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The European voice of the **adhesive and sealant industry**

FEICA WEBINAR

Adhesives and sealants' unique properties in electronics under the EU Ecodesign Regulation

23 November 2023

10:30 - 11:30 Brussels CET

Proceedings

- Please be advised that this webinar will be recorded. By joining, you are consenting to the recording
- Note that you will be muted and your camera will be turned off automatically upon entry
- During the Q&A session following the presentations, you will be able to use the chat box to ask questions
- In case we don't have sufficient time during the Q&A session to address your question, please feel free to send your question to info@feica.eu
- The presentation slides and recording will be sent to all webinar registrants

Speakers

Mr Dimitrios Soutzoukis

Senior Regulatory Affairs Manager, FEICA

Dr Annett Linemann

Director Technology Outlook & Sustainability, H.B. Fuller, Chair
FEICA Electronics Technical Task Force

Dr Matthias Popp

Group Leader Adhesive Formulation, Fraunhofer Institute

Mr Ive Vanderreydt

Circular Economy Expert, VITO NV

Agenda

10:30 **FEICA introduction & regulatory context**

Mr Dimitris Soutzoukis, Senior Manager Regulatory Affairs, FEICA

10:35 Adhesives and sealants' unique properties in the electronics sector

Dr Annett Linemann, Director Technology Outlook & Sustainability, H.B. Fuller, Chair FEICA Electronics Technical Task Force

10:50 Disassembly of electronics and possible adaptations of adhesives and sealants for reusability, repairability and recyclability of electronics 'Debonding on Demand'

Dr Matthias Popp, Group Leader Adhesive Formulation, Fraunhofer Institute

11:05 The circular economy potential of reversible bonding in smartphones

Mr Ive Vanderreydt, Circular Economy Expert, VITO NV

11:20 Q&A moderated by Mr Dimitrios Soutzoukis

11:30 Close of the webinar

Mr Dimitrios Soutzoukis
Senior Regulatory Affairs Manager, FEICA

FEICA introduction & regulatory context

Contribution of the adhesives and sealants industry in Europe

19.9 billion euros contribution to the EU economy

800 adhesives and sealants manufacturers, of which **90% are SMEs**

4.8 million tonnes of adhesives and sealants used in everyday products

Investing **470 million euros in Research and Innovation**

Employing over **45,000 people**




16 National Associations representing 17 Countries 450+ members

AFICAM
FCIC Chemische Industrie Berufsgruppe Bauklebstoffe
APCAS
FKS Fachverband Klebstoff-Industrie Schweiz
aseica
Gospodarska zbornica Slovenije
FEDERCHIMICA AVISA Gruppo Adesivi e Sigillanti
HASC
HACI Hellenic Adhesives and Sealants Cluster
BASA
Industrieverband Klebstoffe e.V. German Adhesives Association
Experience Perfect Services
Danish Coatings and Adhesives Association
PZPFK
deTic
SVEFF Sveriges Färg och Lim Företagare
DEUTSCHE BAUCHEMIE
VLK vereniging lijmen en kitten

25 Direct Company Members

3M
coim
SAPICI
Dow
SELENA GLOBAL EXPERIENCE
ac marca Adhesives
DUPONT
BUILDING TRUST
Sika
AEROSOL SERVICE
H.B. Fuller
SOPREMA
ARaymond MORE THAN FASTENING
Henkel
AVERY DENNISON
SOUDAL
HUNTSMAN Enriching lives through innovation
BASF We create chemistry
Lohmann The Bonding Engineers.
TKK SINCE1947
BOLTON ADHESIVES
TREMCO Construction Products Group
MAPEI
BOSTIK
novatech
Wolf Group

25 Affiliate Company Members

AGC
IMCD
MOLGROUP
ARLANXEO Performance Elastomers
IMERYS
MOMENTIVE
BASF We create chemistry
ingevity
NYNAS
BorsodChem Chemistry for generations
ISOCHEM KAUTSCHUK-GMBH
OMYA
covestro
kaneka
pcc ROKITA
EASTMAN
KRATON
ROBATECH GLUING SOLUTIONS
Emerald Kalama Chemical
LANXESS Energizing Chemistry
Stepan
ERGON
HUNTSMAN Enriching lives through innovation
Mitsui Chemicals Group
synthomer

ADHESIVES AND SEALANTS ARE THE HIDDEN BINDING FORCE THAT SHAPES OUR WORLD

Industrial applications

Healthcare

Agriculture & food production

Transportation

Construction & installation

Furniture

Art, crafts & culture

Textiles, fashion & sports

Electronics

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FEICA Expert Group - Electronics Technical Task Force (TTF)

National Associations

Company Members

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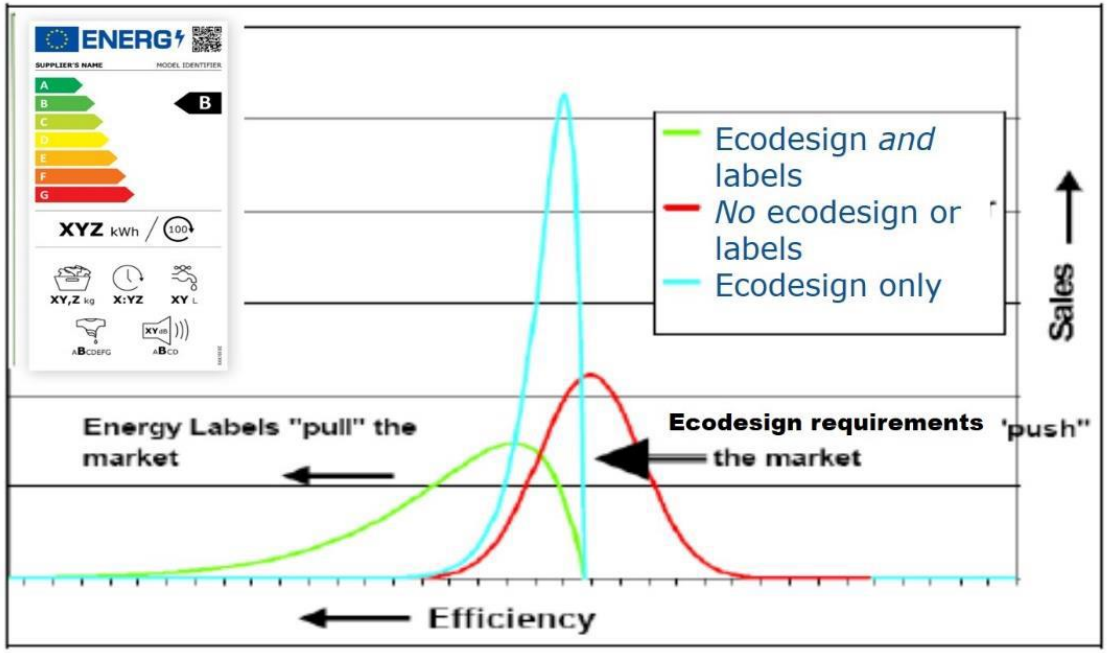
EU Ecodesign

- The Ecodesign Directive is in force since 2009 undergoing regular revisions
- It sets minimum efficiency (and other) requirements
- Regulatory measures for electronics and ICT including mobile phones, tablets and laptops under the Ecodesign Directive so that devices are designed for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling.
- Entry into force: **20 June 2025**



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Adhesives and sealants' unique properties in the electronics sector

Adhesives and sealants making a difference

UV cured adhesives

Conservation of resources

Temporary bonding

Easy separation of bonded components

Chemical or mechanical techniques

Releasable and removable

Debonding on demand

Conservation of resources

Adhesive failure mode

Thermal management

EMI electromagnetic shielding

Less waste generation /fewer production steps

Use of lightweight and alternative materials

Modern, thin and seamless device designs

Safety (flame-retardance)

Improvement of thermal & material efficiency

Repair of electronics devices

Upgradability

Sealing (water-tightness)

Protection against drop

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EU Ecodesign requirements

for smartphones, mobile phones other than smartphones, cordless phones and slate tablets

Design for reliability

- Resistance to **accidental drops**
- **Scratch** resistance
- Protection from **dust and water**
- **Battery endurance**

Materials are designed to fulfill various technical functions to ensure device reliability over service life

Design for repair and reuse

- Disassembly requirements
  - Fasteners shall be **removable, resupplied or reusable**

Recyclability requirements

- Compatibility
- Traceability
- ???

Mobile phone tear down

The World's Most **Waterproof** Smart Phone! – Teardown

https://www.youtube.com/watch?v=x9Qf1dTbhsU

JerryRigEverything
8.14M subscribers

A sticky rubber gasket inlaid into a groove all around the edges → water-tightness

Removable 4500 milliamp hours battery with wireless charging permanently glued on the top

Charging port with its own red rubber ring → ingress protection

Everything is held in place by screws (over 32 screws)

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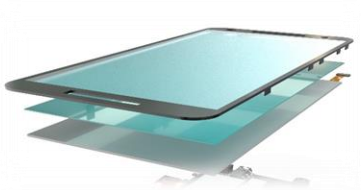
Design for reliability | Material examples

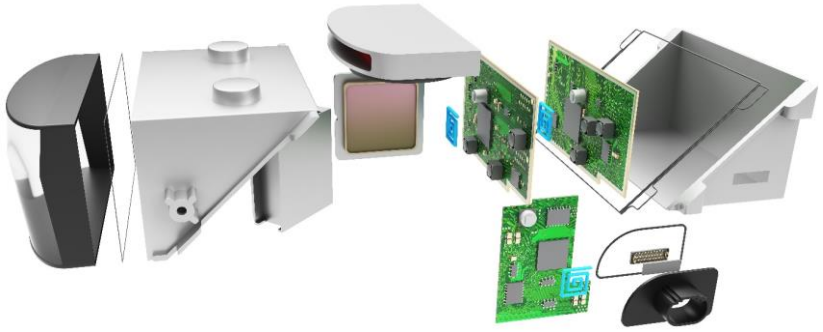
Display solutions

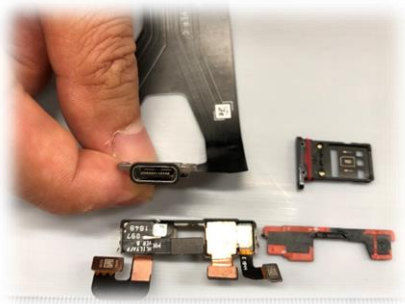

Thermal management and PCB protection



EMI shielding



Gasketing

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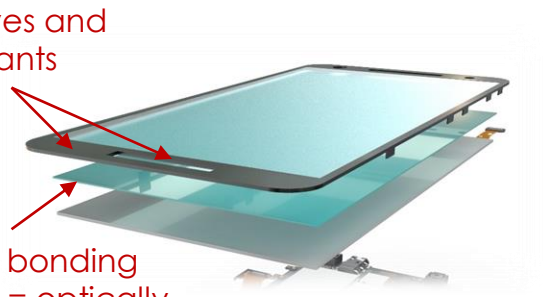
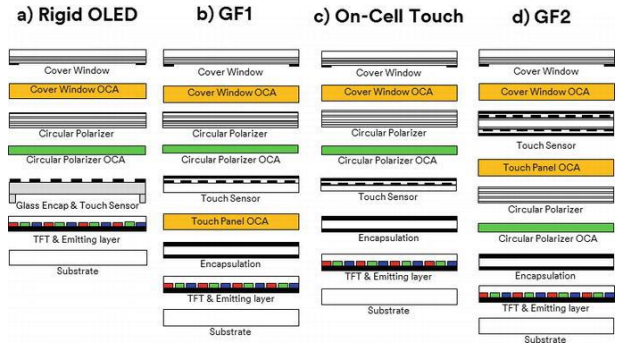
Design for reliability | Material examples

Display solutions



Waterproof sealing adhesives for foldable & rollable smart phones: sealing adhesive provides good *water- & dust-proof*, high *reliability* and jetting & dispensable process-ability for PCB and LCD/OLED system assemblies

Optically clear adhesives for *reliable functionality* of various display designs

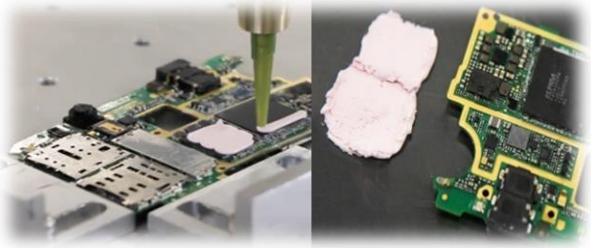


Source: (https://www.intechopen.com/chapters/68746)

Protective film for *scratch resistance* of displays enhancing design *reliability*

Design for reliability | Material examples

Thermal management and PCB protection

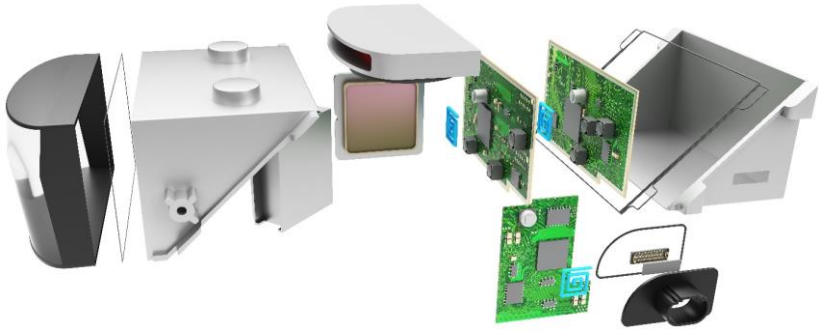


Thermally conductive reworkable gel for heat dissipation of smart phone components enhancing *reliability*

Protective coating to avoid dust and water on sensitive printed circuit board for device *reliability*

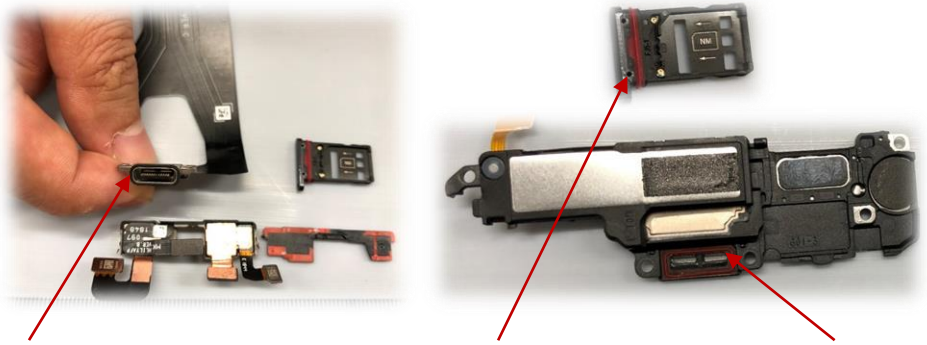
Design for reliability | Material examples

EMI shielding



Electrically conductive adhesives allow for EMI (**e**lectro**m**agnetic **i**nterference) shielding to avoid electric cross-talk between different electronic components allowing device *reliability*

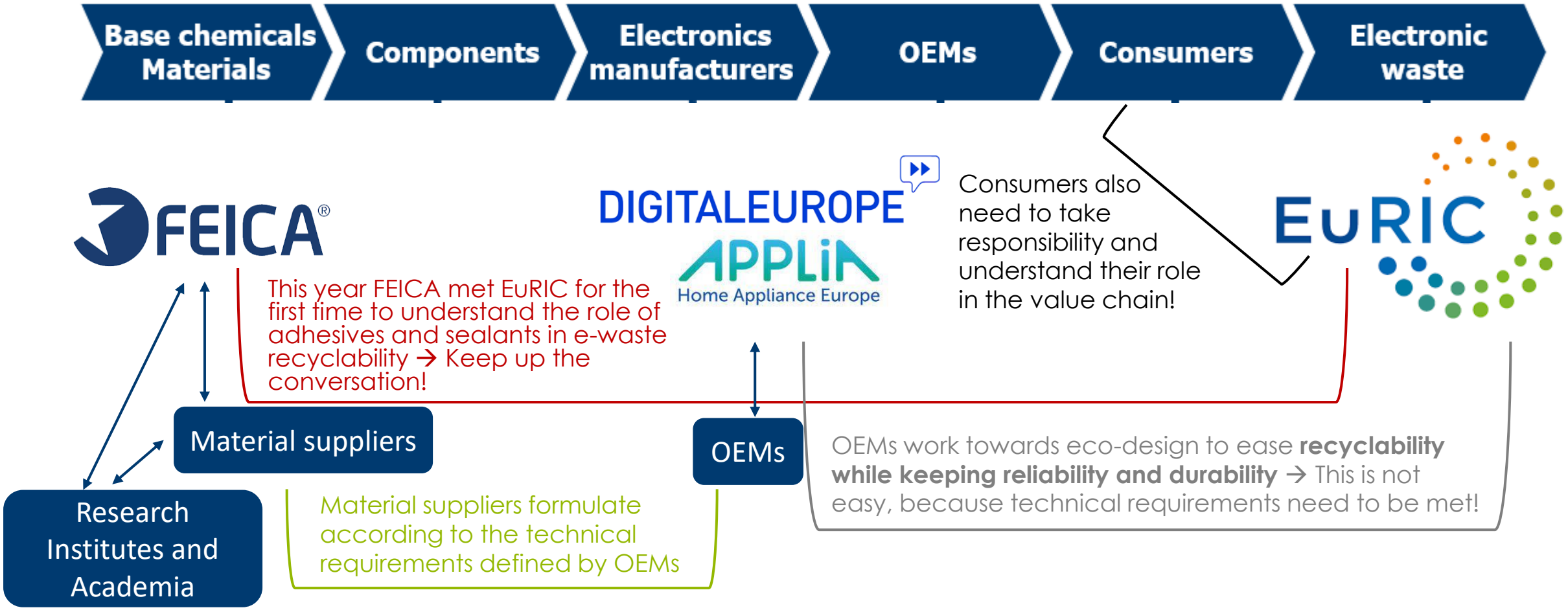
Gasketing



Cured in place gaskets for *water-proof* connectors to enhance device *reliability*

How to tackle the electronics recyclability demand?

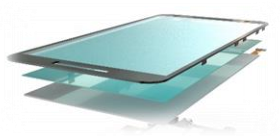
The answer is not obvious!



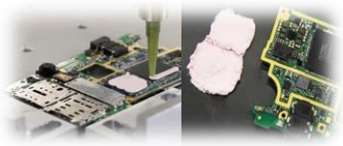
Conclusions

Adhesives and sealants play an important role in design for **reliability** of the eco-design requirements for smartphones

Design for reliability
- Resistance to **accidental drops**
- **Scratch** resistance
- Protection from **dust and water**
- **Battery endurance**



displays



thermal management and PCB protection

EMI shielding

gasketing

- The role of adhesives and sealants in the context of **repair and recycle** of electronic waste needs to be better understood
- Communication across the value chain is crucial
  - FEICA will continue discussions with EuRIC
- Consumer awareness needs to be established

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Disassembly of electronics and possible adaptations of adhesives and sealants for reusability, repairability and recyclability of electronics ‘Debonding on Demand’

Fraunhofer IFAM

Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung IFAM

November 23, 2023

FEICA Webinar - Adhesives and sealants unique properties in electronics under the EU Ecodesign Regulation

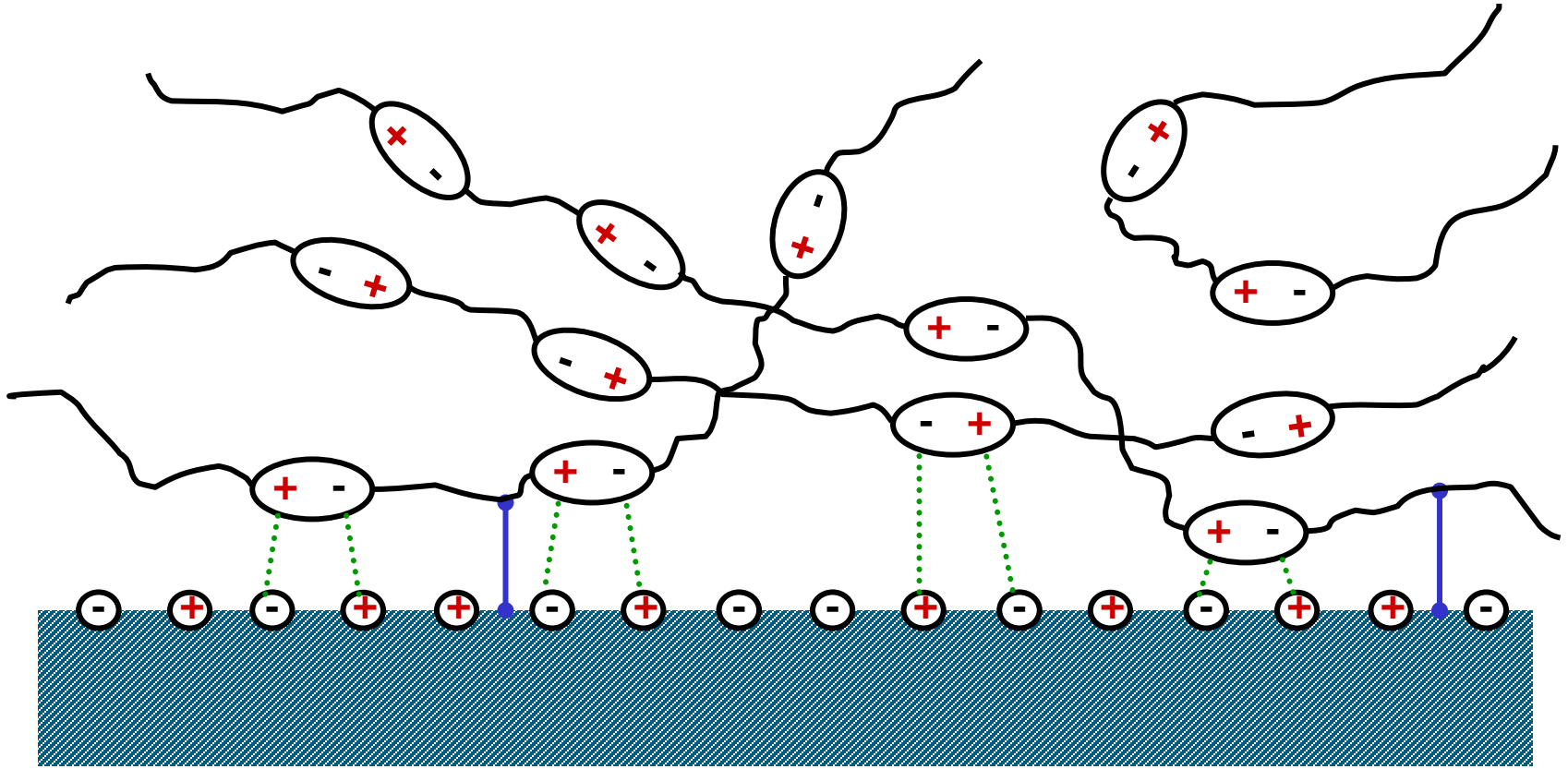
Disassembly of electronics and possible adaptations of adhesives and sealants for reusability, repairability and recyclability of electronics ‘Debonding on Demand’

DIN EN 923

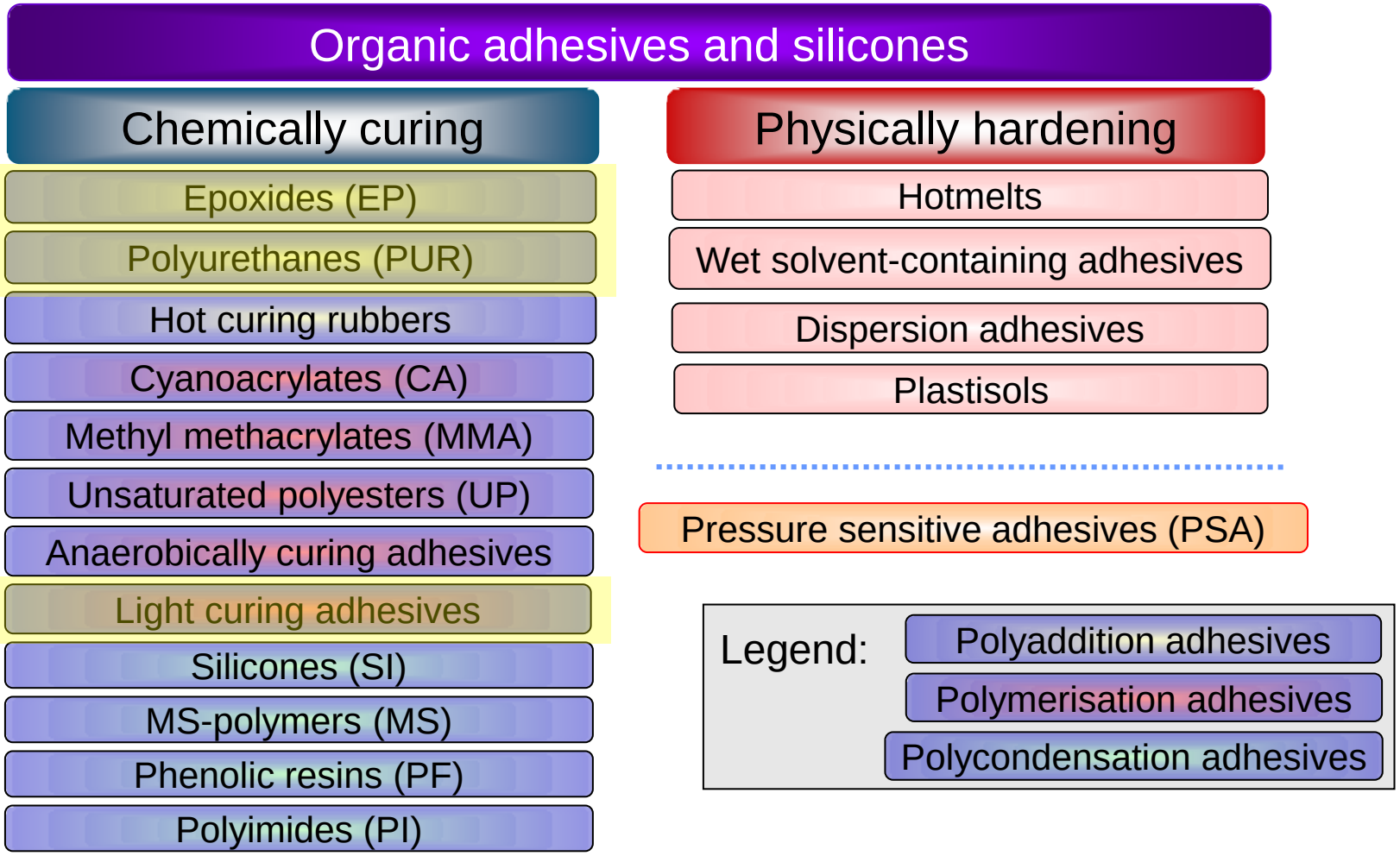
Bonding:
Joining substrates using an adhesive

Adhesive:
A non-metallic substance which can join substrate materials by surface adhesion in such a way that the joint has satisfactory inner strength (cohesion)

Physical interactions and chemical bonds



Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’



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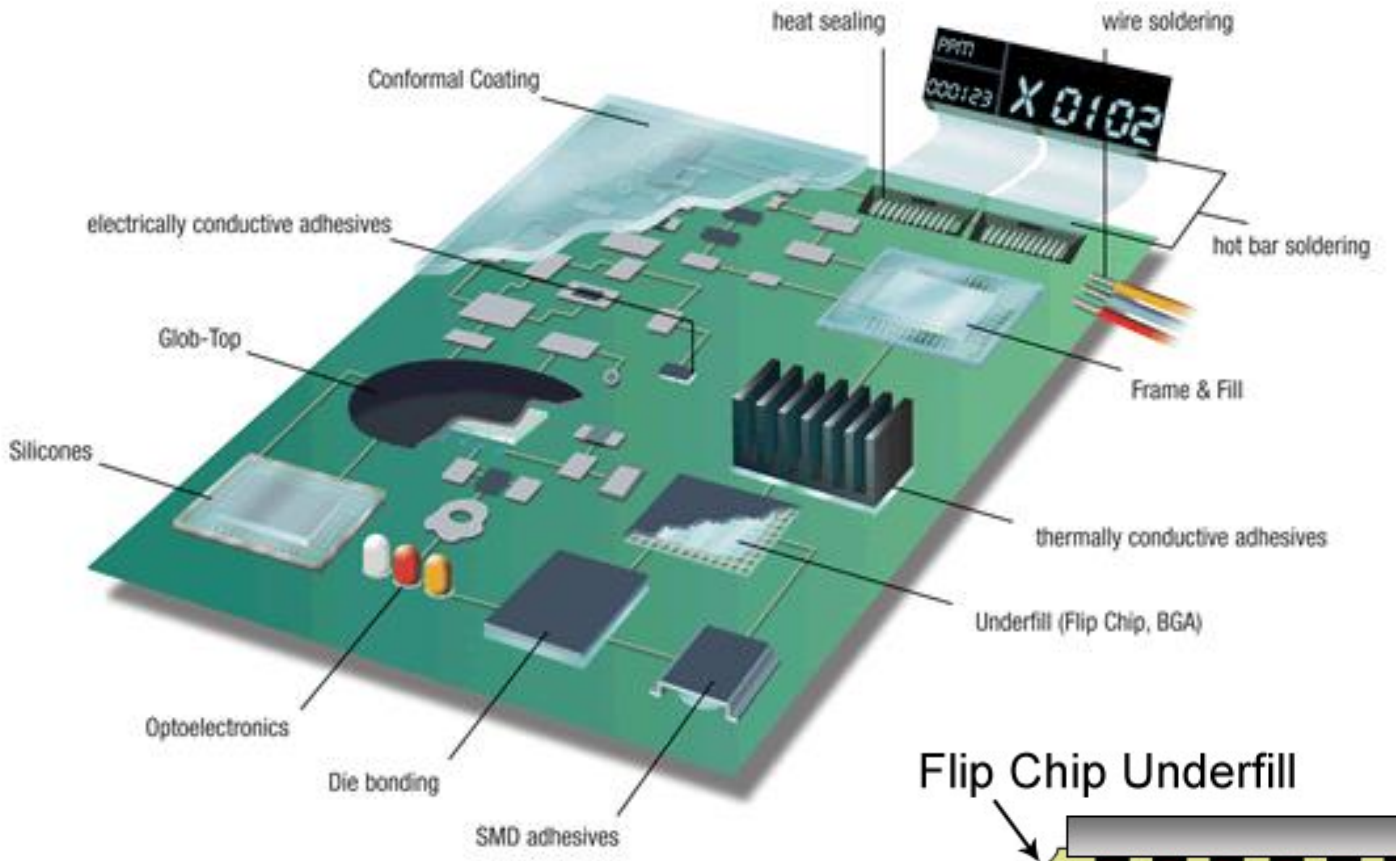
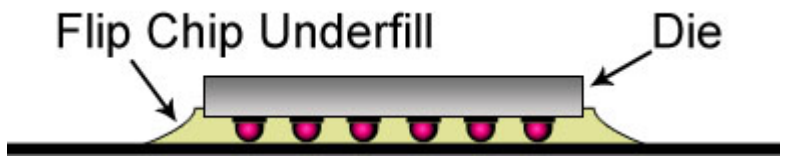
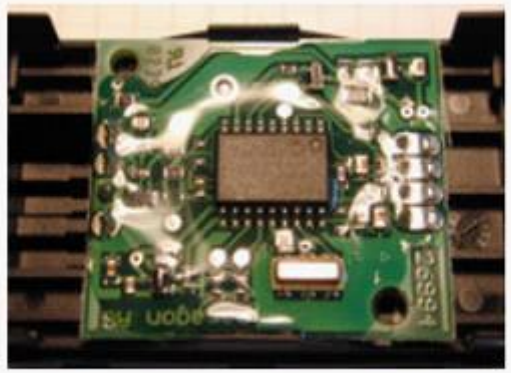


Circuit board applications



Conformal Coating



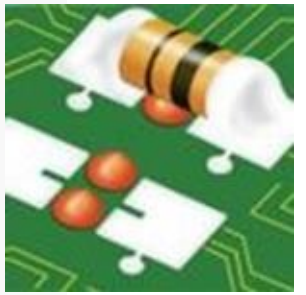
Typical application:

- Protection of circuit boards from environmental factors

Properties of the adhesives

- Flexible, applicable over large areas, excellent running characteristics
- UV-curable epoxy resins and acrylates with dry surface
- Single-component solvent-free, partly ion-free
- Transparent, scratch- and chemicals-resistant and thermally stable
- Fluorescing possible for detection of dispensed product
- Sprayable with ASYMTEC robot, also for partial coating, etc.

Chip bonding, Component assembly

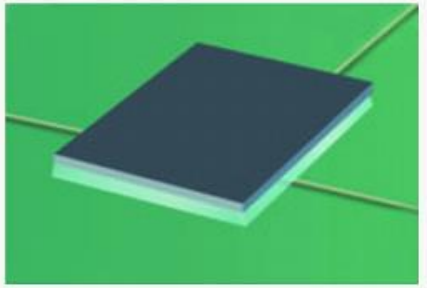


Typical application

Bonding of chip or component assemblies on circuit boards.

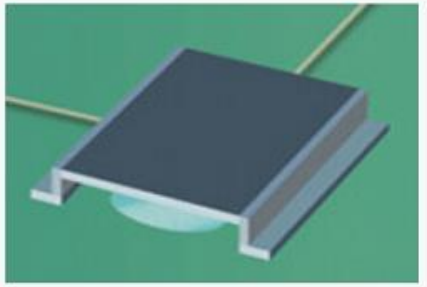
Properties of the electrically conductive adhesives: Die bonding

- Various silver-filled, solvent-free one-and two-component epoxy resin systems
- Processing with dispenser, printing or screen printing
- Short curing times at low temperatures
- Curing in reflow or forced-air oven
- High thermal stability and shock resistance



Properties of the thermally conductive adhesives: Sensor, thermocouple and chip bonding

- Adhesives with heat-conducting fillers
- High mechanical strength
- Good thermal stability and low thermal expansion
- Single- and two-component products
- Thermal curing, for example in reflow or forced-air oven



Properties of the non-conductive adhesives: SMD adhesives

- Bonding of subassemblies before soldering
- Short curing times with UV and/or heat
- Strong red colour for visual inspection
- Processing with dispenser, screen printing or needle transfer

Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’

Most important functions of polymer potting:

- heat dissipation
- mechanical protection
- Protection against media
- electrical insulation

Trends in the automotive sector in particular are increasing requirements with regard to:

- moisture resistance
- temperature resistance
- thermal shock resistance
- Insulation
- Electrical and thermal conductivity

Source: Rampf

Source: Iso-Elektra

Why Debonding on Demand?

1. Recycling
2. Circular economy (reuse)
3. Repair

EU Commission wants a circular economy for plastics. In addition to environmental pollution and CO2 targets, data on the economic value of such waste have encouraged the EU Commission to push for the introduction of a circular economy. The goal is to avoid waste and to recycle more of it. Important instruments for this are the EU-wide WEEE Directive (Waste of Electrical and Electronic Equipment), known in Germany as the Elektroschrottverordnung (Waste Electrical and Electronic Equipment Ordinance) - according to which two-thirds of the expected 12 million tonnes of electrical waste are to be recycled by 2020. In addition, the "Plastics Strategy" aims to reduce environmental litter and promote growth and innovation. This is to create the basis for a new circular economy for plastics and mobilise investments.

https://www.chemanager-online.com/news/elektroschrott-von-der-umweltbelastung-zur-goldgrube

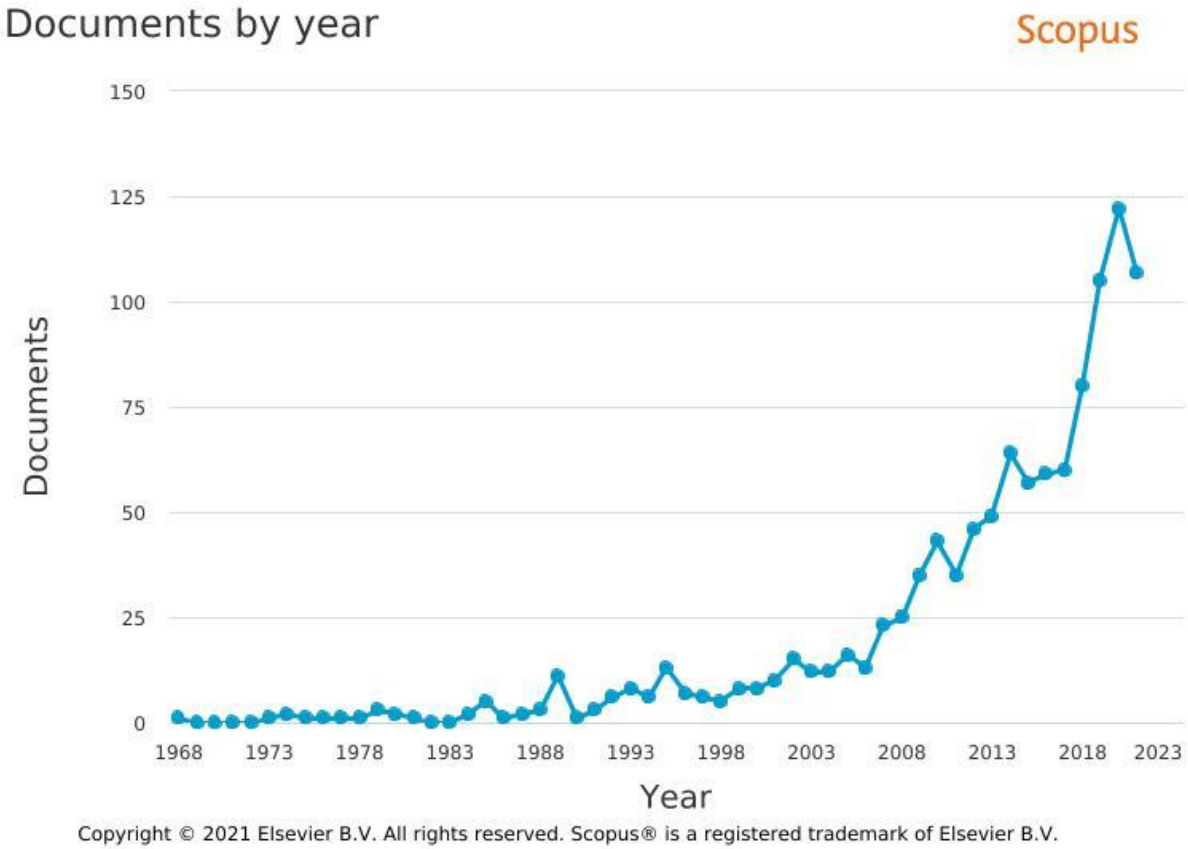
Important: Selective ability for debonding is never a property just added!

It is one among numerous properties of a distinct property profile

The product design is for debonding as important as the selection of the right adhesive

Numerous specific debonding mechanisms available but most not applicable in practice

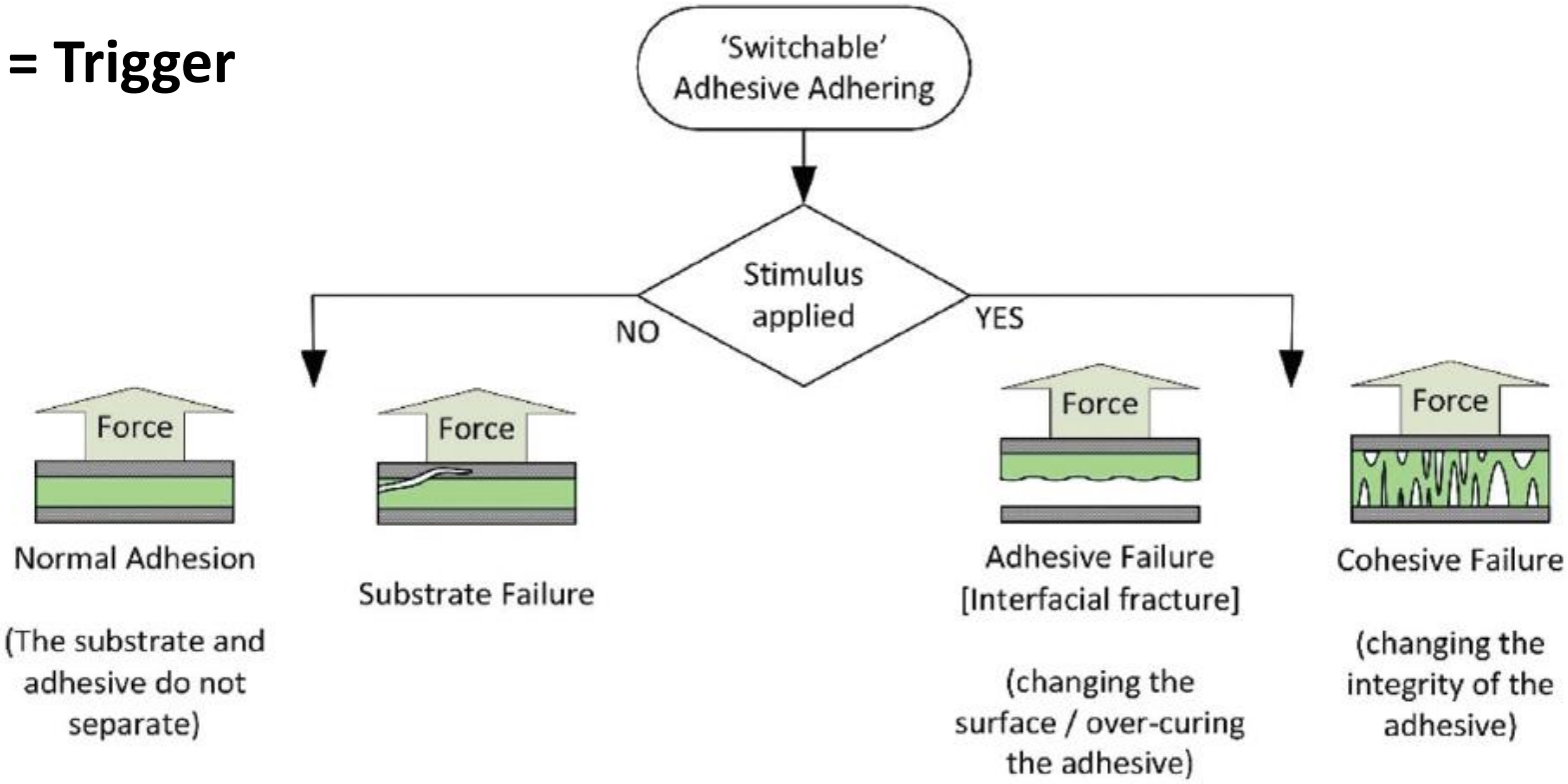
Number of publications over the last few years



Datenmenge „BoD + weitere Synonyme “ – 1100 Veröffentlichungen

Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’

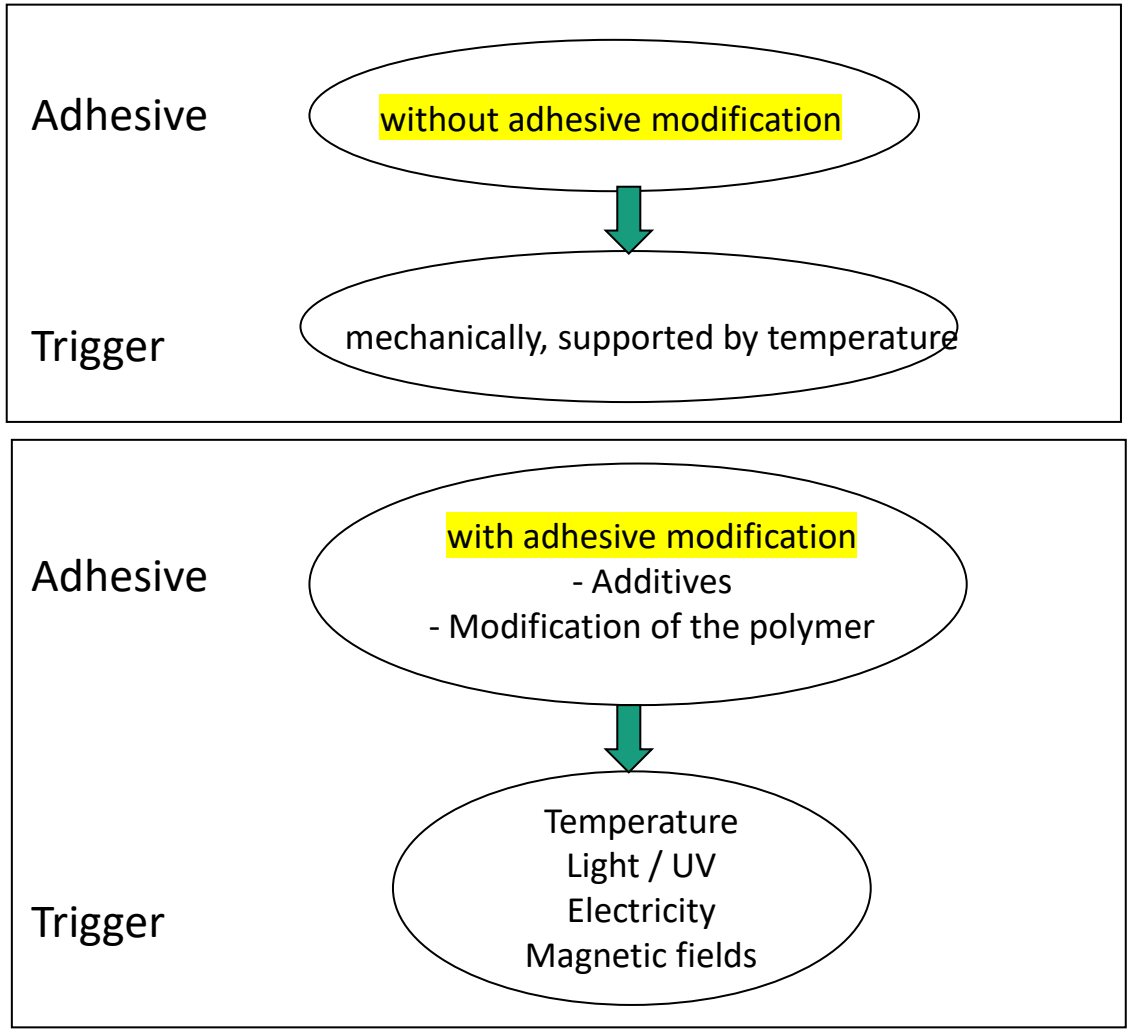
Stimulus = Trigger



MULCAHY, Kira R., et al. Debondable adhesives and their use in recycling. Green Chemistry, 2022, 24. Jg., Nr. 1, S. 36-61.

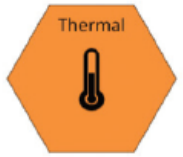
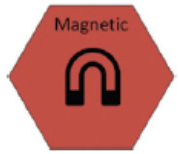
Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’

Summary of principle mechanisms and external triggers



Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’

Table 2 Summary of debonding stimuli, functional groups and applicability

Stimulus						
Potential uses	Thin transparent materials	Inorganic and metallic components	Bonding metals and conductive substrates	Reactive composite adhesives with stable substrates	Biological/ electronic applications	Better for weak adhesive bonds
Limitations	Opaque additives	Equipment operating at high temp. Non-thermally stable/ conductive substrates. Metals when using microwave radiation	Non-metals Non-conductive substrates (these must be bonded with an intermediate patch)	Needs to not etch the substrate	Magnetic substrates	Needs to be wet recycle process
Notes	Harder with complex geometries	Potentially applicable to most adhesives	Better for thin samples	Diffusion can be slow	Low cost, easy to develop	Surface wetting important

MULCAHY, Kira R., et al. Debondable adhesives and their use in recycling. Green Chemistry, 2022, 24. Jg., Nr. 1, S. 36-61.

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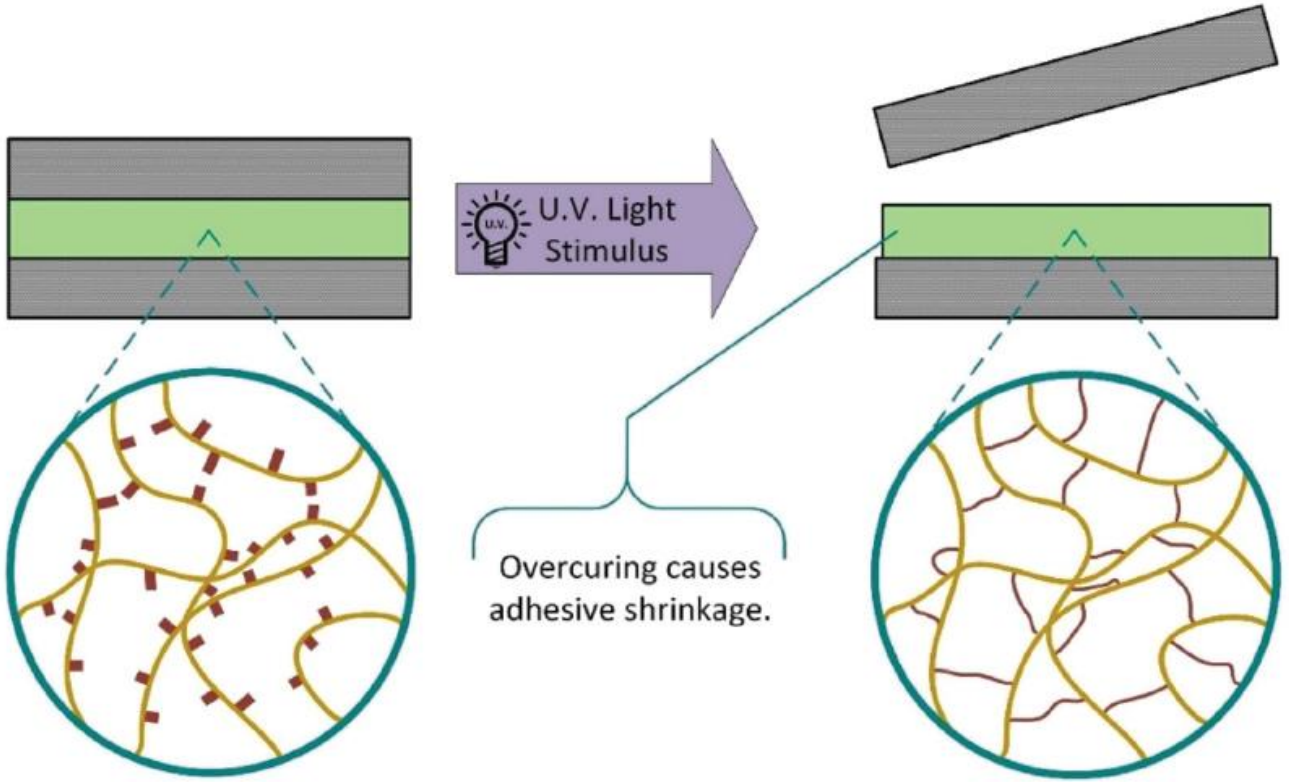
Summary of principle mechanisms and triggers adhesives in electronics

1. Temperature
2. Light / UV
3. Electricity
4. Microwave
5. Ultrasound
6. Magnetic fields
7. Solvents
8. Aqueous solutions

Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’

Light / UV

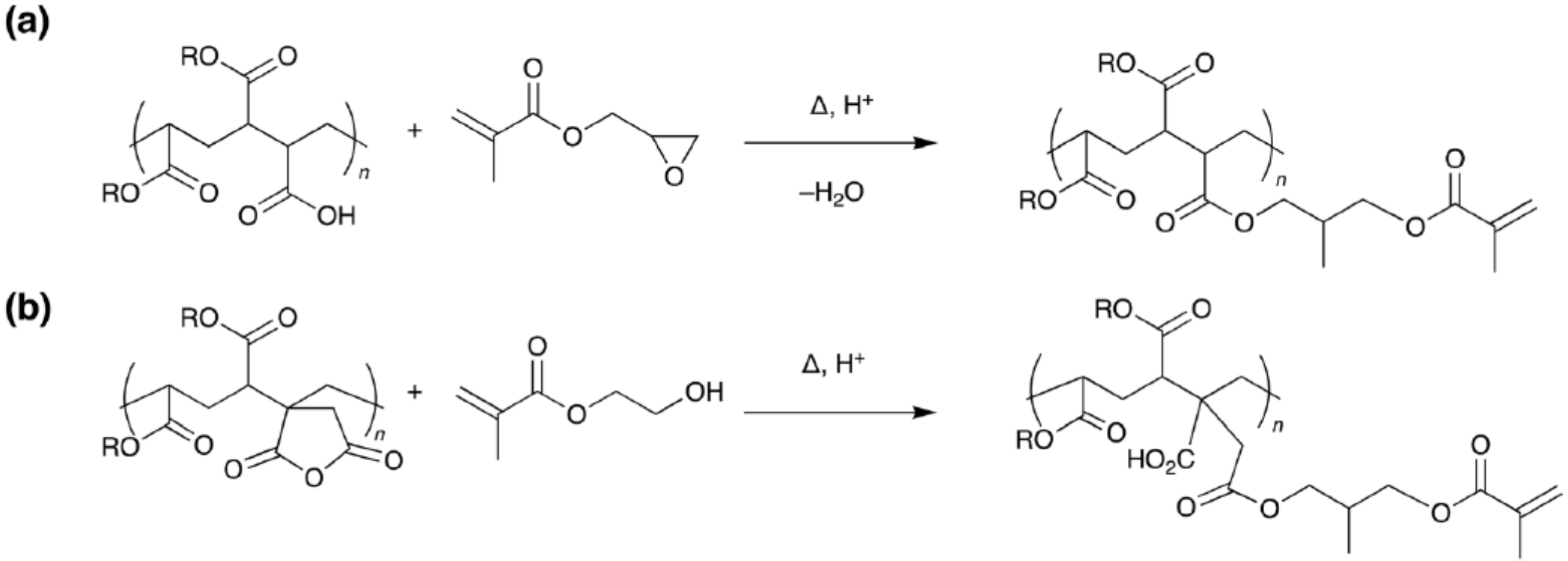


Schematic representation of photoinduced overcuring causing adhesive failure.

MULCAHY, Kira R., et al. Debondable adhesives and their use in recycling. Green Chemistry, 2022, 24. Jg., Nr. 1, S. 36-61.

Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’

Light / UV



Representative examples of side chain functionalisation of acrylic copolymers with methyacrylate residues.[9,15]

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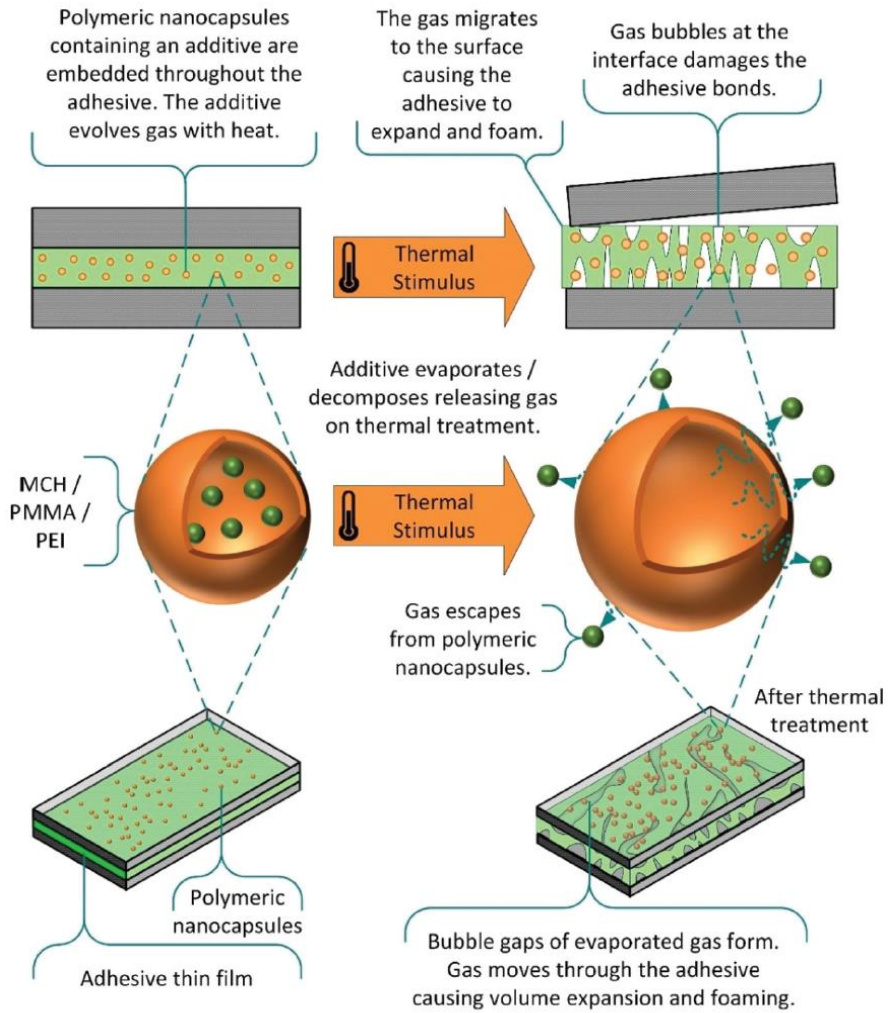
Disassembly of electronics and possible adaptations of adhesives and sealants: ‘Debonding on Demand’

Temperature



Scheme 11 Thermally induced debonding *via* evaporable and decomposable additives.[124]

MULCAHY, Kira R., et al. Debondable adhesives and their use in recycling. Green Chemistry, 2022, 24. Jg., Nr. 1, S. 36-61.

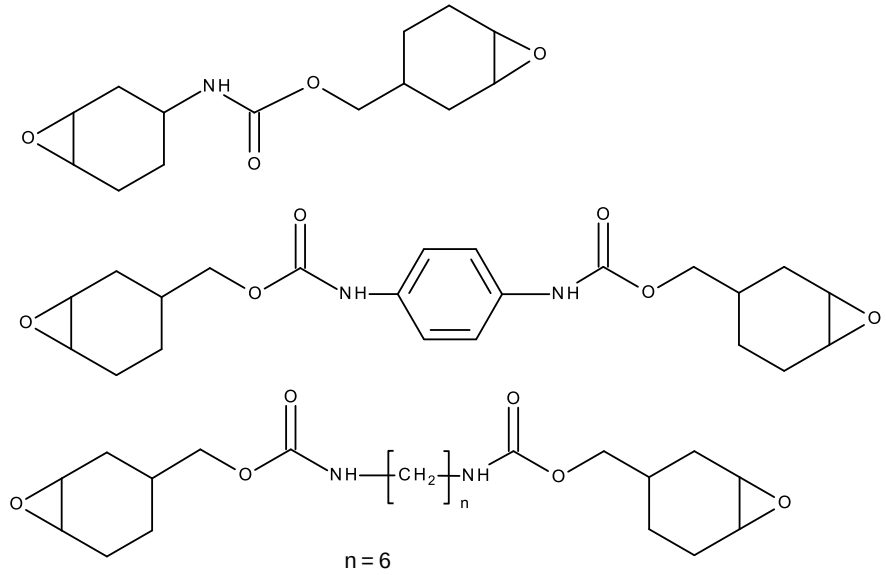
Introduction of thermolabile groups

Temperature

Carbamates and carbonates as thermolabile groups:

- Mainly used for epoxy resins as encapsulation materials in microelectronics.
- Networks decompose when heated between 200 °C and 250 °C.

Carbamates:



Magnetic fields

Heating in the magnetic field

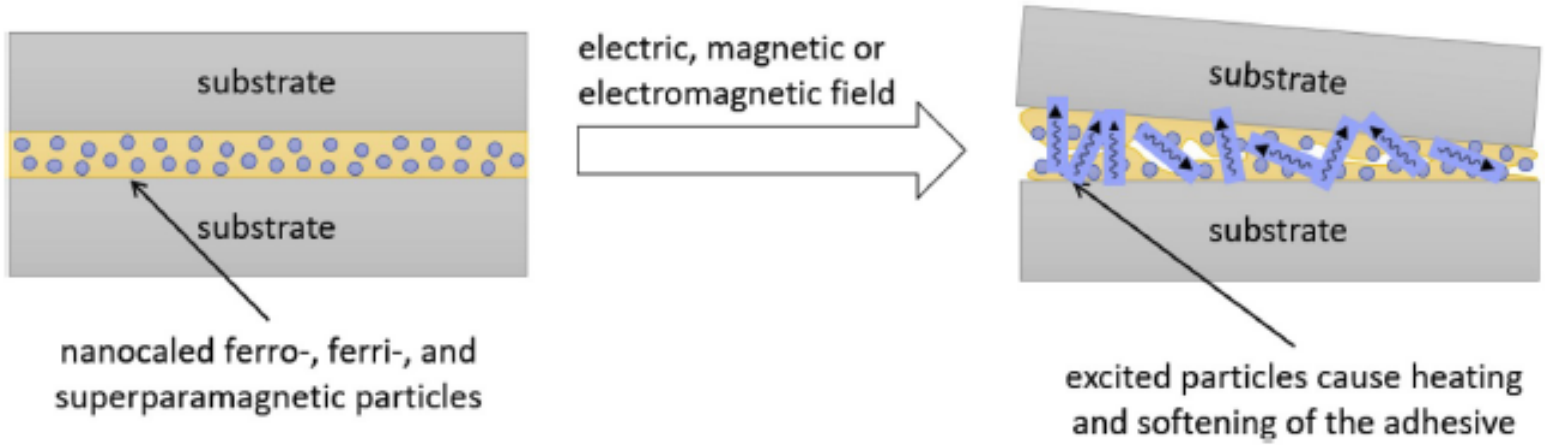
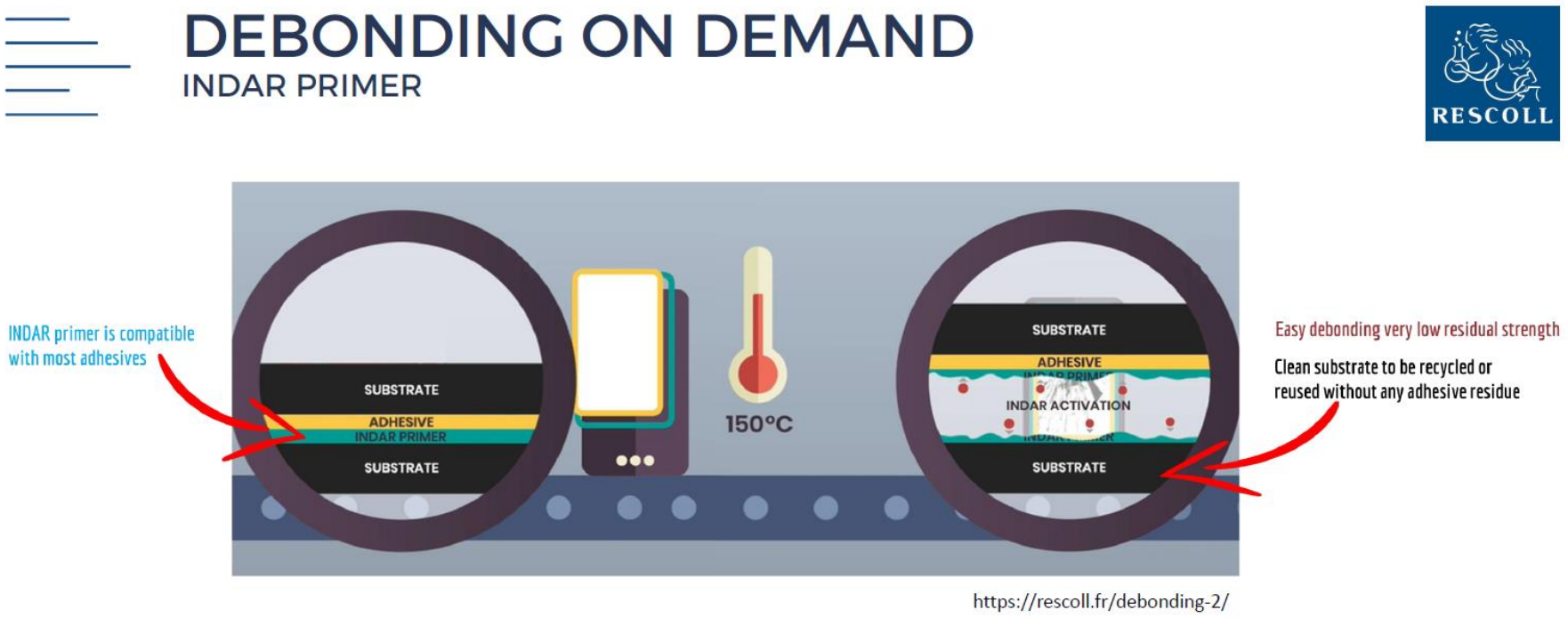


Fig. 18. Concept of magnetically induced debonding (on the basis of Ref [30]).

BANDL, Christine; KERN, Wolfgang; SCHLÖGL, Sandra. Adhesives for “debonding-on-demand”: Triggered release mechanisms and typical applications. International Journal of Adhesion and Adhesives, 2020, 99. Jg., S. 102585.

Use of modified Primers

Temperature



Source: Rescoll

Debonding for Improved Mechanical Tooling

Electricity

Modified hot melt adhesive

Debonding at combination of 48 V and 65°C with clean adhesive failure

Debonding conditions adjustable and transfer to other kind of adhesives

Works only for metalic substrates

Source: IFAM

Fraunhofer
IFAM

Fraunhofer-Institut für Fertigungs-
technik und Angewandte
Materialforschung IFAM

Thank you for your attention

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Fraunhofer
IFAM

Fraunhofer-Institut für Fertigungs-
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Materialforschung IFAM

Agenda

10:30 FEICA introduction & regulatory context

Mr Dimitris Soutzoukis, Senior Manager Regulatory Affairs, FEICA

10:35 Adhesives and sealants' unique properties in the electronics sector

Dr Annett Linemann, Director Technology Outlook & Sustainability, H.B. Fuller, Chair FEICA Electronics Technical Task Force

10:50 Disassembly of electronics and possible adaptations of adhesives and sealants for reusability, repairability and recyclability of electronics 'Debonding on Demand'

Dr Matthias Popp, Group Leader Adhesive Formulation, Fraunhofer Institute

11:05 The circular economy potential of reversible bonding in smartphones

Mr Ive Vanderreydt, Circular Economy Expert, VITO NV

11:20 Q&A moderated by Mr Dimitrios Soutzoukis

11:30 Close of the webinar

Mr Ive Vanderreydt

Circular Economy Expert, VITO NV

The circular economy potential of reversible bonding in smartphones

Outline

- Intro to Circular Bonding Project
- Reversible bonding for a smartphone case
  - Approach
  - Results
- Demonstrators

Turning fundamental research into solutions

Creating value and increased competitiveness for companies and governments

Fundamental research

Research and education

Universities

Joint research projects,
Phds and postdocs

Applied research

Research in the economic reality

vito

Research & Technology Organisations

Contract research
Techtransfer
Research projects, labs, pilots

Companies

Governments

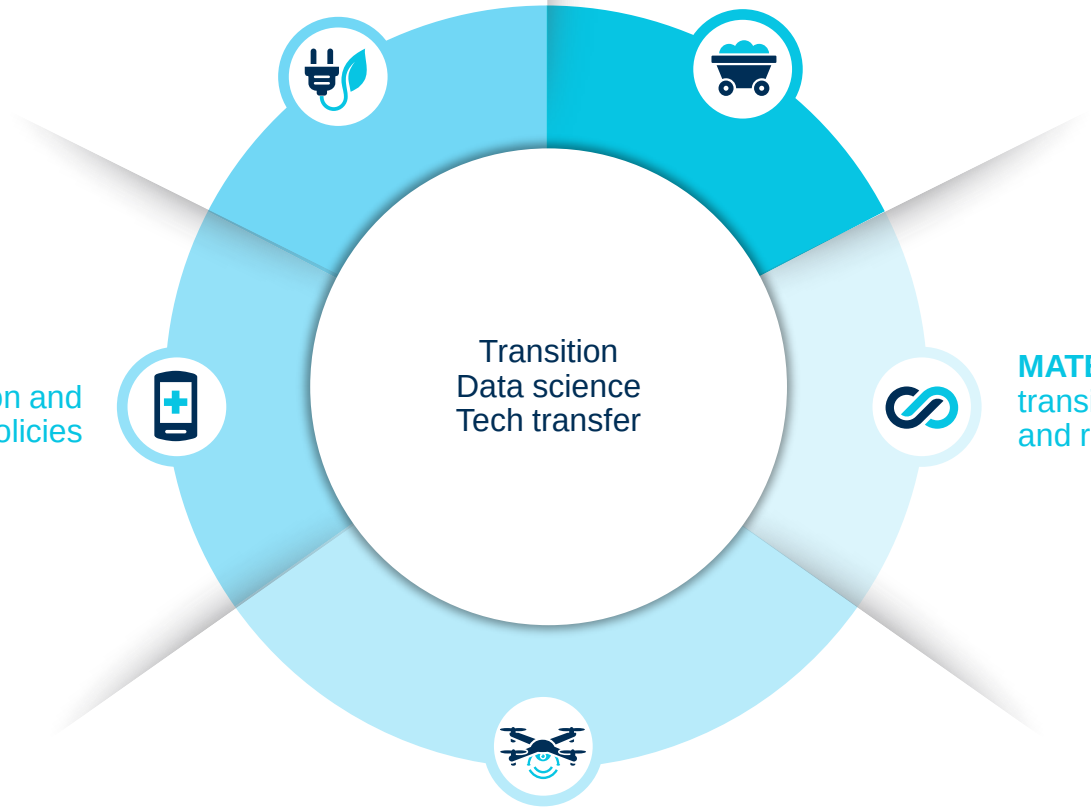
Citizens

Technology Readiness Level

1 2 3 4 5 6 7 8 9

A secure, clean and affordable **ENERGY** system as the cornerstone of a climate neutral society

CHEMISTRY is the basis of sustainable production



Putting prevention and **HEALTH** central in all policies

MATERIALS are key in the transition to a climate-neutral and resource-efficient society

ENVIRONMENT monitoring past and present, advising for the future to balance economic, environmental and social responsibility

We are VITO

In 2022

1048
employees

47
nationalities

237M€
revenues

24
patents/year

281
publications

11/3
11 sites on
3 continents

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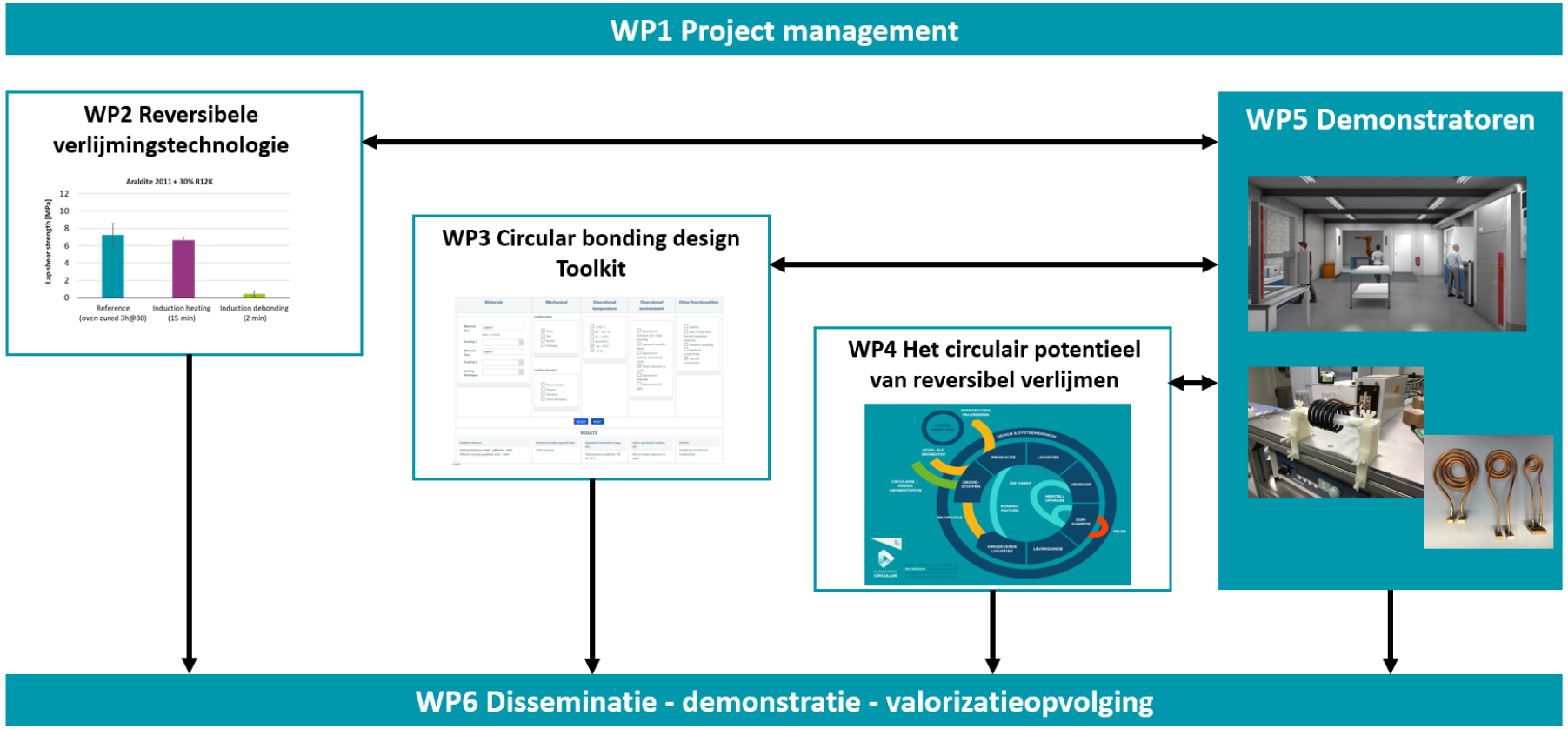
Intro to Circular Bonding Project

- What Reversible adhesive bonding technology and circular economy
- How Experimental data / Technology Selection tools / Business cases / …
- Objective Inform and demonstrate to activate industry, in order to create technology adoption



Partners:

- Flanders Make (coordinator)
- VITO
- BIL

VLAIO COOCK project
www.circularbonding.be

CE potential of reversible bonding of a smartphone:

a theoretical case study

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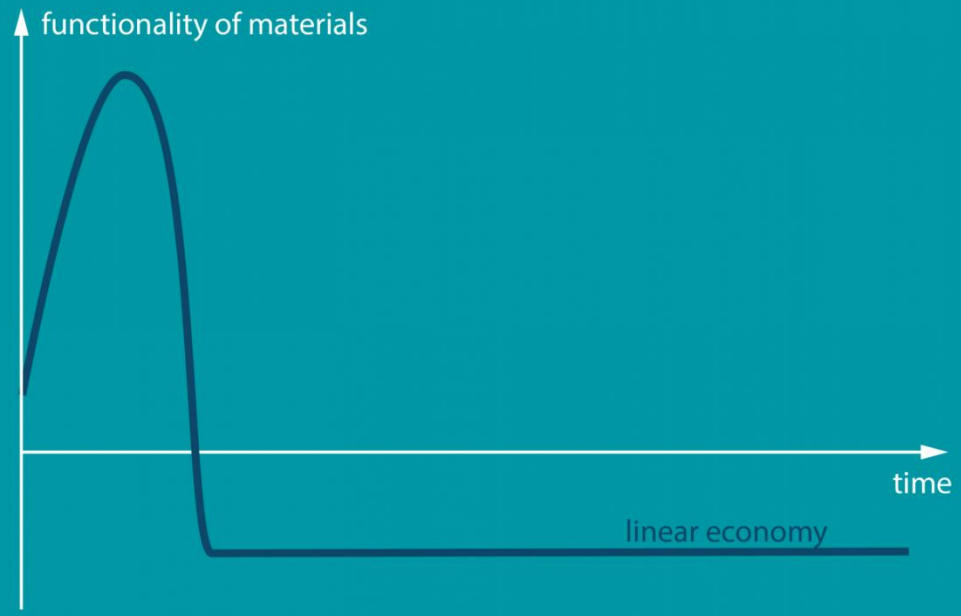
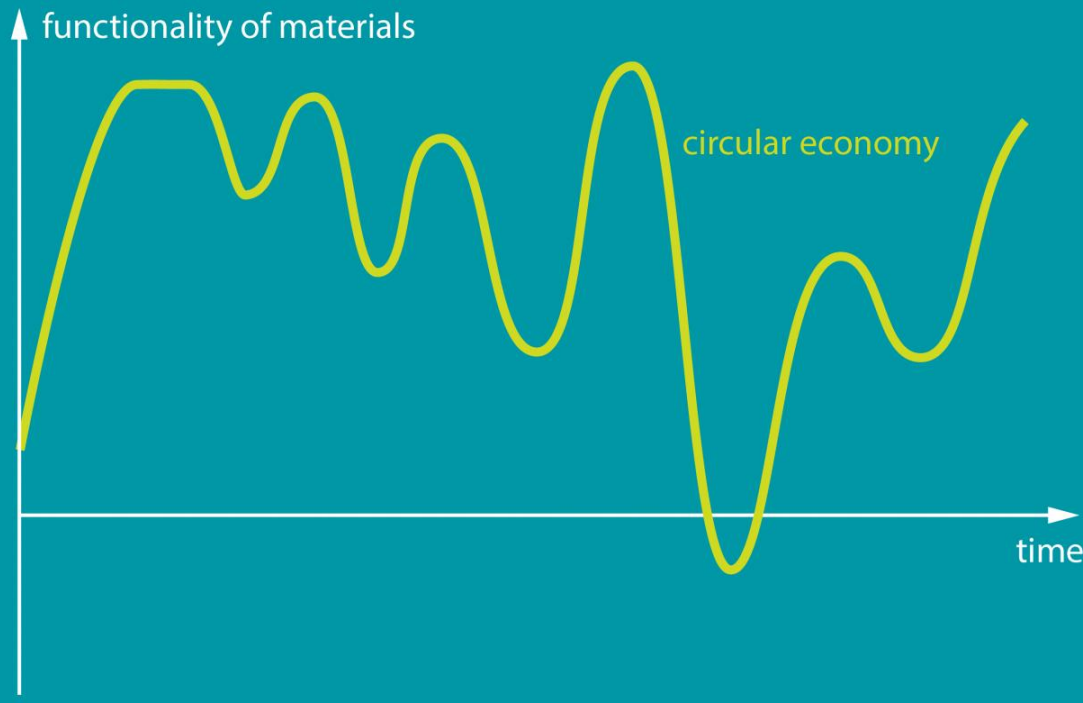
Waste management versus circular economy

A circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimising the generation of waste. The fewer products we discard, the less materials we extract, the better for our environment.

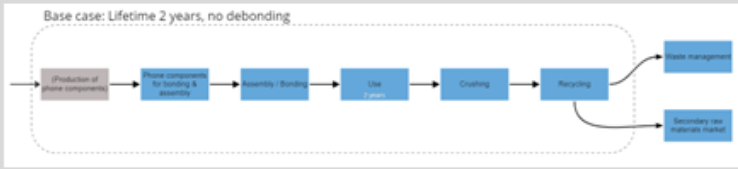
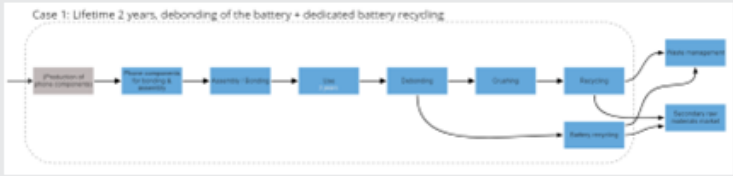
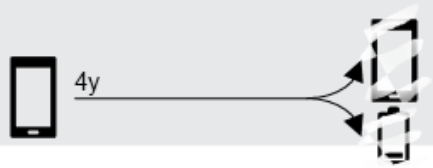
https://ec.europa.eu/eurostat/web/circular-economy



CE = preservation of functionality over time



Three different circular scenarios are investigated for the debonding of a smartphone battery…

Scenario	Description		Process chart
a No debonding + recycling (baseline)	Smartphone is used for 2 years and then recycled (as a whole – given no debonding). An additional new smartphone is bought and again discarded and recycled after 2 years		
b Debonding & separate battery recycling	Smartphone is used for 2 years then debonded and battery and rest of the phone are recycled separately. An additional new smartphone is bought and again discarded and recycled after 2 years, with debonding and recycling the battery of the second phone as well.		
c Debonding & exchange of battery	Smartphone is used for 2 years then the battery is replaced and the smartphone (with new battery) is used for another 2 years. The battery of the second phone is also debonded and recycled separately.		
d Debonding & maintenance	Smartphone is used for 4 years (thanks to good maintenance). After 4 years, the battery is debonded and separately recycled.		

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…from three different perspectives.

Functionality

Environmental

Economic

Key takeaways

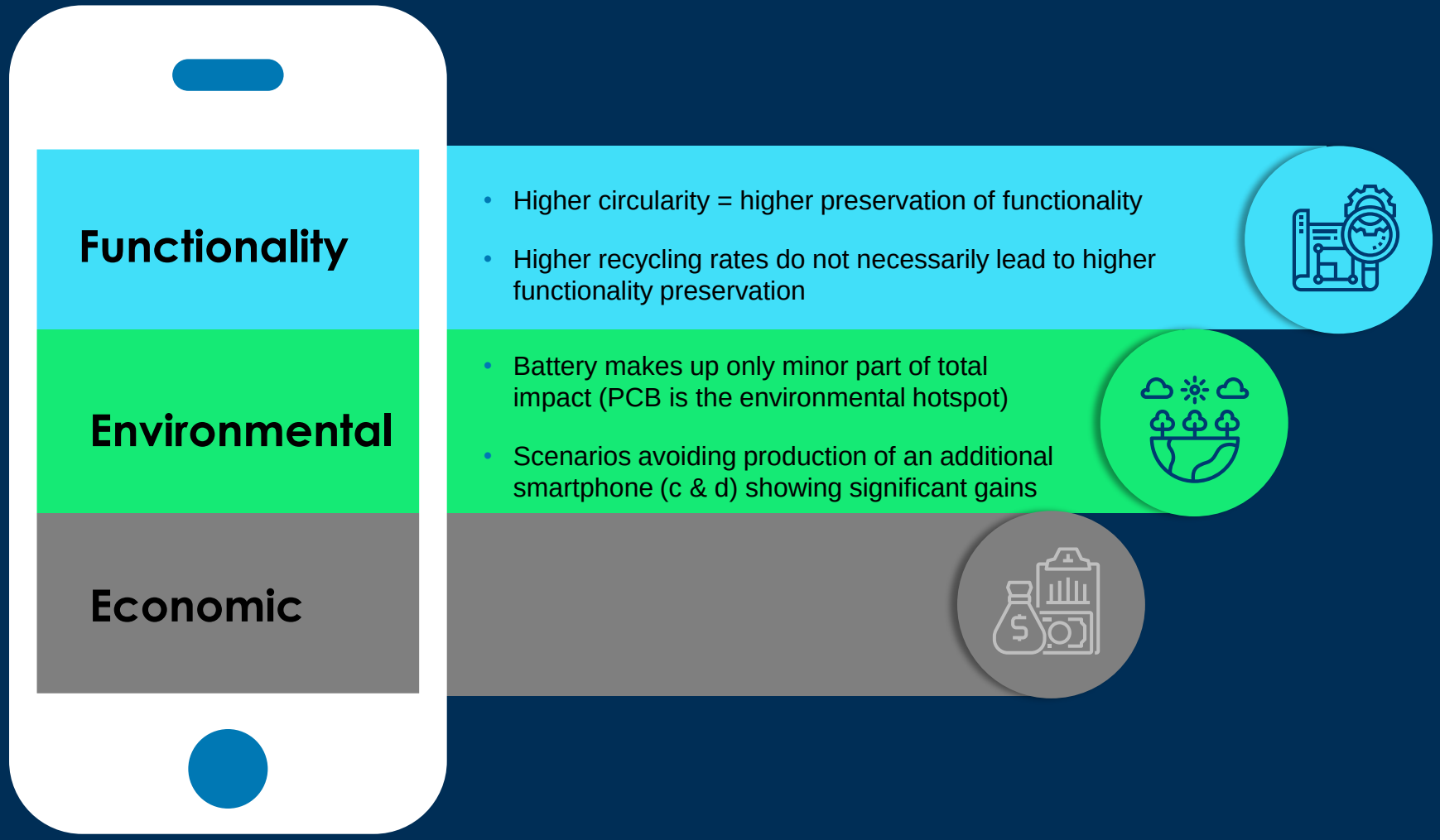
Functionality

- Higher circularity = higher preservation of functionality
- Higher recycling rates do not necessarily lead to higher functionality preservation

Environmental

Economic

Key takeaways



- Higher circularity = higher preservation of functionality
- Higher recycling rates do not necessarily lead to higher functionality preservation

- Battery makes up only minor part of total impact (PCB is the environmental hotspot)
- Scenarios avoiding production of an additional smartphone (c & d) showing significant gains

Key takeaways

Functionality

- Higher circularity = higher preservation of functionality
- Higher recycling rates do not necessarily lead to higher functionality preservation

Environmental

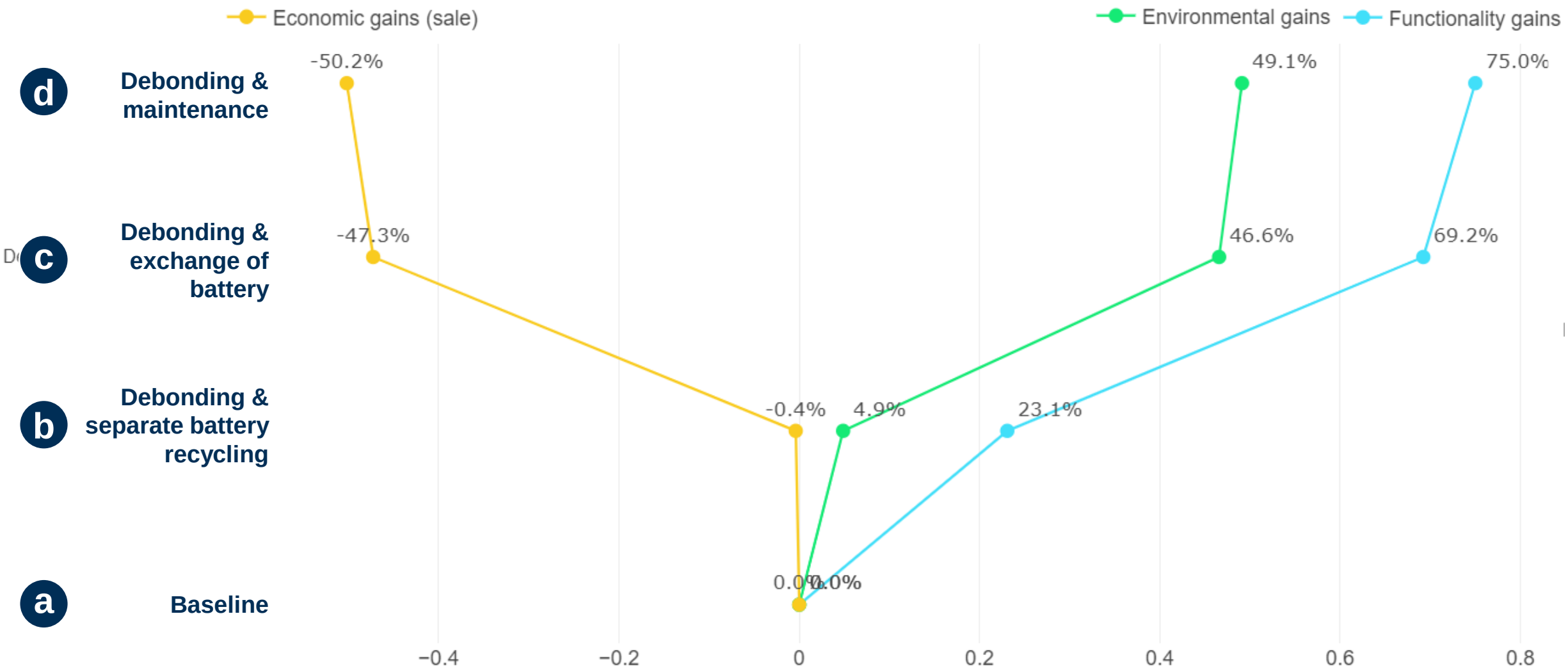
- Battery makes up only minor part of total impact (PCB is the environmental hotspot)
- Scenarios avoiding production of an additional smartphone (c & d) showing significant gains

Economic

- Bonding and debonding make up only a minor fraction of total lifecycle costs
- In a linear system sale is more profitable, for circular strategies leasing

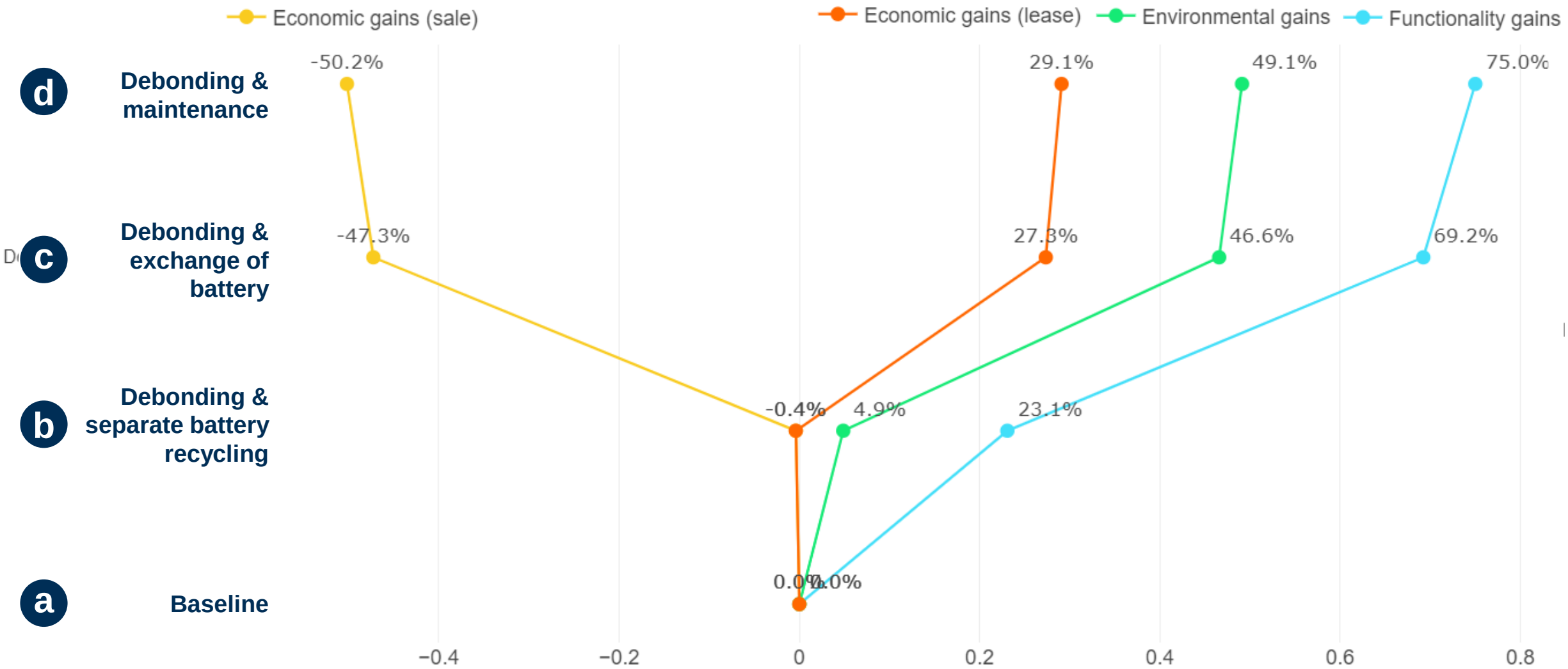
Trade-off between functionality and environmental gains and economic gains…

Summary smartphone case study results



Trade-off between functionality and environmental gains and economic gains solved by introducing circular business models

Summary smartphone case study results



Trade-off between functionality and environmental gains

ins solved by intro usiness models

case study results

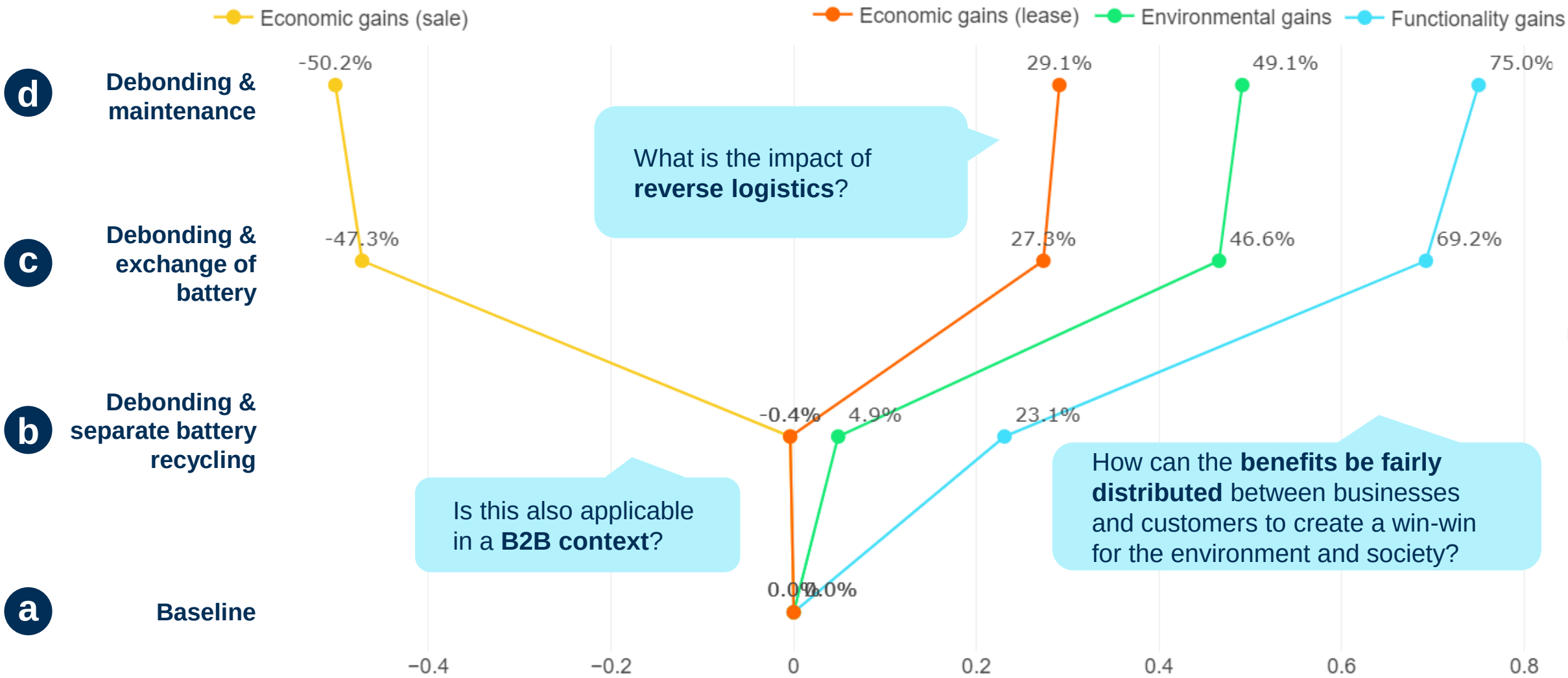
Which **policy instruments** can be used to trigger a similar outcome?

What about **customers**' preference for sale over lease?

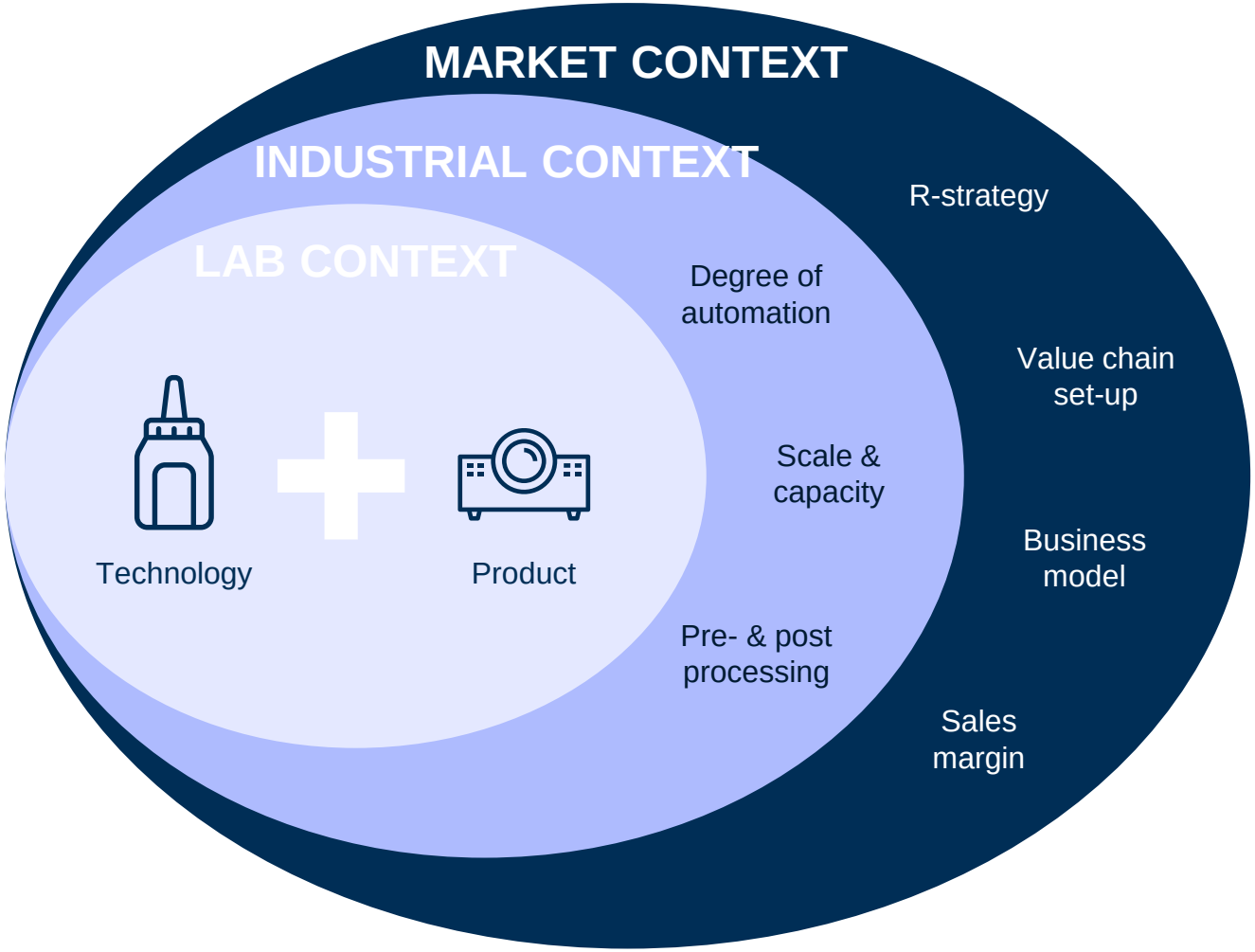
What is the impact of **reverse logistics**?

Is this also applicable in a **B2B context**?

How can the **benefits be fairly distributed** between businesses and customers to create a win-win for the environment and society?



Circularity assessment of demonstrators → in a certain market context



- Key degrees of freedom in **lab context**:
  - **Technology**, e.g. induction, convection, TEP… or a combination
  - **Product**, e.g. Projector + lens + adhesive used
- Key degrees of freedom in **industrial context**:
  - **Degree of automation,** e.g. automated to manual
  - **Scale & capacity**, e.g. max. products / debonding cycle
  - **Pre- & post processing**, e.g. (type of) cleaning required after debonding
- Key degrees of freedom in **market context**:
  - **R-strategy**, e.g. Repair, Reuse, Recycle…
  - **Value chain set-up**, e.g. reverse logistics, partner responsible for debonding, partner responsible for recycling / repair…
  - **Business model**, e.g. sale, lease, maintenance contract…
  - **Sales margin**, e.g. sales price, lease contract set-up, margin on repair / recycle…

Generic demonstrators

1. Automotive/transport

- GFRP & metal (cfr chassis)
- Large surface
- Fatigue, sun, temperatuur
- BC: less production failure

2. Equiment manufacturing

- Glass & aluminum
- Small surface (local debonding)
- Temperature, vibrations
- BC: Remanufacturing (reuse of component(s))

1. Technological demonstration
2. Product-Company-Value Chain-Market Perspective
3. Circularity aspects (material flows, business model, environmental benefits)

More information

www.circularbonding.be

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https://doi.org/10.1016/j.spc.2023.08.017

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Q&A

- Please use the chat box if you have a question
- Questions in the chat box will be covered as we go along
- In case we don't have sufficient time during the Q&A session to address your question, please feel free to send your question to info@feica.eu

Dimitrios Soutzoukis
Senior Regulatory Affairs Manager, FEICA

THANK YOU

Interested in future FEICA webinars ?

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Other interests or questions ?

info@feica.eu