



Sustainable polyurethane lamination adhesives for flexible packaging applications

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Future of BioAdhesives
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ITENE RESEARCH CENTER



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- 1 Introduction.
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1 Introduction

1/ Introduction.
ITENE



+30 years developing
technological solutions
through R+D+I

We generate **knowledge and technology** to build
together a **safer and more sustainable future** through
four main areas of work.



Materials and technologies
for the circular economy



Packaging safety,
design and functionality



Safety and environmental
monitoring technologies



Transport, logistic and
digital transformation

1/ Introduction.

ITENE

ITENE is located in the **Parque Tecnológico of Paterna** (Valencia), in a **12,000 m²** of facilities of its own, distributed in two buildings.



Laboratories and **pilot plants** equipped with state-of-the-art technology.

- Pilot plant for scale-up and characterisation of additives
- Pilot Processing Plant
- Formulation and Printing Laboratory
- Chemical Laboratory
- Toxicology Laboratory
- Materials Characterisation Laboratory
- Laboratory of Barrier Properties Characterisation
- Laboratory of Biosensors
- Molecular Biology Laboratory
- Laboratory of Environmental Sensors and Means of Protection
- Laboratory of Electronics and Industrial Scaling
- Microbiology Laboratory
- Pilot Packaging Plant
- Packaging Evaluation Laboratory
- Transport Simulation Centre
- Laboratory of Packaging for Dangerous Goods Transport
- Pilot Plant for the Recycling of Cellulose Materials
- Pilot Plant for the Recycling and Valorisation of Plastic Waste
- Biotechnology Pilot Plant
- Compostability Laboratory

With the support of



1/ Introduction.



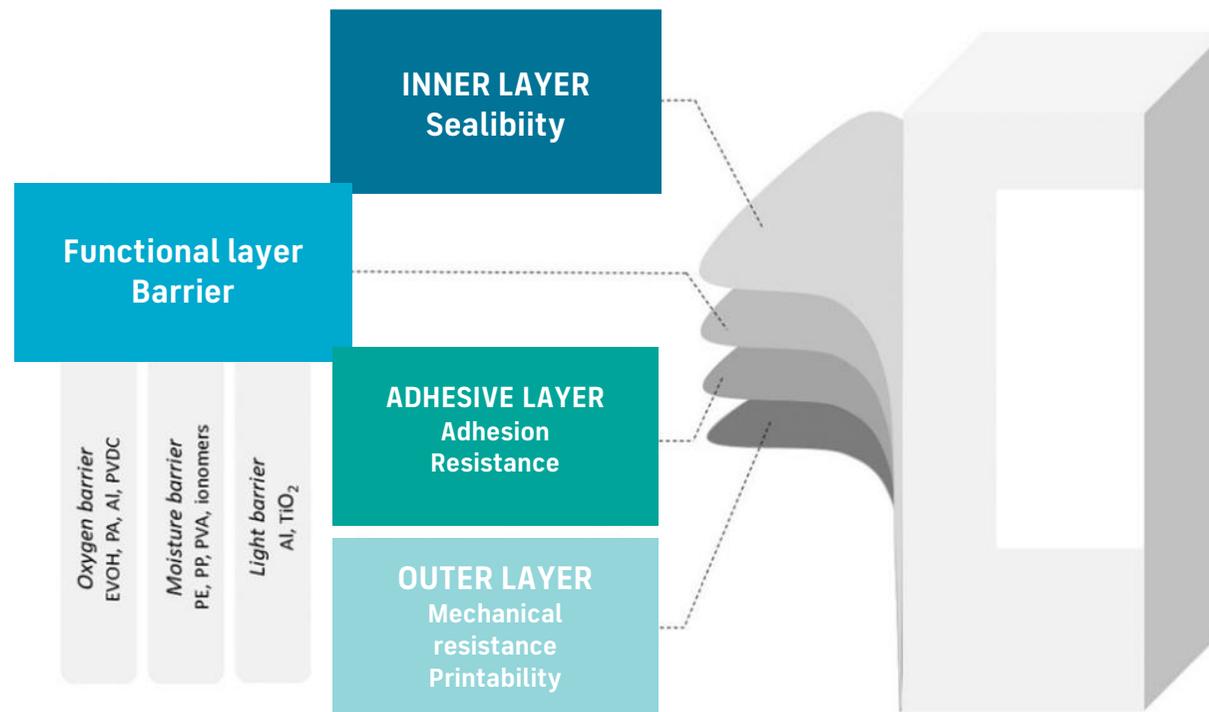
Polyurethane Adhesives



1/ Introduction.

Polyurethane Adhesives for flexible packaging

Why in flexible packaging?



Multilayer flexible packaging

2-24 layers

Plastic / Paper / Metallized

PET/Adhesive/PE

PA/ Adhesive /PE

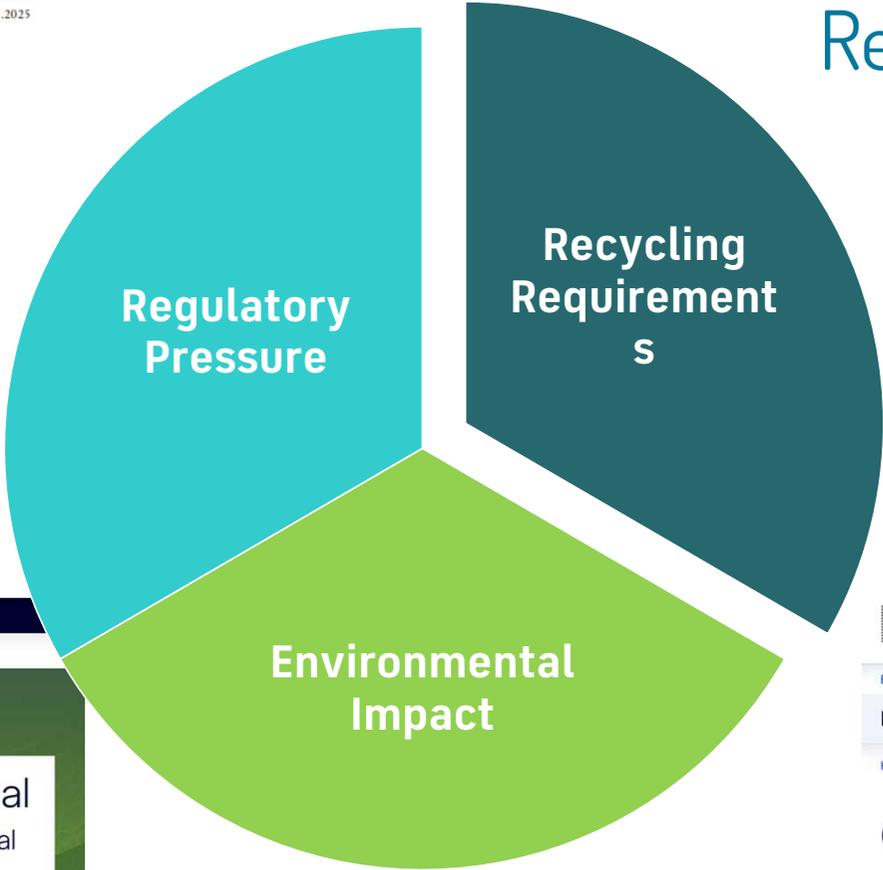
BOPP /Adhesive /PET metallized/ Adhesive /PP

PETAlox/Adhesive/OPA/Adhesive/PP

...

1 / Introduction.

The Challenge



RecyClass



Official Journal of the European Union EN L series
2025/40 22.1.2025

REGULATION (EU) 2025/40 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 December 2024 on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC

► B ► CI REGULATION (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (Text with EEA relevance) (OJ L 396, 30.12.2006, p. 1)

European Commission

Home About us Our priorities News and media Topics Resources Europe and you

Home > Strategy and policy > Priorities 2019-2024 > The European Green Deal

The European Green Deal
Striving to be the first climate-neutral continent

European Commission

Energy, Climate change, Environment

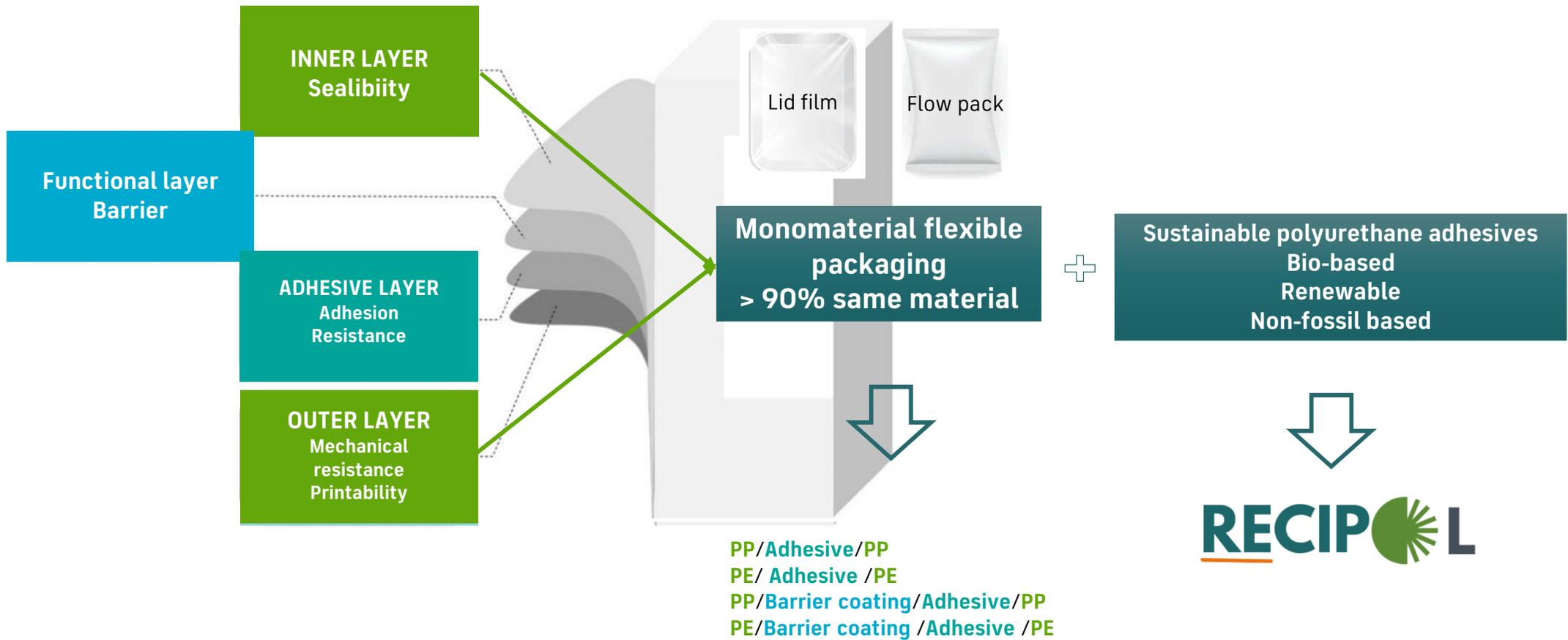
Environment

Home > Strategy > Circular economy action plan

Circular Economy Action Plan
The EU's circular action plan is paving the way for a cleaner and more competitive Europe.

1/ Introduction.

The Approach



RECIPOL

2

RECIPOL Project

2/ RECIPOL Project.

COLLABORATIVE NETWORK FOR THE RESEARCH AND DEVELOPMENT OF TECHNOLOGIES TO PROMOTE THE RECYCLING AND RECOVERY OF POLYURETHANE MATERIALS AND TO BOOST THE CIRCULAR ECONOMY



FOOTWEAR



AUTOMOTIVE



PACKAGING



FURNITURE



<https://recipol-red.com/>

2/ RECIPOL Project.



CIRCULAR POLYURETHANE PRODUCTS

Eco-friendly, high
performance
applications



FOOTWEAR



AUTOMOTIVE



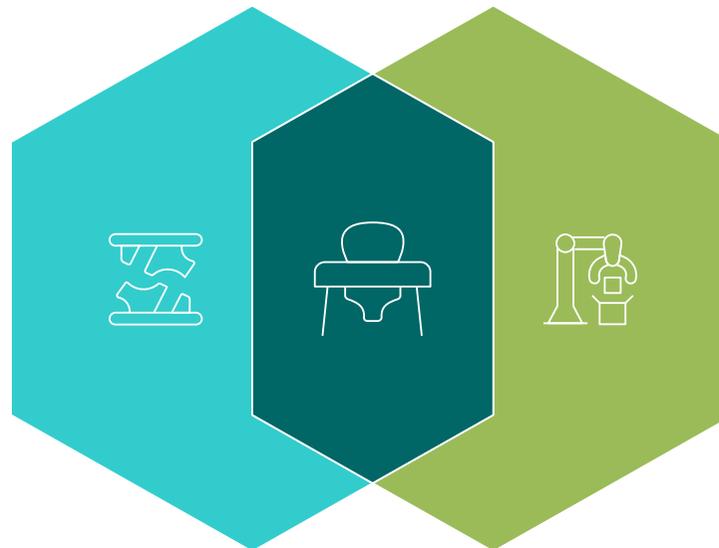
PACKAGING



FURNITURE

SUSTAINABLE RAW MATERIALS

Polyurethane
waste
Bio-based
building blocks



ADVANCED RECYCLING TECHNOLOGIES

Chemical
Biological



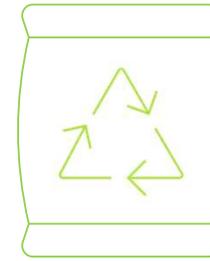
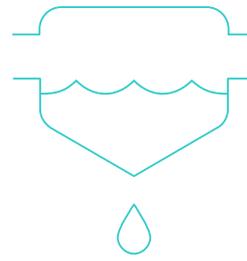
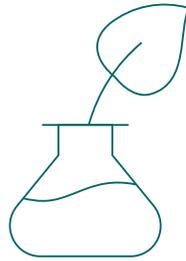


3

Strategies implementation.

3 / Strategies implementation.

Overview of the strategies.



Sustainable Integration

Incorporating renewable raw materials to reduce fossil fuel dependence

1

Sustainable PU adhesive

Formulation of lamination adhesives
Solvent-based
Solventless

2

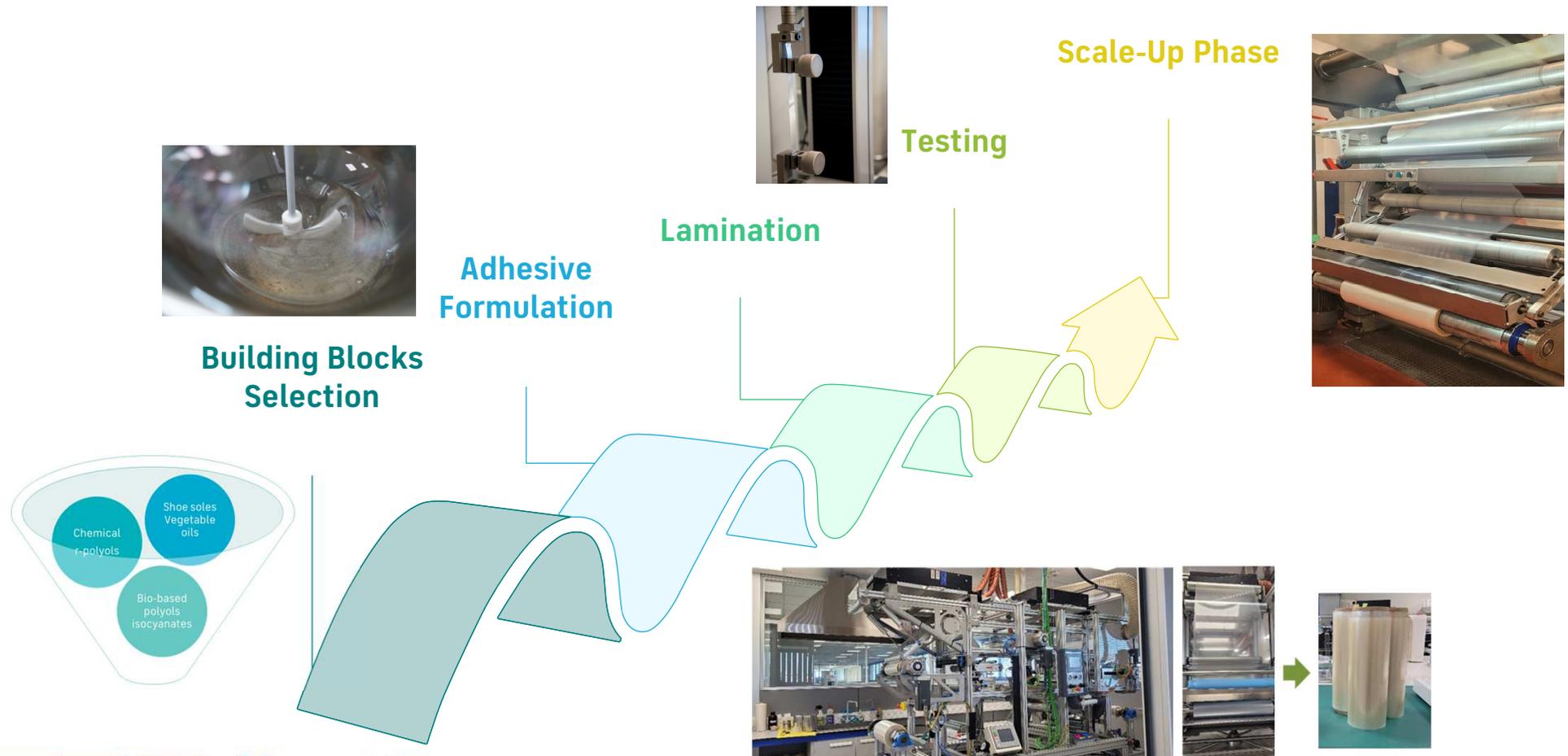
Recyclable flexible packaging

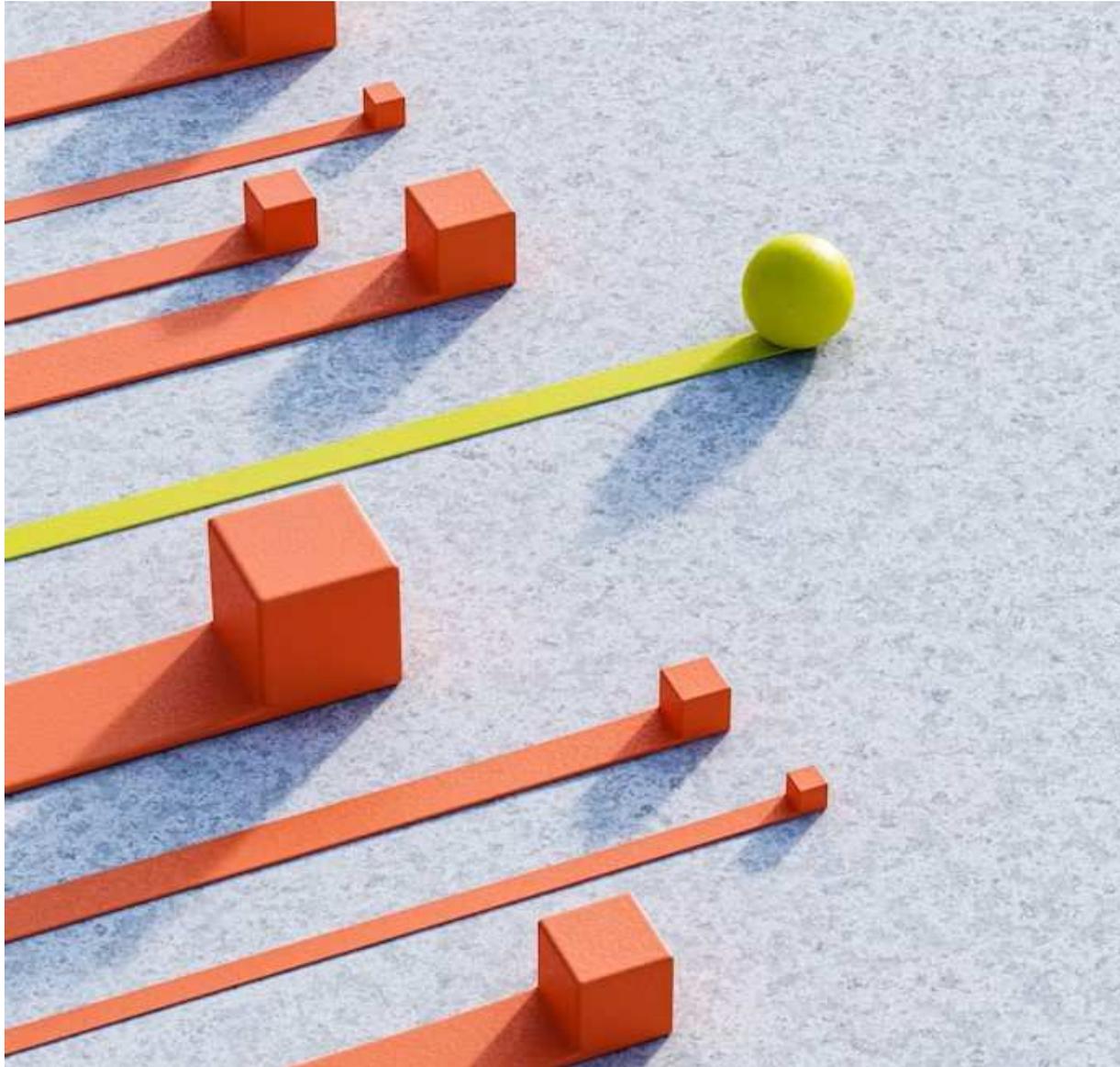
Creating monomaterial polypropylene structures ready for recyclability

3

3 / Strategies implementation.

SUSTAINABLE LAMINATION ADHESIVE FOR RECYCLABLE FLEXIBLE PACKAGING





4 Results

4/ Results.

SOLVENT-BASED ADHESIVE

SOLVENT-BASED ADHESIVE FORMULATIONS

Reference	Polyol	Solvent
CONTROL SB	Fossil-based	Ethyl acetate
AD31	biopolyol 1	THF
AD41	biopolyol 1	Butyl acetate
AD68	biopolyol 1	Ethanol/Ethyl acetate
AD33	biopolyol 2	THF
AD66	biopolyol 2	Ethanol/Ethyl acetate
AD59	biopolyol 3	Butyl acetate
AD69	biopolyol 3	Ethanol/Ethyl acetate
AD80	biopolyol 4	Butyl acetate
AD65	r-polyol	Butyl acetate

- Effect of type of solvent / polyol
 - Isocyanate
 - NCO/OH ratio
 - solid content %wt.
- Structure: OPP 20µm / PPcast 70µm
 - 7 days curing

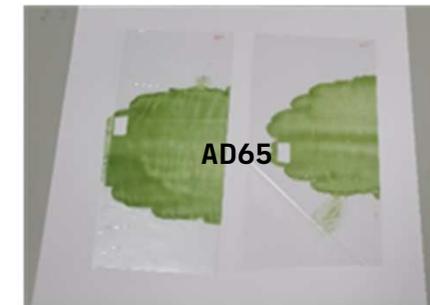
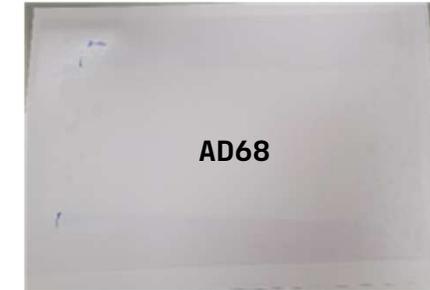
⇒ 60-80% bio-based content

4 / Results.

SOLVENT-BASED ADHESIVE: viscosity and wettability

SOLVENT-BASED ADHESIVE FORMULATIONS

Reference	Polyol	Solvent	Viscosity Ford cup 4 (s)	Wettability
CONTROL SB	Fossil-based	Ethyl acetate	23	Uniform / Transparent
AD31	biopolyol 1	THF	12	Uniform / Transparent
AD41	biopolyol 1	Butyl acetate	13	Uniform / Transparent
AD68	biopolyol 1	Ethanol/Ethyl acetate	12.8	Uniform / Transparent
AD33	biopolyol 2	THF	12.7	Uniform / Transparent
AD66	biopolyol 2	Ethanol/Ethyl acetate	13	Uniform / Transparent
AD59	biopolyol 3	Butyl acetate	12.5	Uniform / Transparent
AD69	biopolyol 3	Ethanol/Ethyl acetate	11.5	Uniform / Transparent
AD80	biopolyol 4	Butyl acetate	15.4	Uniform / Yellowish
AD65	r-polyol	Butyl acetate	17.3	Uniform / Greenish

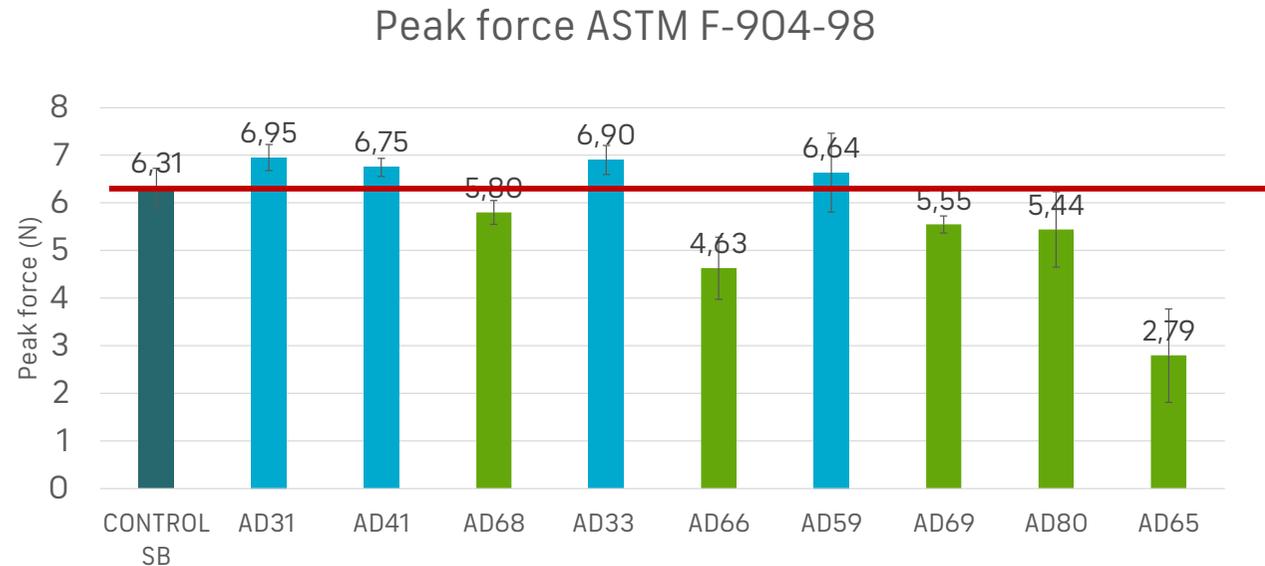


4 / Results.

SOLVENT-BASED ADHESIVE: Peak force

SOLVENT-BASED ADHESIVE FORMULATIONS

Reference	Polyol	Solvent
CONTROL SB	Fossil-based	Ethyl acetate
AD31	biopolyol 1	THF
AD41	biopolyol 1	Butyl acetate
AD68	biopolyol 1	Ethanol/Ethyl acetate
AD33	biopolyol 2	THF
AD66	biopolyol 2	Ethanol/Ethyl acetate
AD59	biopolyol 3	Butyl acetate
AD69	biopolyol 3	Ethanol/Ethyl acetate
AD80	biopolyol 4	Butyl acetate
AD65	r-polyol	Butyl acetate



- THF vs esters and combination with ethanol.
- Biopolyol 1 vs r-polyol
- For peak force > 5 N, material fails before the adhesive.

4/ Results.

SOLVENT-FREE ADHESIVE

SOLVENT-FREE ADHESIVE FORMULATIONS

Reference	Polyol	NCO/OH ratio
CONTROL SF	Fossil-based	↕
AD70	biopolyol 1	↓
AD71	biopolyol 1	↑
AD74	biopolyol 4	↓
AD79	biopolyol 4	↑
AD81	r-polyol	↓
AD83	r-polyol	↑

⇒ 60-80% biobased content

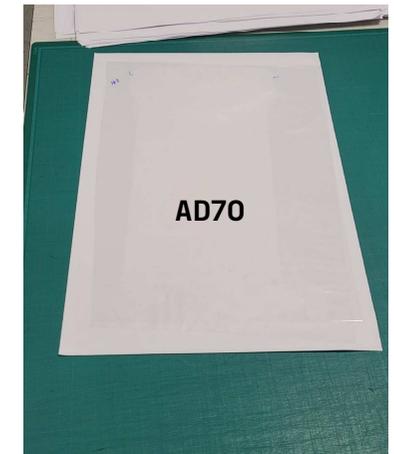
- Effect of NCO/OH ratio
 - Isocyanate
 - Liquid state polyols
- Structure: OPP 20µm / PPcast 70µm
 - 7 days curing

4 / Results.

SOLVENT-FREE ADHESIVE: wettability

SOLVENT-FREE ADHESIVE FORMULATIONS

Reference	Polyol	NCO/OH ratio	Wettability
CONTROL SF	Fossil-based	↕	Uniform / Transparent
AD70	biopolyol 1	↓	Uniform / Transparent
AD71	biopolyol 1	↑	Uniform / Transparent
AD74	biopolyol 4	↓	Uniform / Yellowish
AD79	biopolyol 4	↑	Uniform / Yellowish
AD81	r-polyol	↓	Uniform / Greenish
AD83	r-polyol	↑	Uniform / Greenish

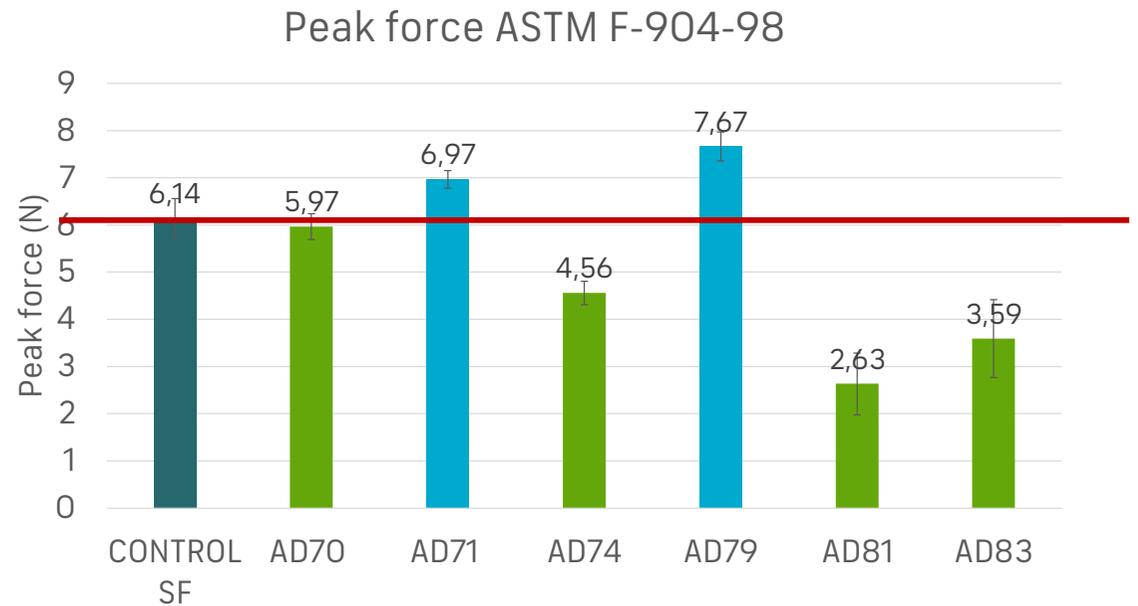


4 / Results.

SOLVENT-FREE ADHESIVE: Peak force

SOLVENT-FREE ADHESIVE FORMULATIONS

Reference	Polyol	NCO/OH ratio
CONTROL SF	Fossil-based	↕
AD70	biopolyol 1	↘
AD71	biopolyol 1	↗
AD74	biopolyol 4	↘
AD79	biopolyol 4	↗
AD81	r-polyol	↘
AD83	r-polyol	↗

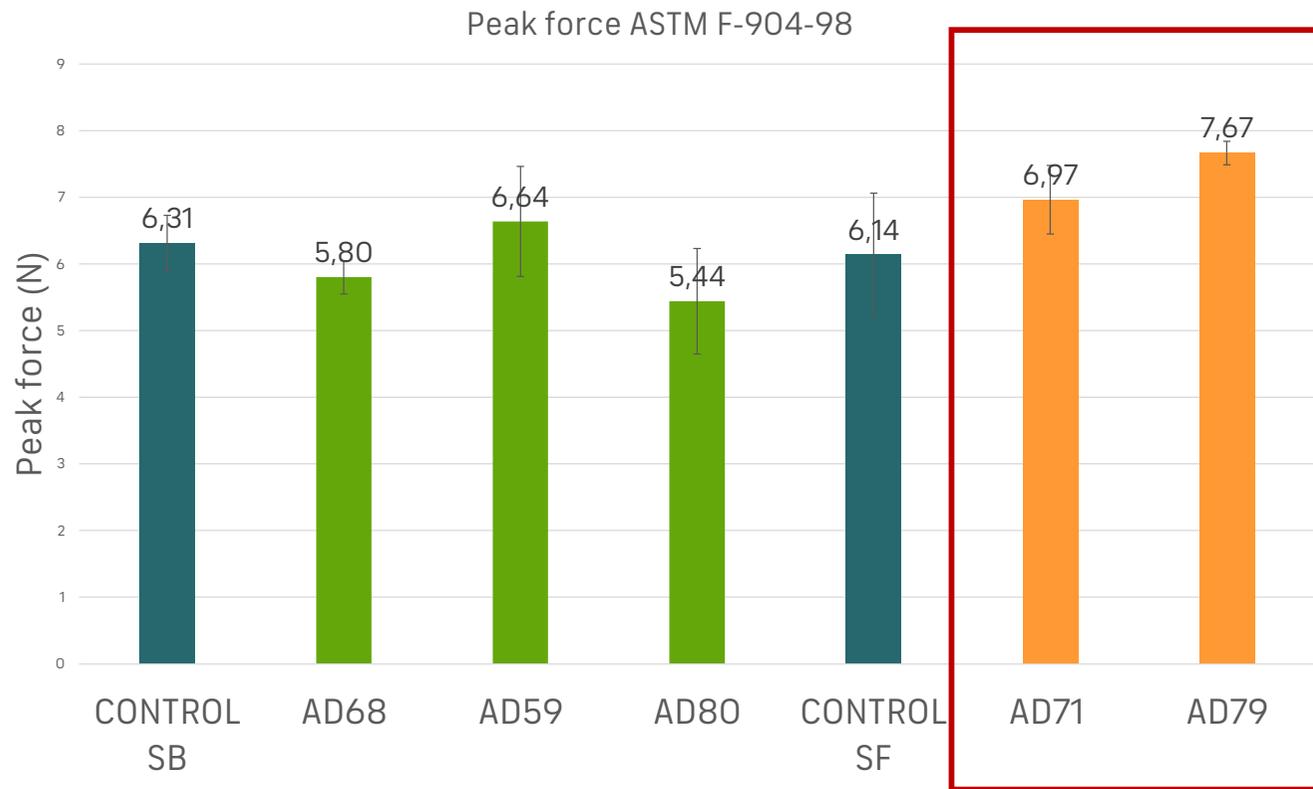


- Higher ratios benefit bond strength.
- Biopolyol vs r-polyol
- For peak force > 5 N, material fails before the adhesive.

4 / Results.

SOLVENT-BASED vs SOLVENT-FREE ADHESIVE: Peak force

SOLVENT-BASED VS SOLVENT-FREE ADHESIVE FORMULATIONS

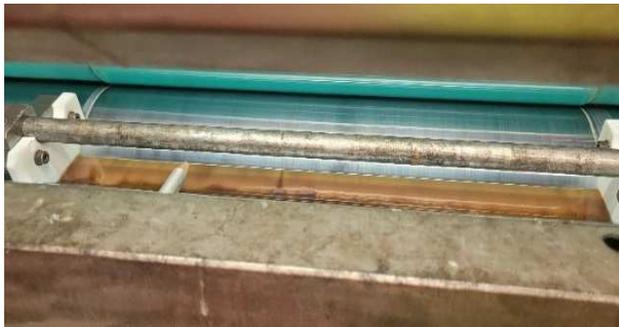


AD71 - Biopolyol 1

Scale-up

4 / Results.
SCALE-UP

SCALE-UP SOLVENT-FREE ADHESIVE FORMULATION



Scale-up solvent-free lamination

Bio-based PU adhesive

Biopolyol 1

Speed (m/min)

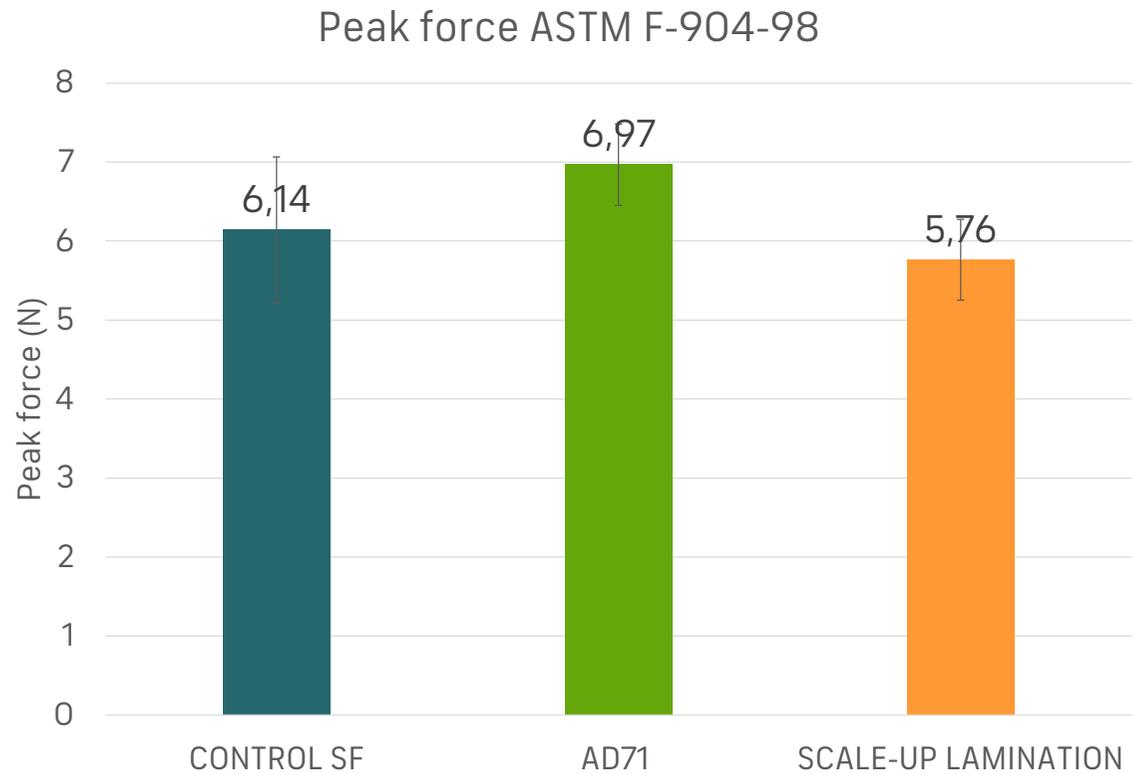
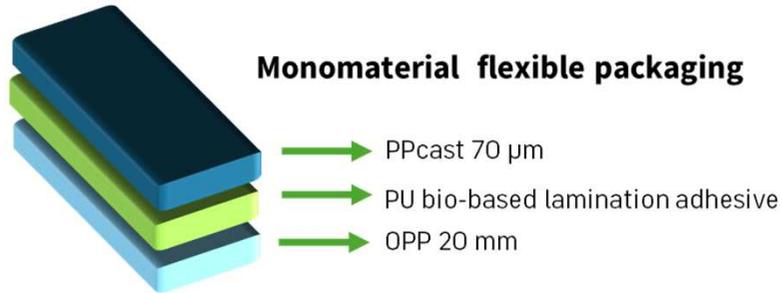
121 m/min

Coating weight (g/m²)

2

4 / Results.
SCALE-UP

SCALE-UP SOLVENT-FREE ADHESIVE FORMULATION





5 Conclusions

5 / Conclusions.

Sustainable polyurethane adhesives for flexible packaging lamination



- ✓ **Environmental and technical compatibility:** Bio-based or renewable polyurethane adhesives are a promising alternative in flexible packaging solutions.
- ✓ **Performance maintained:** Equivalent bond strength is achieved using renewable materials instead of fossil-based ones.
- ✓ **Support for the circular economy:** application in recyclable packaging structures.

Thank you for your attention!

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