twin-screw extruders. Furthermore, it aims to increase the economic feasibility of the generated approach by establishing an optimised logistic concept and a harmonised material quality classification scheme.

The result will be a circular economy solution transforming waste streams - that are currently incinerated at costs of >180 €/t - into value-bringing secondary raw materials. The economic viability of CREAToR will be validated through material benchmarking and LCA/LCC assessment for the whole value chain leading to next generation products.

Halfway, the project, we can already mention the following interesting results:

- the requirements from the recyclers and end-users have been compiled and the legal framework has been summarized. Furthermore, external industrial partners are being consulted concerning the recycled materials and the design and implementation of a smart label.
- A prototype sorting line using LIBS-technology was built up (including the set-up of the offline characterisation of bromine content and calibration of the device).

LIBS technology to sort bromine-contaminated plastics

A reverse logistics process
for the collection of waste materials

New technologies
for sorting and quality control

A new purification
process to remove Br flame retardants

A labelling concept
for the Br-free material

Modification for reuse
of the purified material

- PS-based input materials were used to optimize the bromine removal strategy. In this perspective, the best suited NADES candidates have been identified (up to 94% extraction efficiencies in off-line test set-ups, see figure 1). The sc-CO_2 extraction process is under optimization and soon the inline combination with the selected NADES will be investigated.

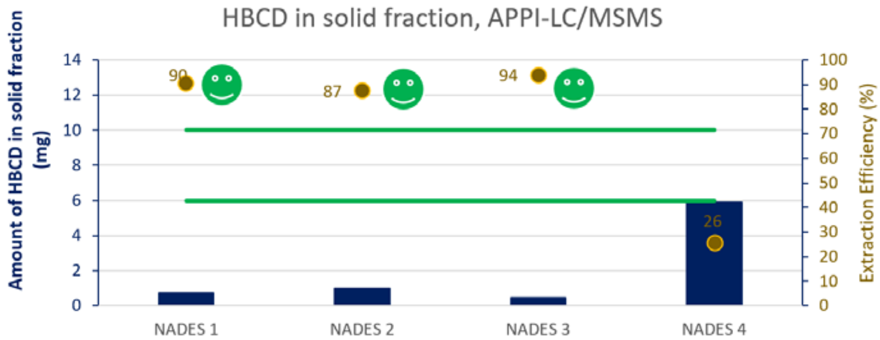

Figure 1: High extraction efficiencies have been obtained in off-line extraction set-ups, using NADES as extraction medium.

Apart from effective extractions, there is also focussed on safe processing conditions in the organisations' plants. Besides the focus on the bromine removal, also the feasibility to use partners' patented technology to further improve the quality of the non-brominated fractions in ton scale has been elaborated on.

- Environmentally friendly flame-retardant recipes have been developed and are now under investigation for implementation in the aeronautic, building and construction demonstrators (flame retardancy is not needed for the automotive interior part) (see figure 2).

Figure 2:

Injection moulding mould (left), rABS-based automotive demonstrator (middle) and rABS-based 3D printing filament, recycled from fridges (white) and WEEE (black)(right)

- In view of the reverse logistics cycle, an extensive mapping of the existing recycling chains has been carried out for WEEE, packaging and paper waste, construction & demolition and household waste, covering very different recycling schemes and therefore enabling best practice advice for the design of the CREAToR logistics cycle. For this, the specifications are currently being compiled.
- Potential business cases are being designed and monitored.

To be continued...

RECYCLING

CREATOR PARTNERS

RE-USE

LCA • DISSEMINATION • LEGAL

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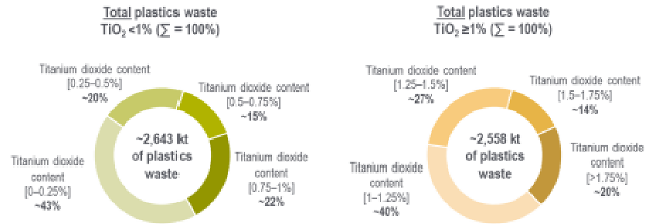
RECYCLING OF TITANIUM DIOXIDE

TITANIUM DIOXIDE is a white powder pigment that is used to impart whiteness, brightness, and opacity in paints and varnishes, paper and plastics. Plastics account for about 80% of the world's titanium dioxide consumption[1]. The pigment is chemically inert, insoluble in polymers and heat-stable under harsh processing conditions. Titanium dioxide also provides many unique properties, such as minimising brittleness, fading and cracking in plastics as result of light exposure. This results in a yearly production and consumption of over 1 million tonnes of titanium dioxide in the European Economic Area. The worldwide production even succeeds 9 million tonnes!

Although TiO_2 is the ninth most abundant element in the earth's crust, the feedstock is depleting. Mines with the highest quality minerals (anastase, rutile and ilmenite), which are the raw materials to produce TiO_2, are becoming rare, necessitating the mining of lower quality minerals. This will inevitably result in higher cost prices of produced TiO_2. Recycling TiO_2 is therefore a good alternative and needs investigation.

Plastics waste in 2017	Plastics waste [in kt]*	Ø share of TiO_2 [in %]	Amount of TiO_2 [in kt]	Plastics waste TiO_2<1% [in kt]	Plastics waste TiO_2≥1% [in kt]
Packaging	3,081	0.9%	28	1,479	1,602
Construction	495	1.1%	6	238	257
Automotive	232	0.3%	1	200	32
Electrical/ electronics	307	0.9%	3	166	141
Agriculture	277	1.3%	4	116	161
Other	809	0.7%	6	445	364
Total	5,201	0.9%	46	2,643	2,558

* Substance flow illustration of plastics in Germany in 2017; internal analyses on plastics waste in the construction sector (Conversio, 2016–2018)



The waste streams of the main end products for TiO_2 will be analysed based on available waste statistics, literature data, and own analysis of available waste streams. In the plastics sector, titanium dioxide is used in polyolefin-based applications such as rigid and flexible packaging, in agriculture films, in PVC for building materials, HIPS for food packaging and in PS, ABS, PC in electric appliances, etc. The available post-industrial and post-consumer waste will also be thoroughly characterized.

TiO_2 is used at an average of 1% in the plastics industry. However, almost 50% of the total amount of plastic waste contains more than 1% of TiO_2. PS packaging, PP and PE films, window profiles and floorings far exceed the 1% TiO_2, containing TiO_2 contents of 3 – 5%. Moreover, higher TiO_2 contents can be found in products with special requirements such as higher UV absorption capacity.

The figure above shows that it is especially packaging and construction products that contain high amounts of TiO_2. Moreover, they also contain polymer waste streams (e.g. window profiles) with high TiO_2 concentrations[2].

1 Titanium Dioxide Market Report: Industry Analysis, 2025
https://www.ceresana.com/en/market-studies/chemicals/titanium-dioxide/ceresana-market-study-titanium-dioxide.html

2 Titanium Dioxide in Plastics, pp. 2–5

TiO_2 is a valuable additive that can be found in high concentrations in various plastic waste streams. Because titanium dioxide is a pigment that is present in the polymer matrices, it cannot be simply separated from the polymers. The Remove2Reclaim project will therefore develop advanced dissolution and separation techniques to remove additives such as titanium dioxide from various polymer matrices allowing to reuse both the titanium dioxide and the polymers in new products.

Centexbel and **VITO** will not only reprocess the recovered materials, but also focus on dissolving the polymer matrix to recuperate TiO_2.

To this end, Centexbel uses a dual approach: firstly, we will try to dissolve the different polymer matrices (PVC, PE, (HI)PS, SAN and ABS) by **using commercially available green and safe solvents**, which are often a blend of multiple solvents (trial and error approach). Secondly, we will use the **Hansen Solubility Parameters (HSP)** allowing a more theoretical approach. Each solvent can be characterized based on three parameters:

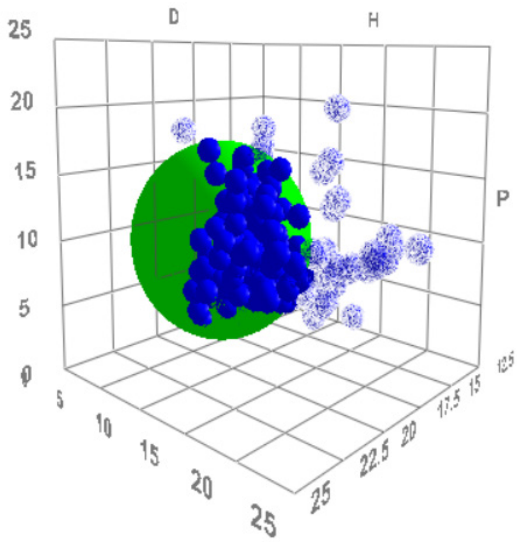
- δ_h is the energy from hydrogen bond formation between solvent molecules
- δ_d is the energy from dispersion forces between solvent molecules
- δ_p is the energy from dipolar forces between solvent molecules

These three parameters lead to a specific position in the 3D HSP space. Besides solvents, also polymers can be characterized and positioned in this space by using these 3 δ-values. Each polymer has a defined radius (see green sphere in the figure below).

All solvents located within this radius are theoretically able to dissolve this polymer, and are shown in dark blue. The closer the solvent is located near the center point of the sphere, the better it will dissolve the corresponding polymer. Solvents outside this sphere (light blue ones) will not dissolve the polymer.

Solvent match for PVC (HSPiP software)

This **HSPiP software** is used to assess whether green solvents are capable to dissolve a specific polymer. Based on HSP calculations,



solvent mixtures can also be proposed. Later on, the theoretical outcome is verified against real dissolution experiments. After dissolving the matrix, the TiO_2 needs to be precipitated/separated from the polymer soup and purified, which is done by **UGent** and **KULeuven**.

INDUSTRIAL PARTNERS

Chemours, **MatcoPlastics**, **Lybover**, **Deceuninck**, and **Ineos Styrolution** assist the research and are responsible for the industrial uptake.

ACKNOWLEDGEMENTS

The project has received funding from **Flanders Innovation & Entrepreneurship** as a **Catalisti Cluster project in transition priorities - Circular economy** under number HBC.2020.2464.

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More info: https://www.centexbel.be/en/projects/remove2reclaim https://youtu.be/nUU-3_-dHR8

PRESERVE

life cycle approach with innovative materials for plastic packaging

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https://www.centexbel.be/en/projects/preserve

project website: https://www.preserve-h2020.eu/

INTRODUCING A LIFE CYCLE APPROACH with innovative materials can help us reach unexplored potentials for plastic packaging and its end of life. In PRESERVE, we have the potential to change up to 60% of packaging currently used by the market. To achieve this goal, we will enhance bio-based packaging by improving both the PROPERTIES that currently limit the application of bioplastics and their END OF LIFE.

The benefits of new approaches and uses of bioplastics, adhesives and biopolymers can help us to upcycle materials and create secondary raw materials to manufacture new products, resulting in a reduction of plastic waste.

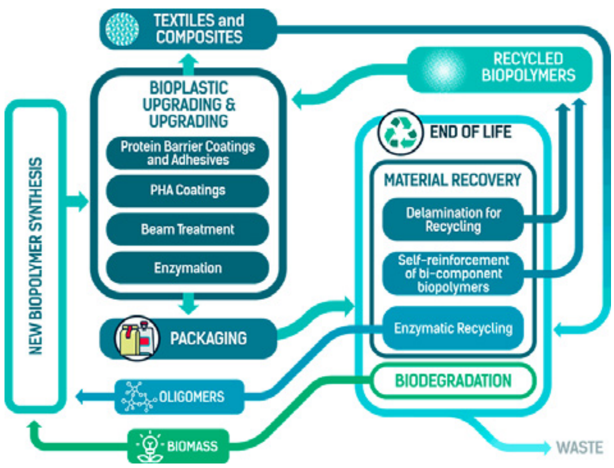
While Europe depends heavily on fossil-derived plastics and consumes around 50 million tonnes of plastic per year, only 32% of their waste is recycled. Given that packaging represents over 40% of all plastics produced each year, improving its circularity is more than urgent.

The upcycling strategies to boost packaging performance in the first and subsequent life cycles of the materials comprise several steps:

BETTER PACKAGING DESIGN allowing delamination with bio-based barrier coatings and adhesives, eBeam treatment and enzymation to prevent microplastics release

ESTABLISHMENT OF A DELAMINATION PILOT PLANT, with subsequent adjusting and upscaling of the new recycling process, with an initial sorting via advanced photonic and artificial intelligence approaches

DEVELOPMENT OF UPCYCLED DEMONSTRATORS deriving from recycled food packaging, with at least 85% of recovered materials for non-food-contact applications.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952983.

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https://www.centexbel.be/en/projects/nenu2phar
Project website: https://nenu2phar.eu/

PHA FROM MICRO-ALGAE BIOMASS

THE NENU2PHAR PROJECT PARTNERS will develop an original route to produce PHA (Polyhydroxyalkanoate) from sustainable and renewable resources: micro-algae biomass using CO_2 as carbon source and processed by selected bacterial strains. PHA are a group of biopolymers recognised as attractive substitutes to fossil fuel-derived plastics in a wide range of applications, for they are renewable, biodegradable and bio-based polyesters.

Nenu2PHAr brings together teams from 16 partners from 7 European countries at different stages of the value chain. The project will be carried out over 42 months, from September 2020 to February 2024, with an overall budget of € 6.4M including € 5M funding from the Bio-Based Industries Joint Undertaking (BBI-JU) under the European Union's Horizon 2020 research and innovation programme.

Nenu2PHAr targets the development of high-performance bioplastic materials and products with a better environmental profile which is key for the sustainable growth of the plastic industry. Such development must proceed from the establishment of innovative and affordable value chains of bioplastics at a European level. The project is raising the following challenges :

TECHNOLOGICAL

- Develop competitive and sustainable bio-source PHA polymers
- Formulate and functionalise PHA polymers for masterbatch and compound development
- Optimise processing of PHA-materials to reach targeted functional properties of bioplastics
- Develop eco-designed PHA-biobased products
- Ensure a sustainable and controlled end-of-life

ENVIRONMENT

- Demonstrate the sustainability of the project value chain

SOCIETY

- Increase stakeholders and consumer awareness of new bio-plastic products

This project has received funding from the Bio Based Industries Joint Undertaking (BBI-JU) under grant agreement No 887474. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

Interreg
EUROPEAN UNION
North-West Europe

CurCol BIO-BASED COLORANTS 4 BIODEGRADABLE PACKAGING

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https://www.centexbel.be/en/projects/curcol

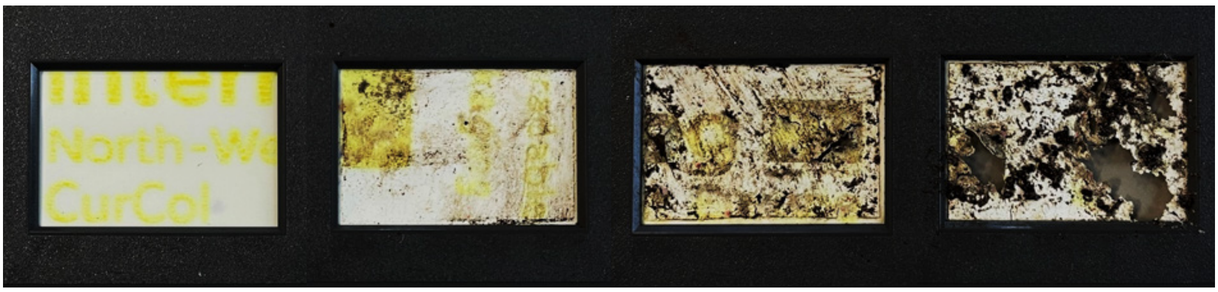
PRINTING INKS FOR A FULLY BIODEGRADABLE PACKAGING SOLUTION

THE CURCOL PROJECT is all about using novel dyes - extracted from locally grown turmeric plants - in packaging materials. But packaging is more than the wrap. It is printed with product information and colourful decorations to entice customers to buy the packaged product. To obtain a completely biodegradable packaging, Curcol investigates the use of biobased and biodegradable printing inks in combination with curcumin-derived colorants.

To be as eco-friendly as possible, we're not only looking at the inks, but also at the printing techniques. Digital printing processes consume less ink and produce less waste than conventional techniques. Because digital printing doesn't require any set-up (in contrast to screen or offset printing), it 's a very suited technique for small production runs.

The main concern of Curcol remains the development and assessment of bio-based printing inks. Therefore, we monitor every step in the life cycle of a potential biodegradable packaging, including its recyclability and biodegradability.

We are engineering the inks and dye concentrations in such a way that both the ink and the pigments are home compostable, which is a true innovation for the packaging printing industry!



The biodegradation process during the first three weeks shows that areas printed with the biodegradable inks are degrading first.

The prints were applied on a thermoplastic starch packaging material.

But we still have a few hurdles to overcome: the colorant still needs extensive stabilization. All components of the printed packaging (bio-based plastics and bio-based inks/colorants need to be durable, biodegradable, recyclable at the same time.

A CHALLENGING TASK THE CURCOL TEAM IS HAPPY TO ACCEPT!

Interreg NWE project with the support of the European Regional Development Fund

BIO-PLASTICS STABILIZATION OF CURCUMIN

IN THE CURCOL PROJECT, we also studied curcumin as colorant in bio-plastics: two biodegradable polymers, i.e. a starch-based polymer and PLA, were selected to study the UV stability of curcumin in a plastic matrix. Curcumin is known as an unstable substance when exposed to UV. In order to improve its stability, we investigated (1) the use of (both natural and synthetic) stabilizers and (2) the modification of curcumin to tune its color and stability (performed by AVANS Hogeschool).

In case of the starch-based polymer (figure 1), stabilizers were added to the polymer matrix (figure 1) their addition already resulted in a color change. In a next step, the samples were aged by a Q-UV treatment for 500 hours (figure 2). As all samples turned brown, the selected stabilizers did not result in a successful stabilization of curcumin.

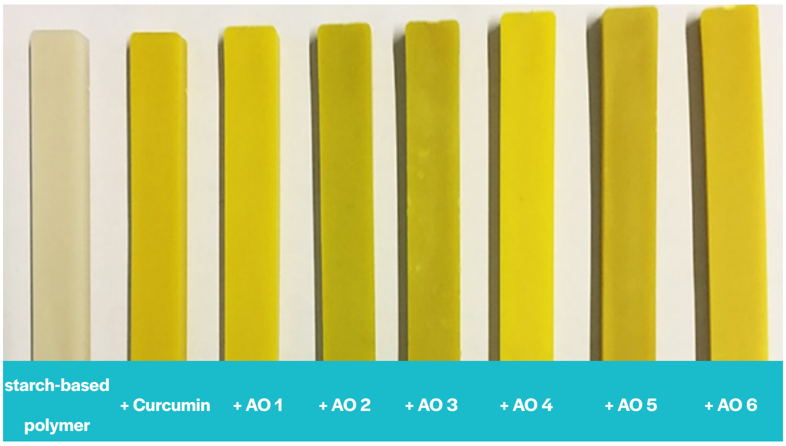
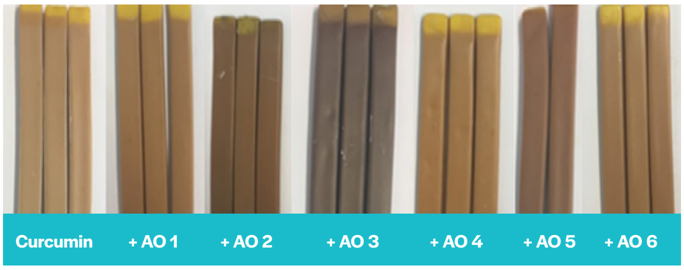


Figure 1 (left)

Starch-based polymer samples: a blanc sample is shown, together with a curcumin-containing sample and the stabilized versions (i.e. + AO). Commercial stabilizers, but also natural ones were added to study their UV-stabilization effect.

Figure 2 (bottom)

Starch-based polymer samples after 500 hours of Q-UV ageing.



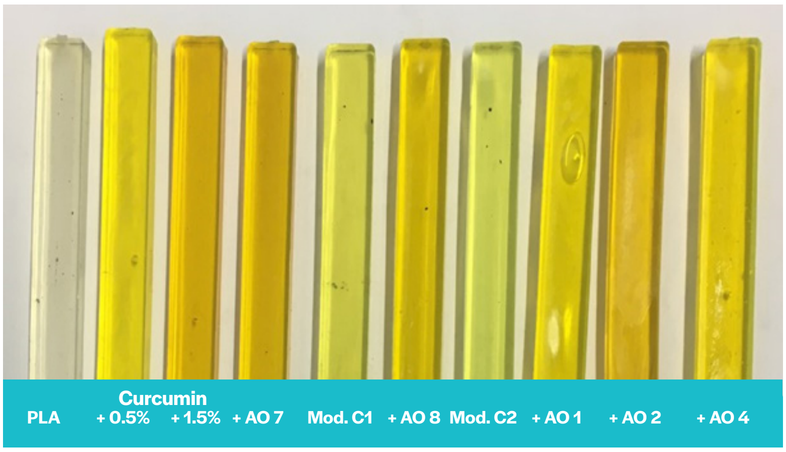
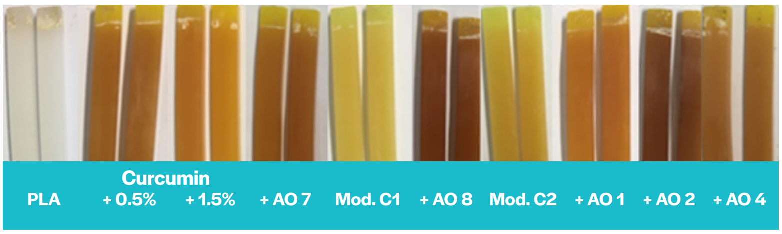


Figure 3 (left)

PLA-based polymer samples: a blanc sample is shown, curcumin-containing samples, samples containing the modified curcumin-based versions (Mod. C1 and Mod. C2) and samples containing curcumin and a stabilizer (i.e. + AO).

Figure 4 (bottom)

PLA-based polymer samples after 500 hours of Q-UV ageing: C= Curcumin; Mod. C= modified curcumin and AO= stabilizer or antioxidant.



For the PLA material, a selection was made of natural stabilizers, but also the modified curcumin variants were tested to see the impact on color stabilization. Again, a variation in color was obtained after adding the additives, but to a lesser extent compared with the starch-based polymers.

After 300 hours of Q-UV ageing, The PLA samples crystallized and most of them turned into orange-like to brownish samples. In this context, discoloration was less prominent in samples containing the modified curcumin variants.

IN CONCLUSION, CURCUMIN MODIFICATION IS A VALUABLE ROUTE FOR FUTURE EXPERIMENTS.

CIRCULAR USE OF PVC

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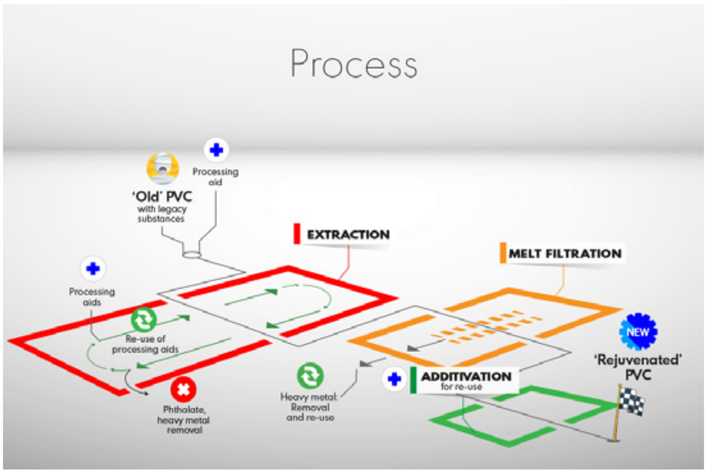
https://www.centexbel.be/en/projects/remadyl

Project website: http://www.remadyl.eu/

REMADYL aims at recycling the so-called "old PVC", i.e. PVC additivated with hazardous legacy substances (LS) such as low molecular weight phthalate plasticisers (mainly DEHP) and heavy metal-based stabilisers (mainly lead). This "old PVC" constitutes most of the current hard (e.g. window frames, tubes) and soft (e.g. flooring or cables) PVC post-consumer waste.

The presence of LS is a persistent barrier for PVC recycling as there are currently no economically viable solutions for their removal. To tackle this major challenge, REMADYL will develop a **breakthrough continuous process based on extractive extrusion technology in combination with novel solvents and melt filtration,** which has the potential of rejuvenating 'old PVC' into high purity PVC tuned towards the demands of various soft and hard PVC products at market competitive cost. The process also has potential for other plastics applications, e.g. removal of (halogenated) flame retardants.



Using this process, REMADYL will demonstrate the **circular use of PVC for window profiles and waterproofing sheets**, providing a flagship example for the circular economy.

The extracted phthalate plasticizers will be **safely disposed** (with energy valorisation) and the **lead will be re-used in batteries**.

The REMADYL project will contribute to the development of the EU Circular Economy Package and resource efficiency targets for Europe as recovered PVC will reduce incineration and landfill. Safety aspects will be studied, leading to best practices, standardisation input and policy recommendations.

Belgian partners: Centexbel, Ovam, and Deceuninck

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 821136

Novel packaging films and textiles

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https://www.centexbel.be/en/projects/biontop

Project website: https://biontop.eu/

PACKAGING MATERIALS are often difficult to recycle because of their being contaminated by food rests or because of their multilayered structure. To increase the recycling rate of plastic packaging waste, Centexbel and partners in the BiOnTOP project are looking to develop biobased packaging materials that are designed to be easily recycled, and if this is not possible, to be composted under domestic conditions.

In the **BiOnTOP** project we will look for new types of "home compostable" PLA, copolymers and compounds, to be used in many types of packaging materials.

The main challenge is to obtain packaging materials with suffient barrier properties against oxygen, moisture and aromas for food packaging purposes. At present, different polymer types (e.g. polyamid, polyethylene and ethylene vinyl alcohol) are combined in multilayer films to obtain the right properties.

During this project we will research alternatives based on PLA, proteins, alginates and other biobased polymers to create new packaging materials as well as reusable grocery totes, food wraps and satchels.

BiOnTOP will cover a large domain of research topics and therefore requires a lot of expertise.

The project is coordinated by **Aimplas** (Spain). The Belgian partners are **Centexbel, Sioen** and **Organic Waste Systems (OWS)**, a world leader in the assement and certification of biodegradable products.

Within this project, Centexbel investigates the production process of biodegradable filaments from PLA and helps the project with its expertise in biodegradable polymer coating.

BBI JU

Horizon 2020
European Union Funding
for Research & Innovation

Bio-based Industries Consortium

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No. 837761.

RESEARCH & TEST EQUIPMENT

OUR RESEARCH INTO SUSTAINABLE PLASTICS requires performant appliances for pellitization, extraction of legacy chemicals, (co)mingling, extrusion, digital printing, etc. Some instruments are acquired by and set up at our research partners, according to the expertise of each centre. Below we will describe the appliances that we have purchased to carry out our research and testing activities.

FLAT DIE PELLETING PRESS - COMPACTOR

The compactor facilitates the production of low density pellets (fibres) by pushing this material through a die at high pressures. The resulting heat and shear cause the agglomeration of the material, leading to a more processable material.

Functioning

The Kahl 33-390 compactor is fed at the top with low bulk density material.

This material is then compressed by the rollers. When a sufficient amount of material has been collected, the pressure build-up will cause the material to be pushed through the die.

The compactor is equipped with 2 dies with different length/diameter ratios. This ratio has a major influence on the processing pressure and temperature of the material.

A cutter, underneath the die, cuts the compressed strands, and pushes them out.

Depending on the material, the rolls can exert more or less pressure, in order to better control the process.

The main parameters that control the process are the L/D of the die, the feed rate and the set pressure.

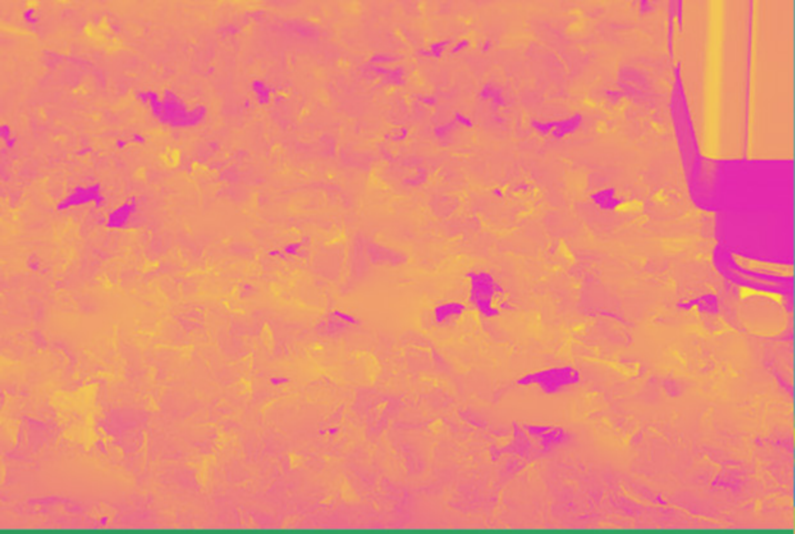
$scCO_2$ EXTRACTOR

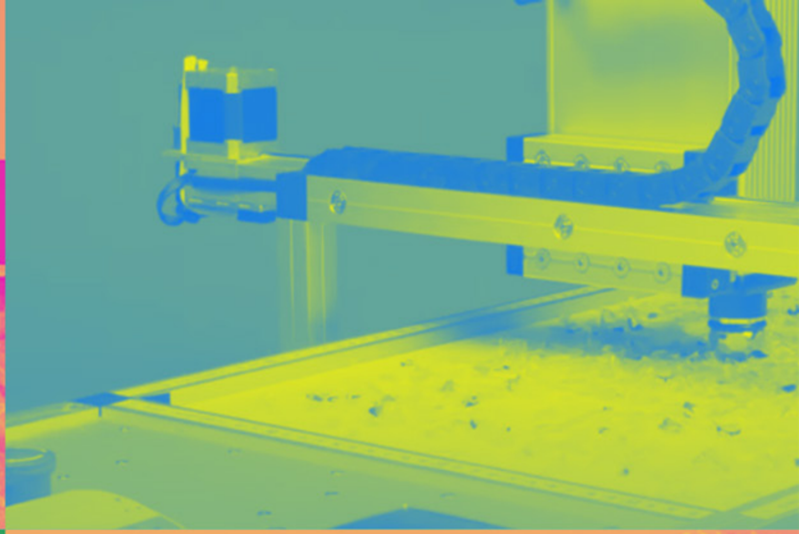
The **$scCO_2$ extractor** allows Centexbel to perform research on the extraction of **legacy additives from recycled plastics** within the framework of the European H2020 projects **CREAToR** and **REMADYL**, and also serves as a showcase to guide plastic converting companies, desiring to increase the recycled content in their products, and recycled plastics suppliers, desiring to market purified recyclates, in selecting an efficient technology to remove undesired chemicals

In addition to the research into the extraction of undesirable chemicals from recyclates, the interest in the use of $scCO_2$ as a **green solvent for textile dyeing** has grown in recent years.

The scCO2 extractor has been acquired in the framework of the EFRO GTI project

EFRO
EUROPEES FONDS
VOOR REGIONALE
ONTWIKKELING





SIROPAD

The SiRoPAD is a Near Infrared Measuring System designed to detect the composition of plastic samples that are taken directly from production or from a recycling process, enabling us to automatically characterize plastic flakes, granules and pellets in an accurate and quick manner.

The sIRoPAD scans the samples that are distributed on the reflection plate in a continuous pass. it measures and saves the results as a complete file with all information or as Excel files via USB or WLAN on the PC.

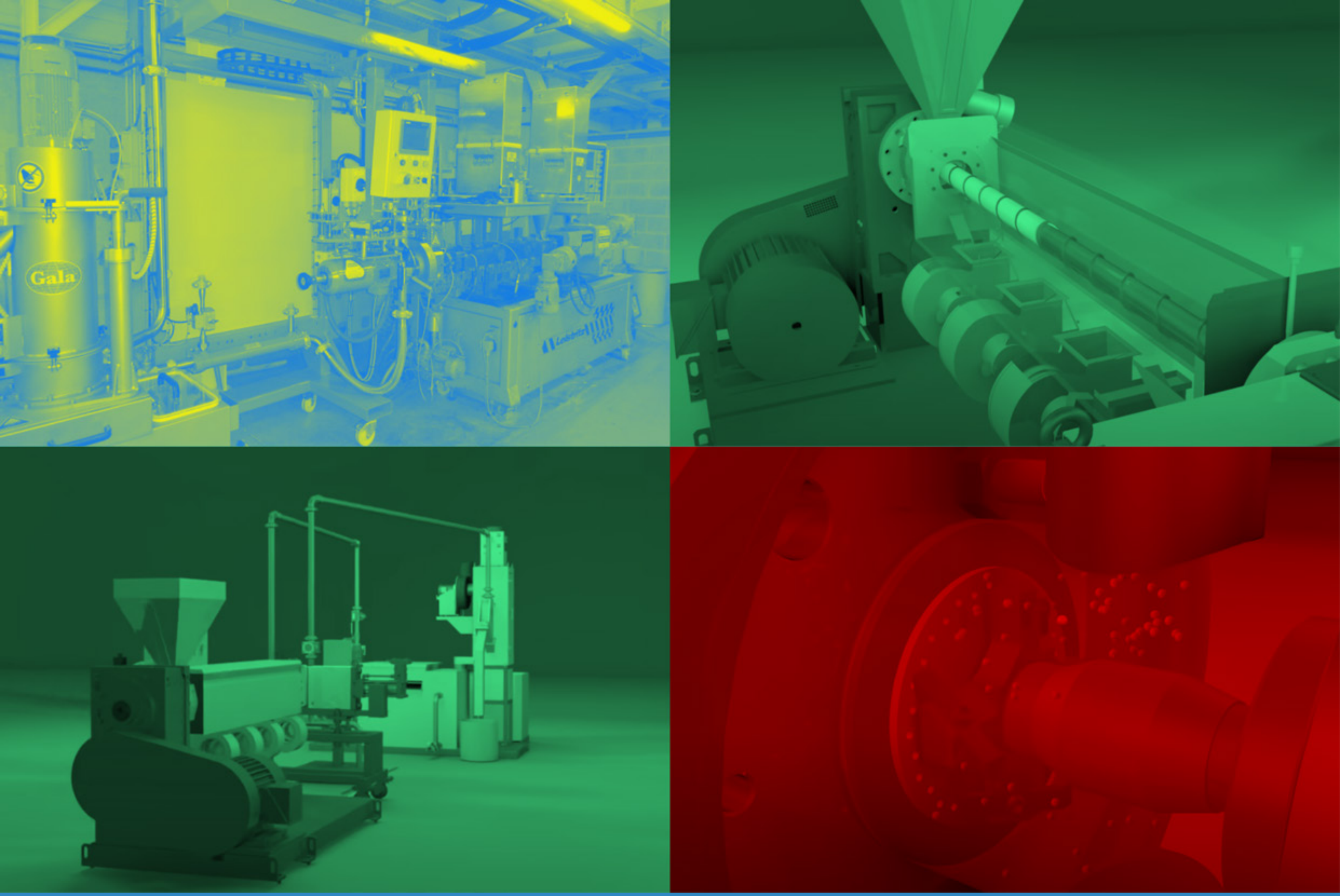
The sizes of the measuring fields and the measurement parameters can be predefined depending on the specimen texture. The entire plate is measured in less than 15 minutes.

Samples of up to 100 grams per disk are measured with an accuracy down to the ppm range, either as manual single scans or as automated batch files, which individually process the individual measurement fields and store the results automatically.

The measurement results can be displayed graphically on the touchscreen and PC screen and arranged as a complete analysis report.

All measurement files can be automatically or manually combined and converted into statistics enabling quality controls of all types over time periods, production processes or supplier quality. Differences in the specific weight, the thickness, etc. can also be compensated here.

This system also allows to perform spectral comparisons for the fine-differentiation of plastics and is used to measure larger amounts of mixed plastic flakes, granules and pellets from several waste streams, including W.E.E.E., packaging, post-consumer, and industrial plastics.



U-PELLETIZER

Underwater pelletizing for thermoplastic compounds

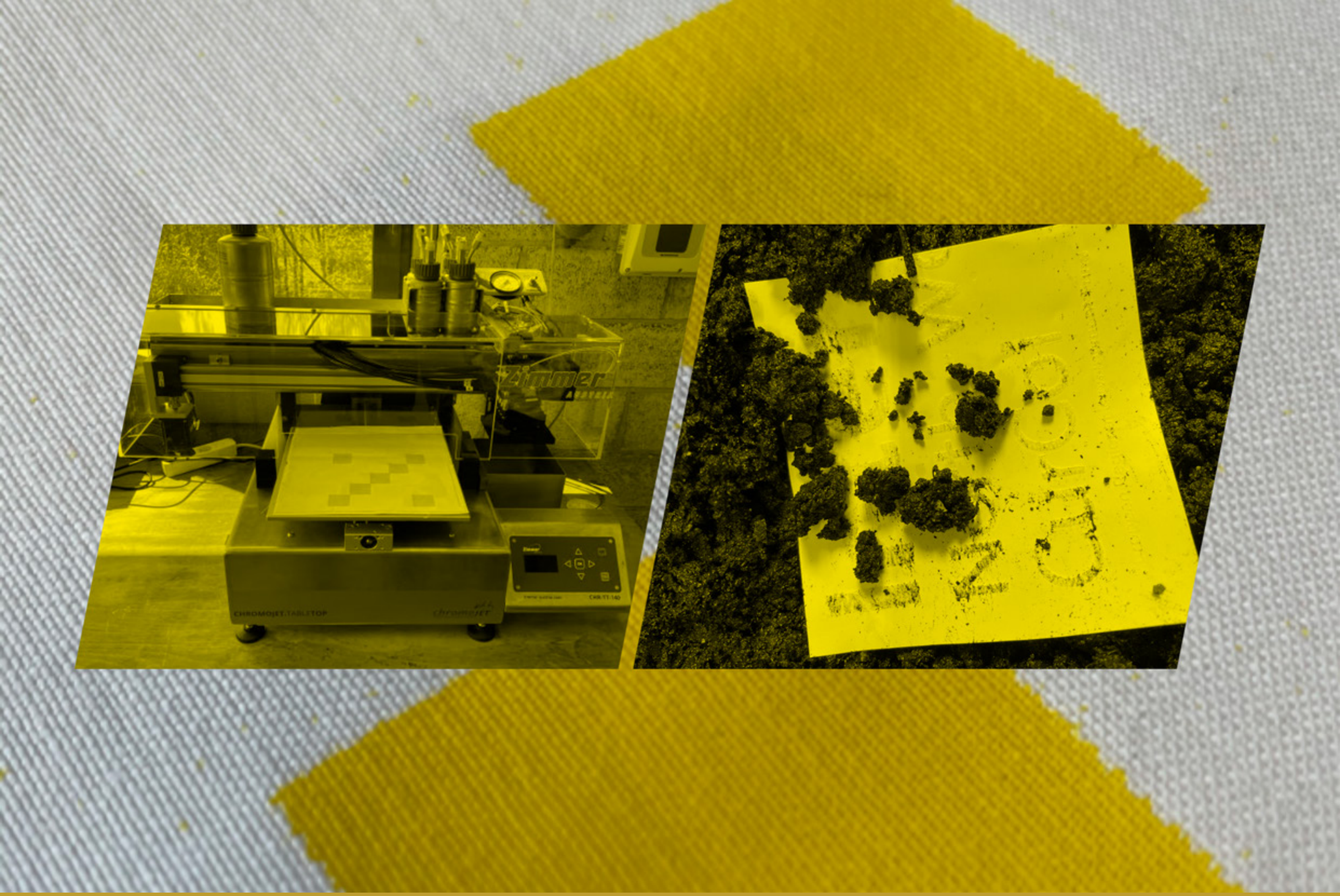
Compared to the "dry-cut pelletizing" systems the underwater pelletizer is less subject to wear and offers more flexibility during the production of thermoplastic compounds. The granules are perfectly spherical and there is no dust emission during the cutting process.

The pelletizing system interfaces with the twin screw compounder. The process is performed in a closed loop system. The pelletized product is conveyed by the process water from the cutting chamber into the centrifugal dryer. During the process, the pelletized product has no contact with the ambient air and there is no risk of gas, dust emission or contamination of the product.

The process water remains in the closed loop tempered water system, another advantage which contributes to the environment.

The Gala's LPU™ Laboratory Pelletizing System is a small lab pelletizing system, designed for pellet rates up to 100 kg/h. The LPU™ Laboratory Pelletizing System includes an underwater pelletizer, a tempered water system, and a new and simple pellet dryer — all mounted on a single chassis with swivel casters.

This investment was made in the framework of the programme "Circularity in & with New Materials" aiming at optimizing the use of recyclates to promote the circular economy.



CHROMOJET DIGITAL PRINTER

Digital printing technologies are using lesser quantities of ink compared to conventional methods.

They are more environmentally friendly and versatile in changing design.

Centexbel invested in a valve-jet digital printer to be deployed in a broad range of developments, including digital printing, finishing, and dyeing. The Chromojet is applied in our research projects on biodegradable packaging.

One of the biggest hurdles in developing biodegradable packaging is the limited availability of biodegradable additives. This is particularly problematic when non-biodegradable inks and dyes are applied on packaging films that are intended for biodegradation.

CREATE

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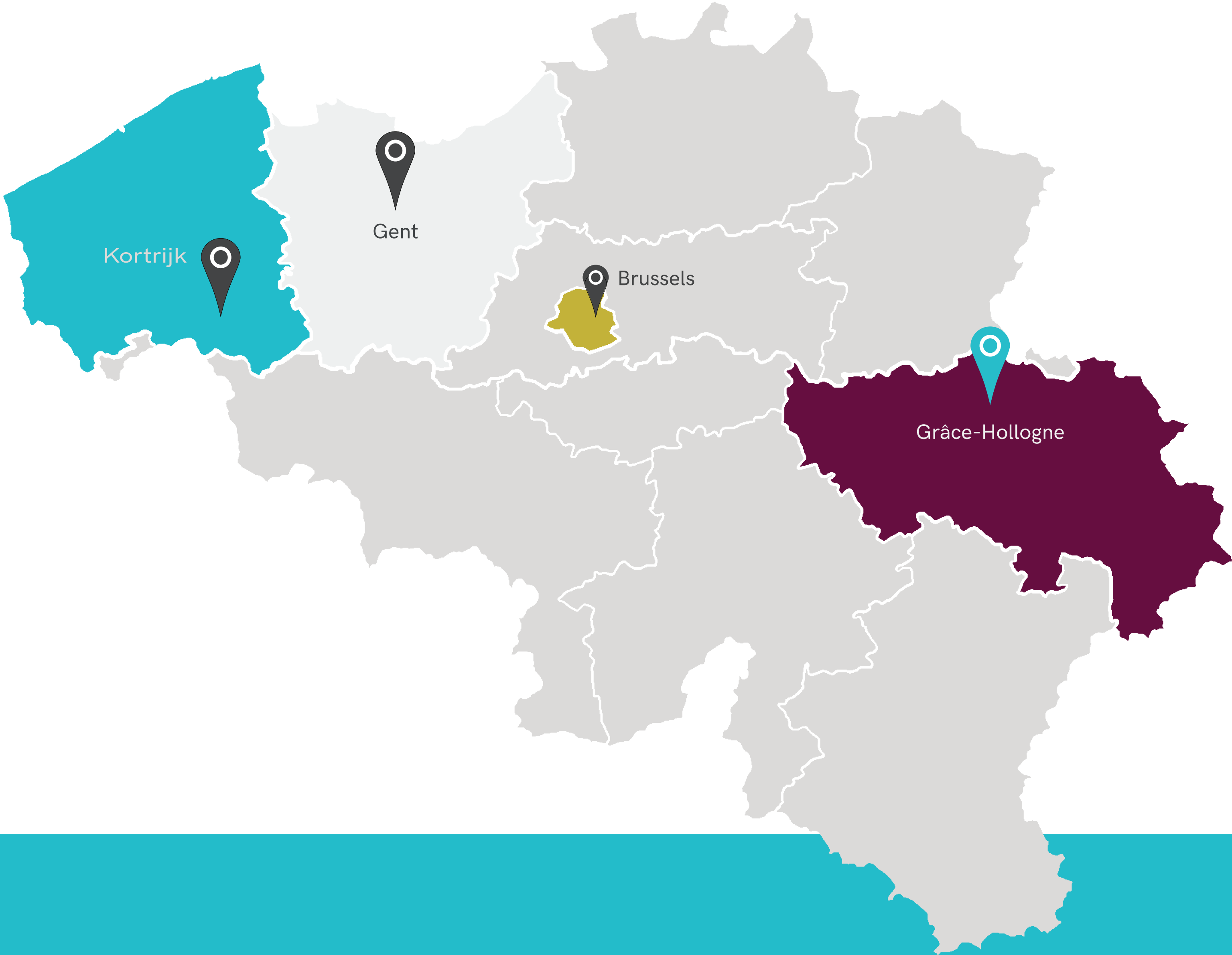

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