



Michel Mies
Director Product Development
tesa tape, inc.



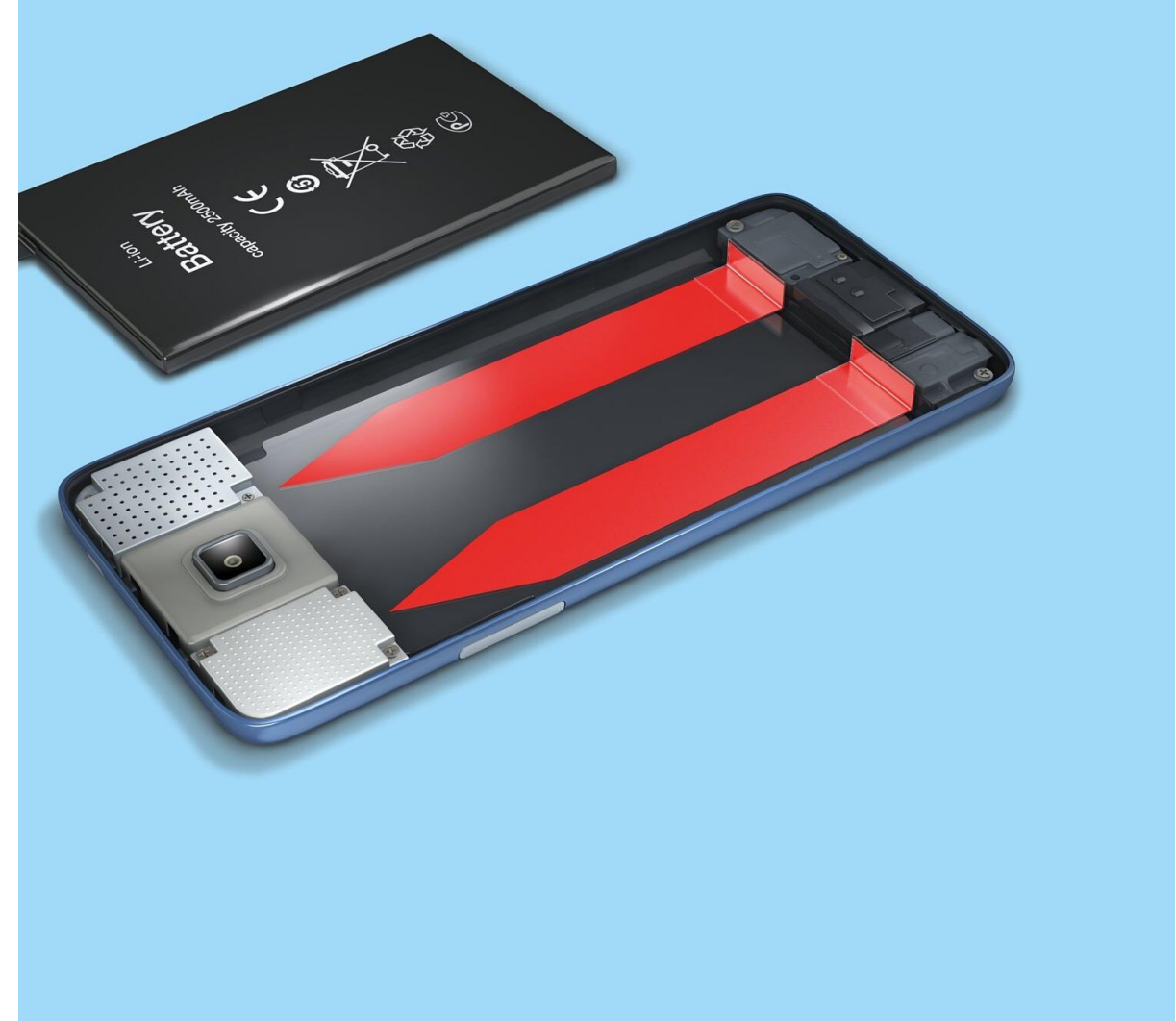
DEBONDING ON DEMAND

AGENDA

Debonding on Demand



- Product Life Cycle
 - Renewable Carbon
- Beginning / End of Life Solutions
 - Legislation
- Stretch Release
- Electrical Release
- Thermal Release
- Laser Debonding



Consumer: Practical adhesive solutions for a beautiful home

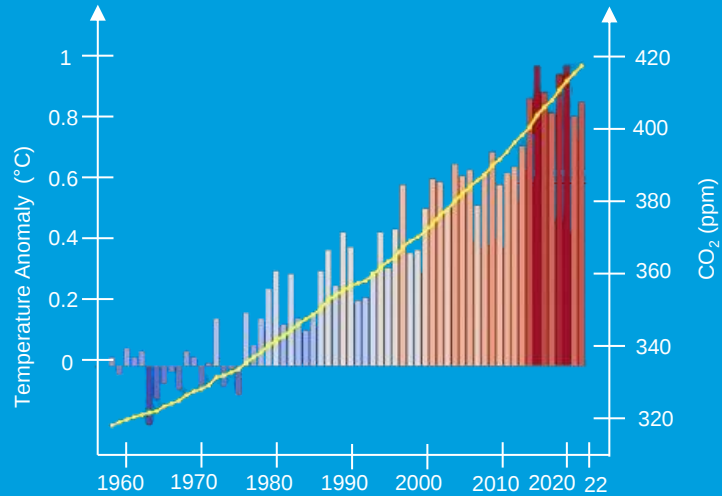
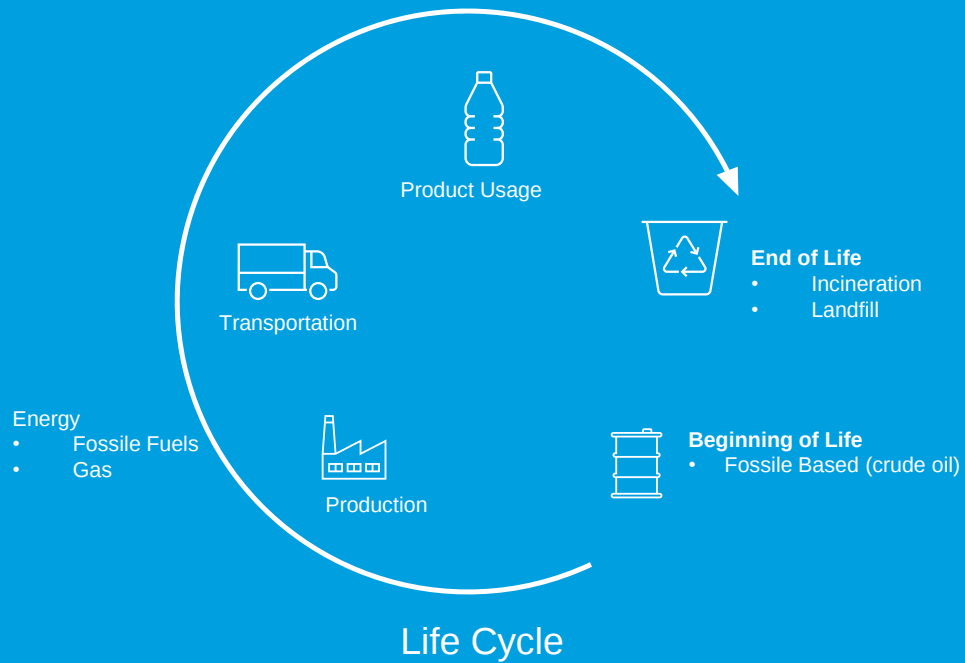
Our Consumer business: deep expertise in adhesives solutions for home improvement to help make everyday life easier.



Industry: Smart adhesive solutions for industrial markets

Our Industry business: Close partnerships for powerful innovations, state-of-the-art new adhesive solutions for industrial markets that solve our customers' challenges – today and tomorrow.



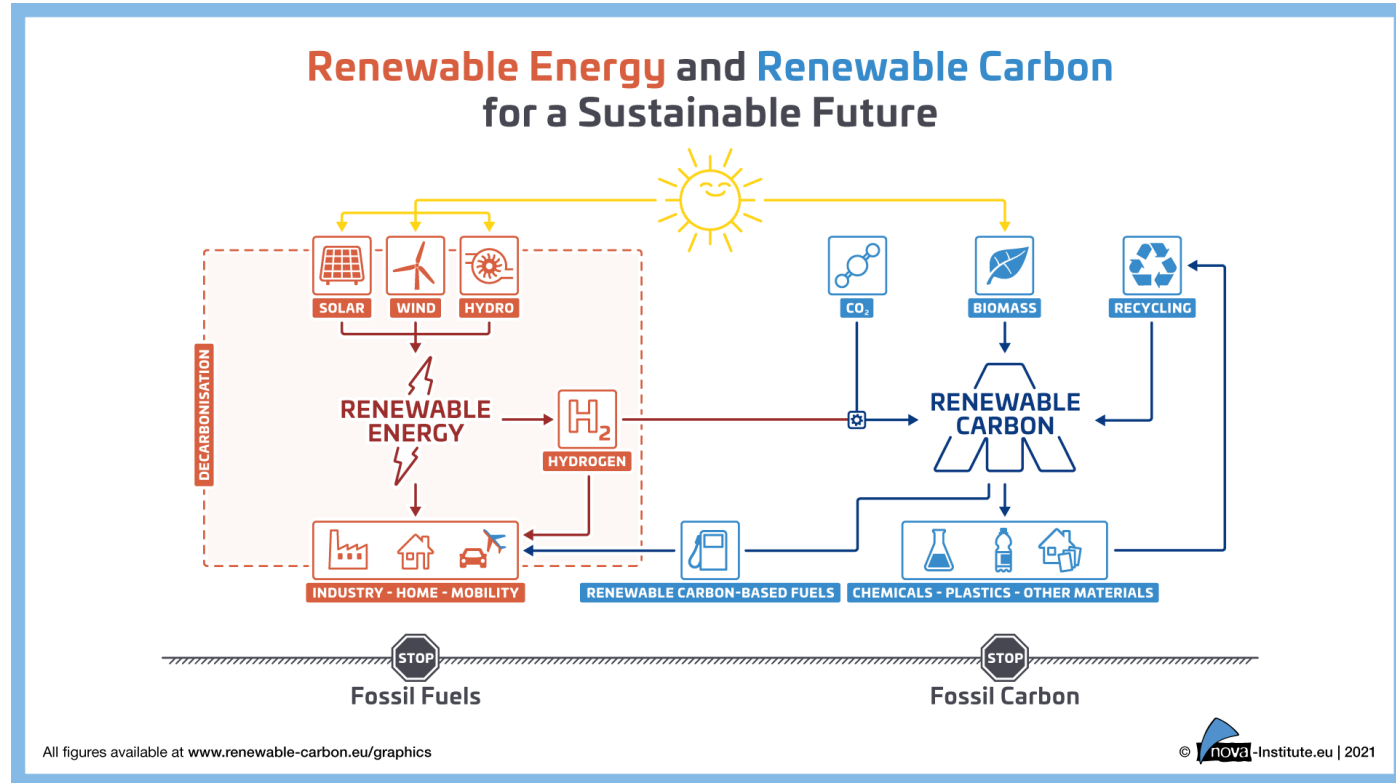


Increase of CO₂ Concentration and Climate Warming

SUSTAINABILITY



Beginning of Life - Renewable Carbon



Renewable Carbon concept: If carbon sources are only used from above the ground, the increase of CO₂ in the atmosphere will end.

Alternative to using fossil carbon:

- renewable carbon from biomass,
- CO₂ utilization
- recycling

Together with renewable energy, the concept can become the foundation of a sustainable future

Example: Old corrugated cardboard (OCC) Recycling

USA OCC Recycling Rate 2024: 94%

Aspect	Virgin Fiber (Wood Pulp)	Recycled Fiber (OCC)
Raw Material Cost	High – Trees must be harvested, transported, debarked, and chipped	Lower – OCC is widely available and collected from commercial/residential sources
Processing Energy	High – Kraft pulping uses lots of heat, pressure, and chemicals	Lower – Pulping OCC uses less energy and no harsh chemicals
Water Usage	High – Fresh pulping requires a lot of water for cooking and washing	Lower – OCC pulping uses less water, more closed-loop systems
Chemical Use	High – Requires pulping agents (e.g. NaOH, Na ₂ S), bleaching (for white grades)	Low – Mostly mechanical cleaning (screens, floatation); fewer chemicals
Market Cost (2023 avg)	\$700–\$900 per ton (depending on grade)	\$50–\$160 per ton for OCC (fluctuates based on demand/export conditions)

No regulatory aspects → Decision is made by the industry



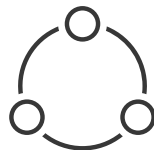


450 million citizens in the European Union
139 million smartphone shipments
50 billion Euro Sales

SUSTAINABILITY



End Of Life



Circular Economy Action Plan

COM (2020), Date March 2020

Promotes sustainable design and reduced waste.

Targets electronics, packaging, batteries, and vehicles.



EU Eco Design Regulation

Regulation (EU) 2024/123, July 2024

Promotes durable, recyclable, and repairable product design

Aims to reduce waste and keep resources in use longer.



Right to repair Directive

Directive (EU) 2024/789, July 2024

Ensures repair access after warranty ends.

Standardizes spare parts availability.

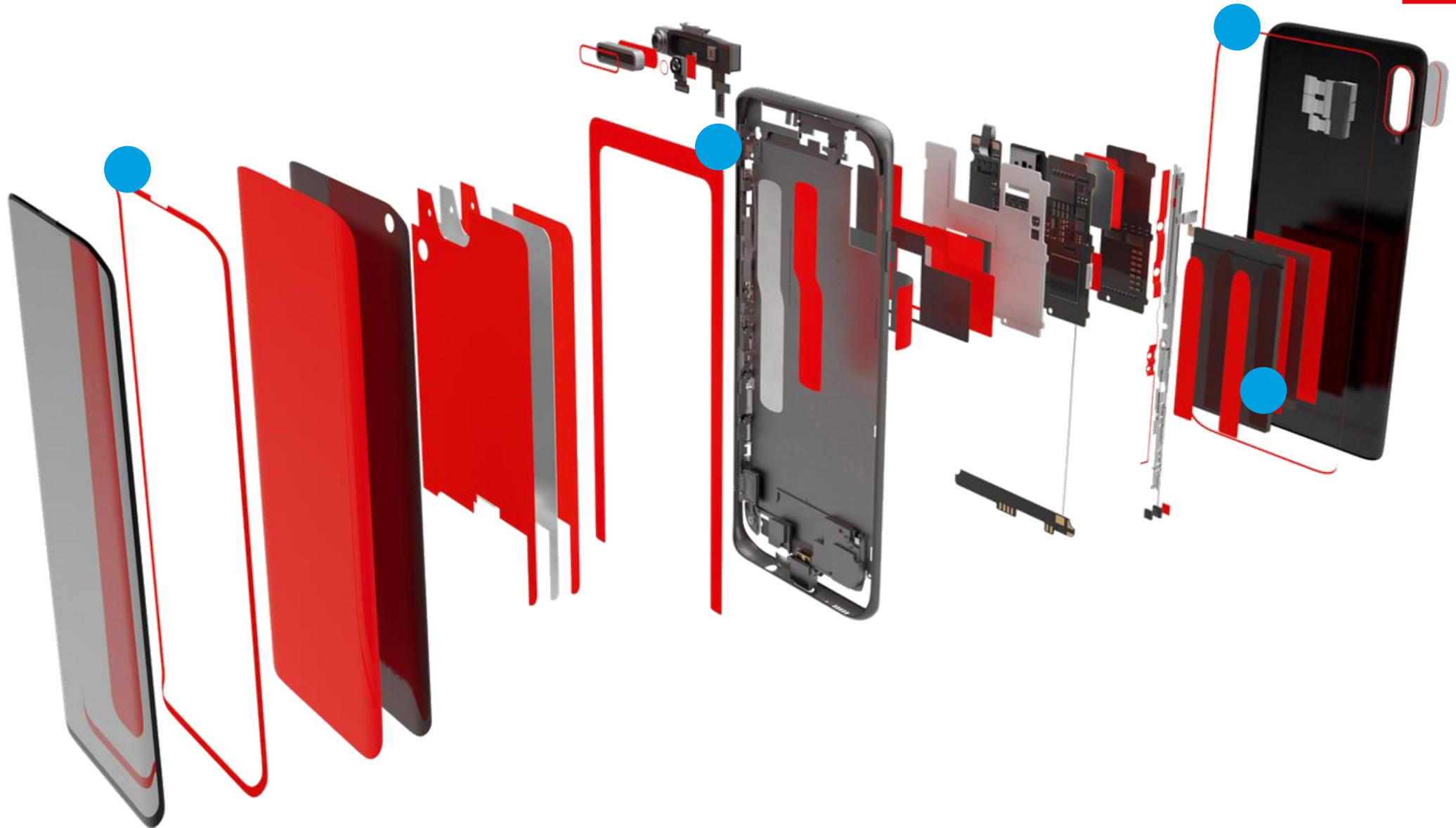


End-of-Life Vehicles (ELV) Directive

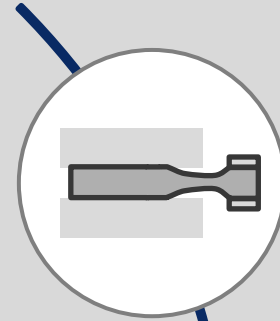
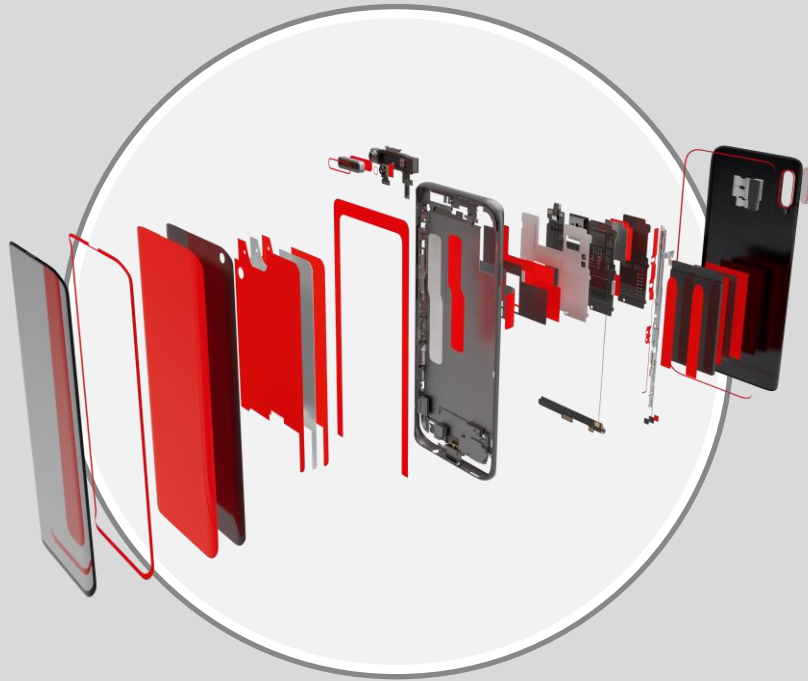
Directive 2000/53/EC,

Limits hazardous substances in cars.

Sets 95% reuse/recovery target..

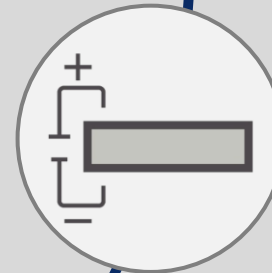


tesa® DoD Concepts



Existing Technologies

- Stretch Release



New technologies

- Electrical release
- Thermal release
- Laser debonding

Removal of adhesive occurs at various stages of a device's life



- At Factory Level

- Re-working and removability of adhesive tapes within seconds, minutes, hours after application
- Removal due to process (temporary fixation) or mis-alignment issue (processing)



- At Repair Facility Level

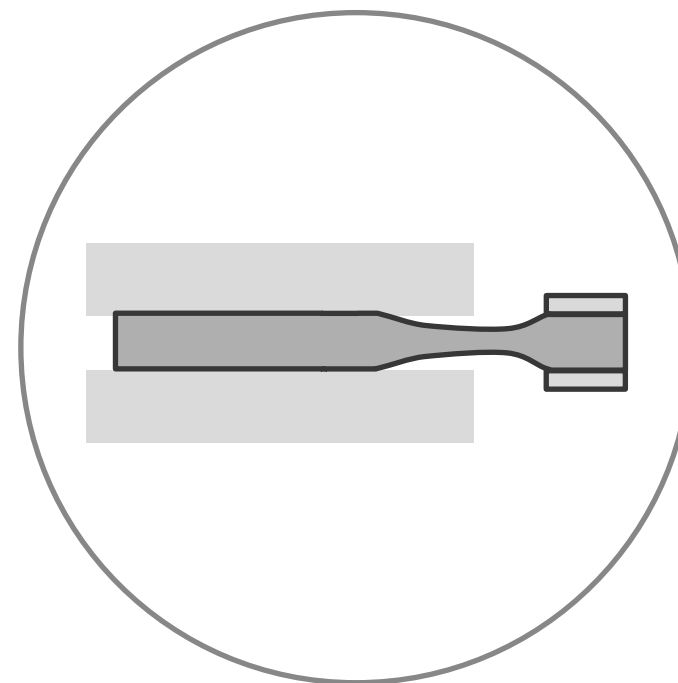
- Removability of an adhesive tape at a repair facility months or years after initial application



- At End-of-Life Level

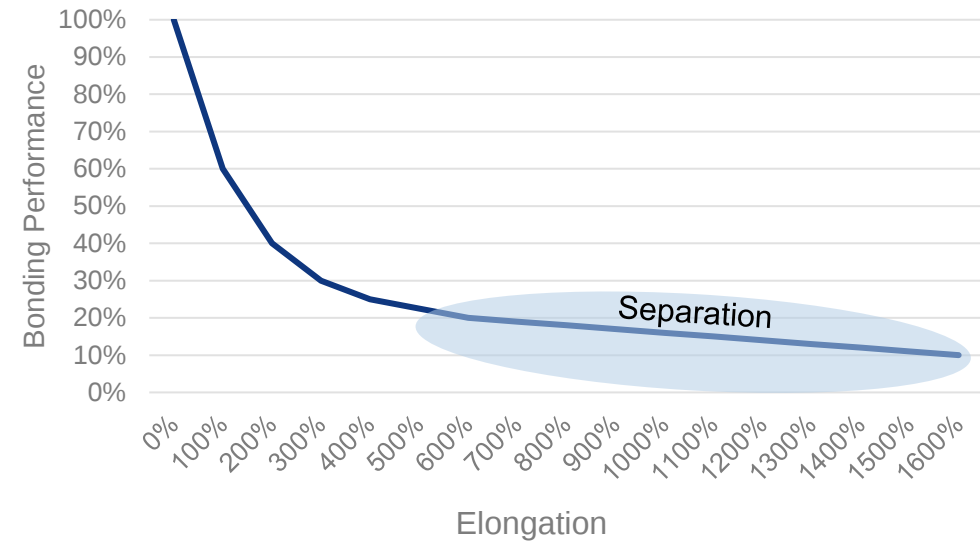
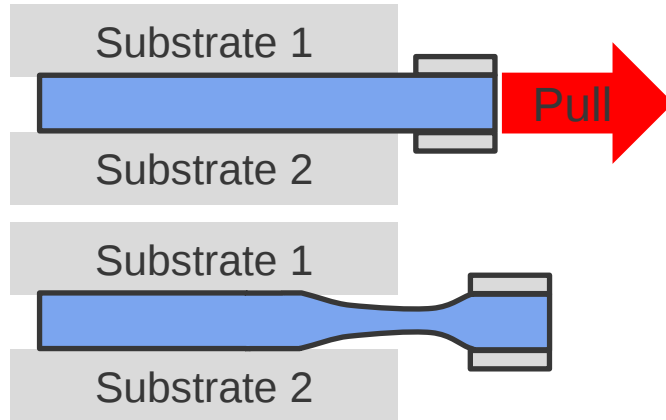
- Removability many years after original application of adhesive tapes
- Recycling facility needs to separate parts for recycling and re-use

Stretch Release Tapes



Stretch Release Tapes

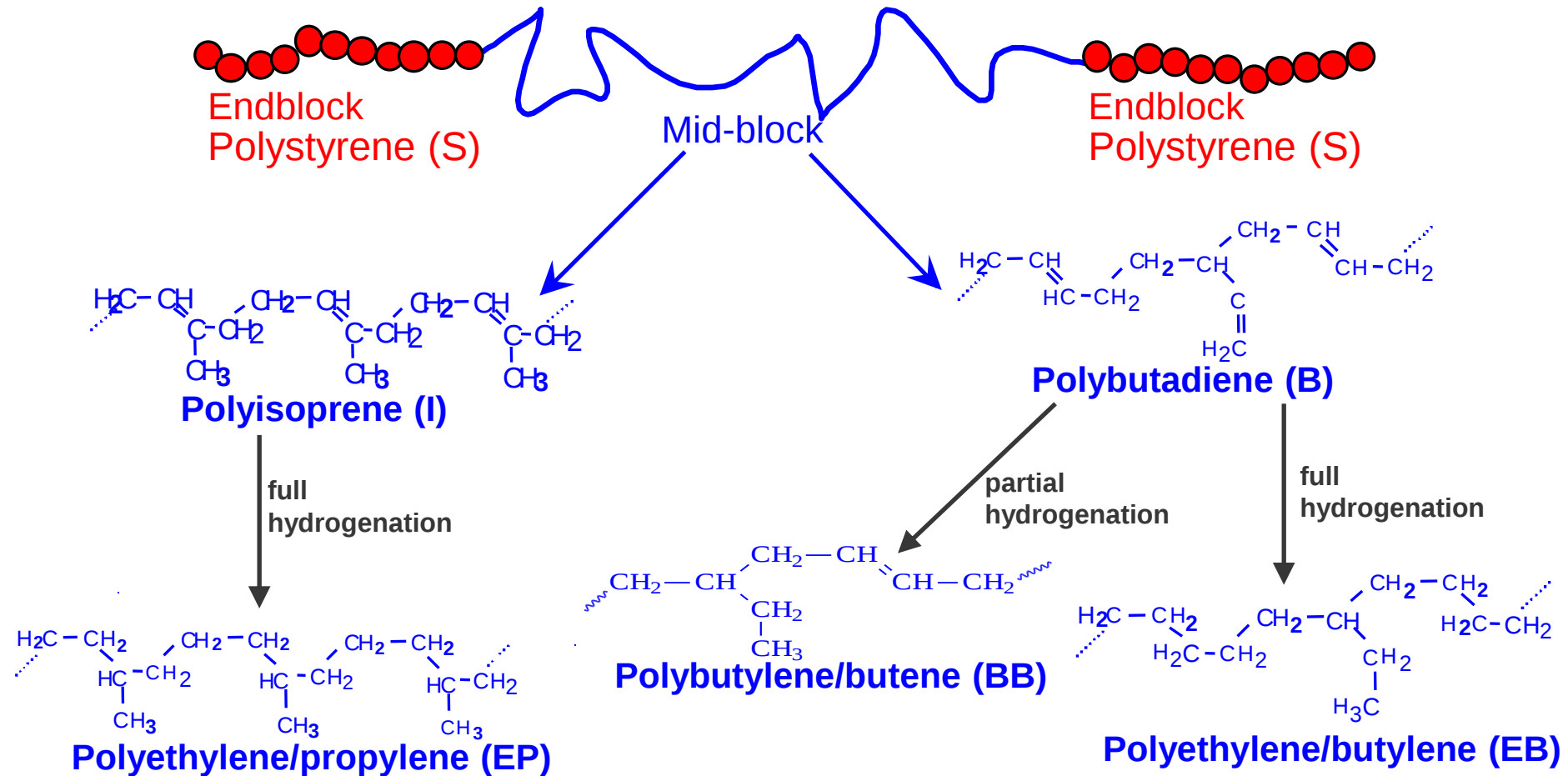
Concept



How does the concept work?

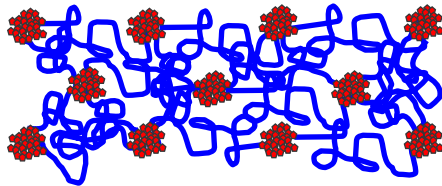
- High peel, tack and shock resistance at 0% elongation
- By stretching the level of tack is decreasing
- From an elongation of > 400% it is easy to remove the tapes without leaving residues

Typical middleblock compositions of SBC:

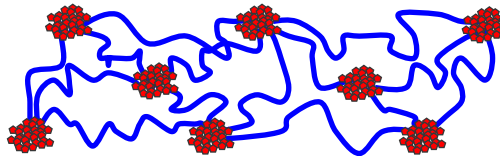


Stripping effect:

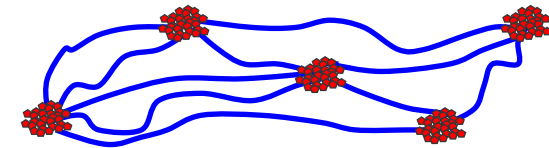
- **unstretched:** hard block domains arrange cubically centered, chains of soft block matrix are able to flow freely
→ **ability to wet** the surface of the substrate
- **being stretched:** hard block domains keep their shape, but move away from each other. Mid-block chains are forced to stretch
→ reduced ability to move, **adhesion decreases**
- **fully stretched:** mid-block chains cannot wet the surface any more
→ **loss of adhesion**



Unstretched

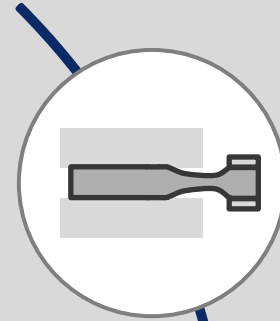
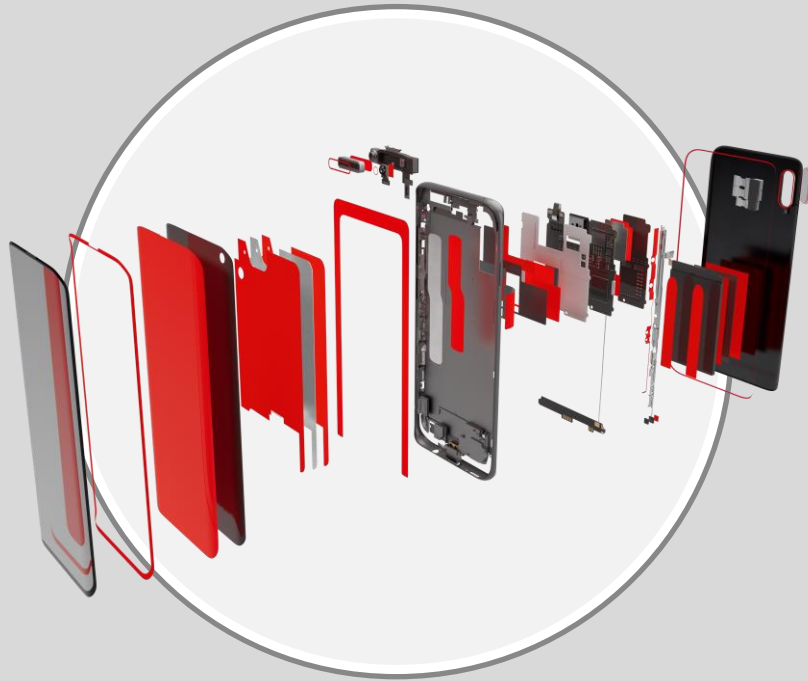


somewhat stretched



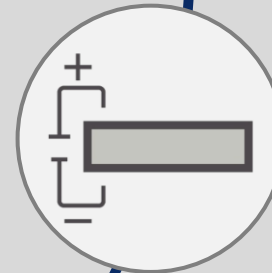
fully stretched

tesa® DoD Concepts



Existing Technologies

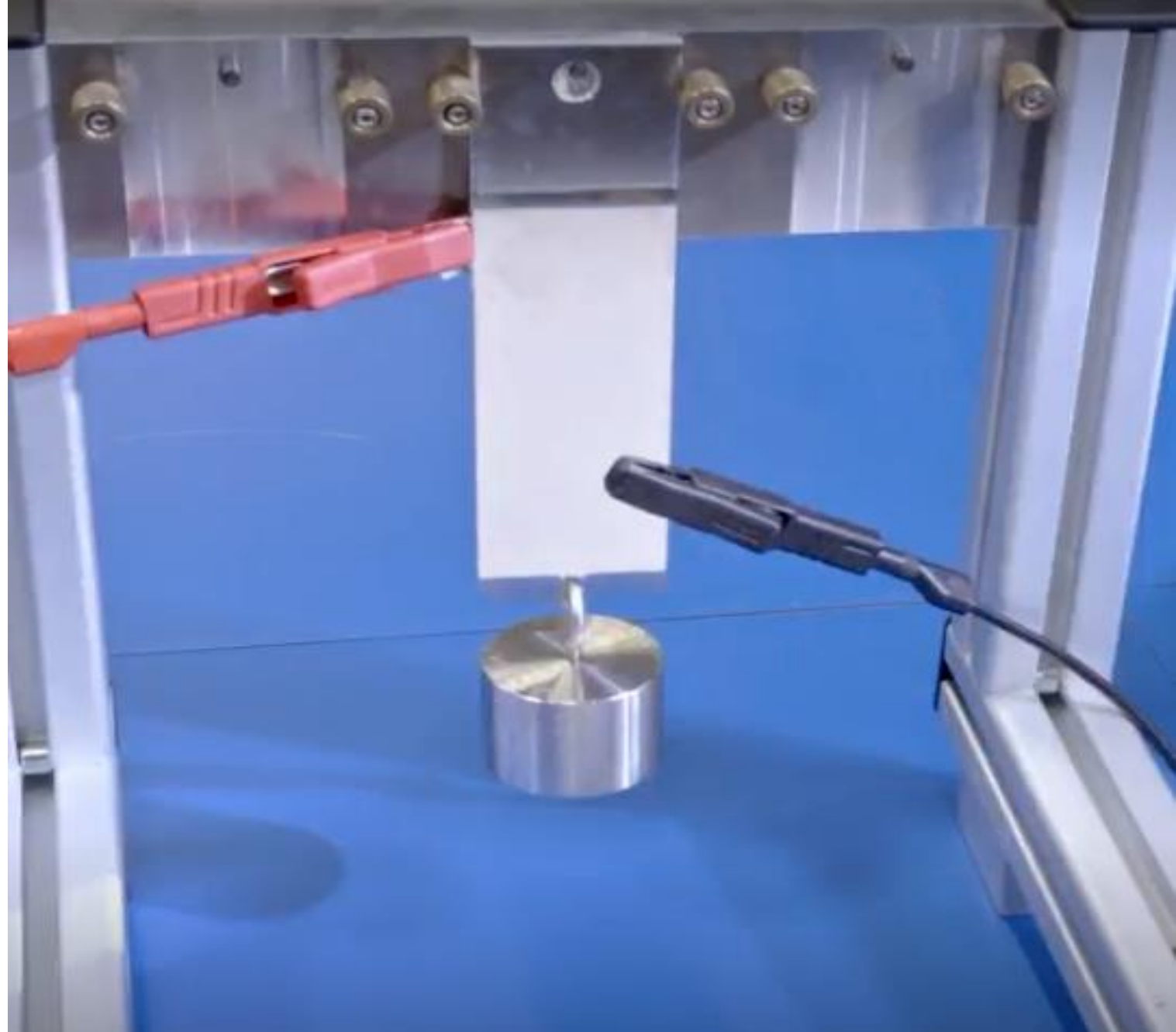
- Stretch Release



New technologies

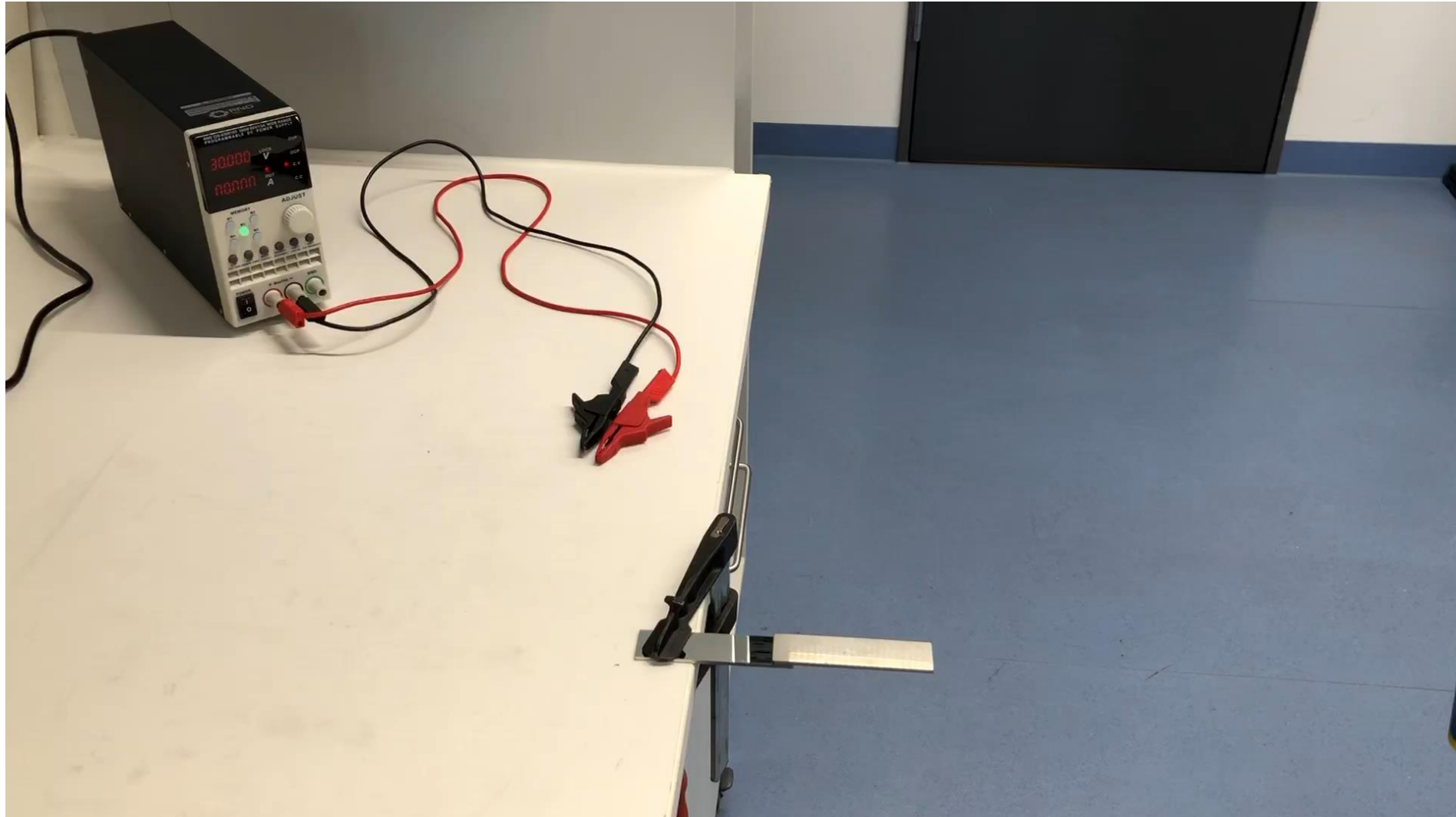
- Electrical release
- Thermal release
- Laser debonding

Electrical debonding with ionic electrolyte



Electrical Release

Concept: How it works? Video of 100 micron structural adhesive tape

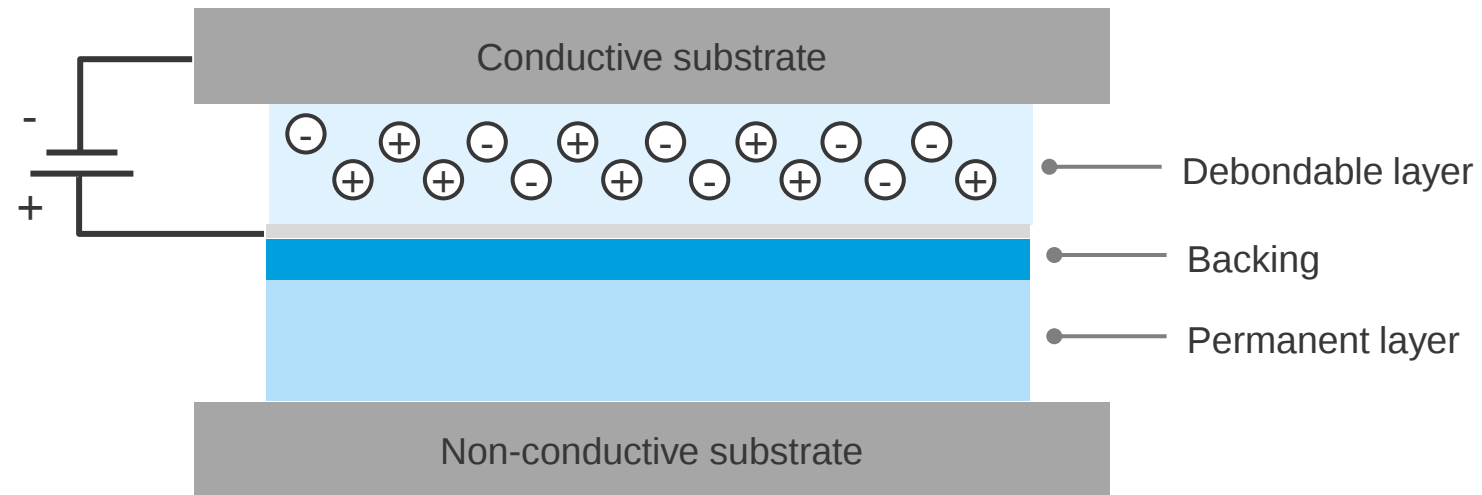


Electrical Release

Debonding on Demand Electrical release – concept



- Ionic liquids are used as electrolytes
- After current is applied the Electrolytes can move in the debondable layer
- cations are moving to the minus-electrode and anions to the plus-electrode
- The electrochemical reaction in the adhesive significantly reduces the adhesion
- The tape can be debonded without any residues from the conductive substrate



Induction debonding (electro-magnetic)

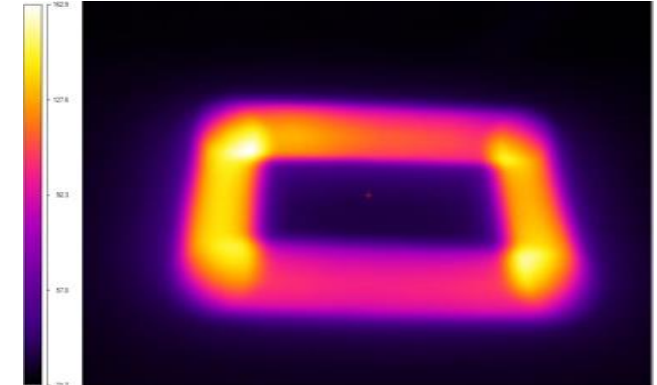
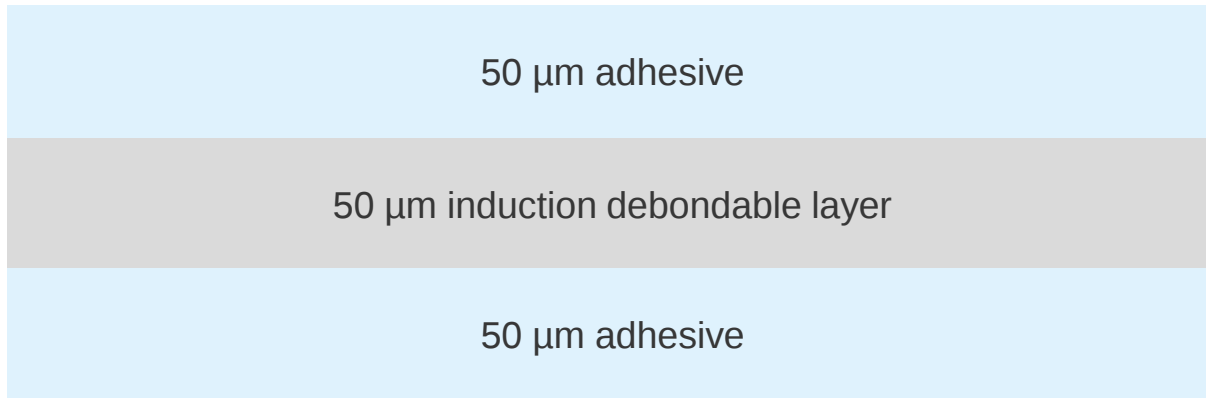


Induction debonding (electro-magnetic)

Concept: Faraday's Law of electromagnetic induction



- High frequency alternating current generates magnetic field
- If a conductive material is placed inside this field, eddy currents encounter electrical resistance and generate localized heat
- Reliable 5s~30s contactless induction debonding
- Debonding: substrate temperature is 45°C
- handheld inductors can be used



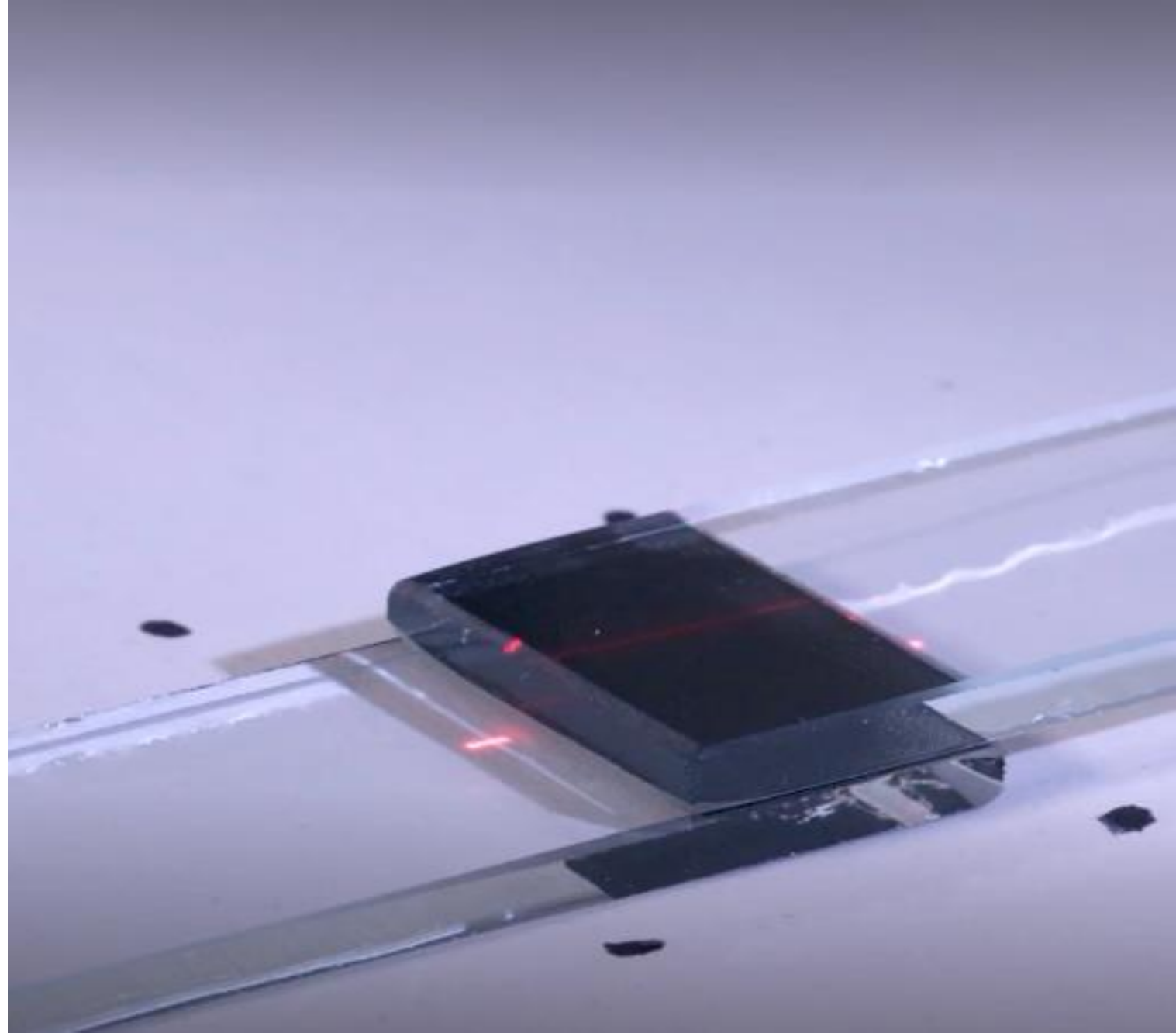
contactless induction

Induction debonding (electro-magnetic)

Video

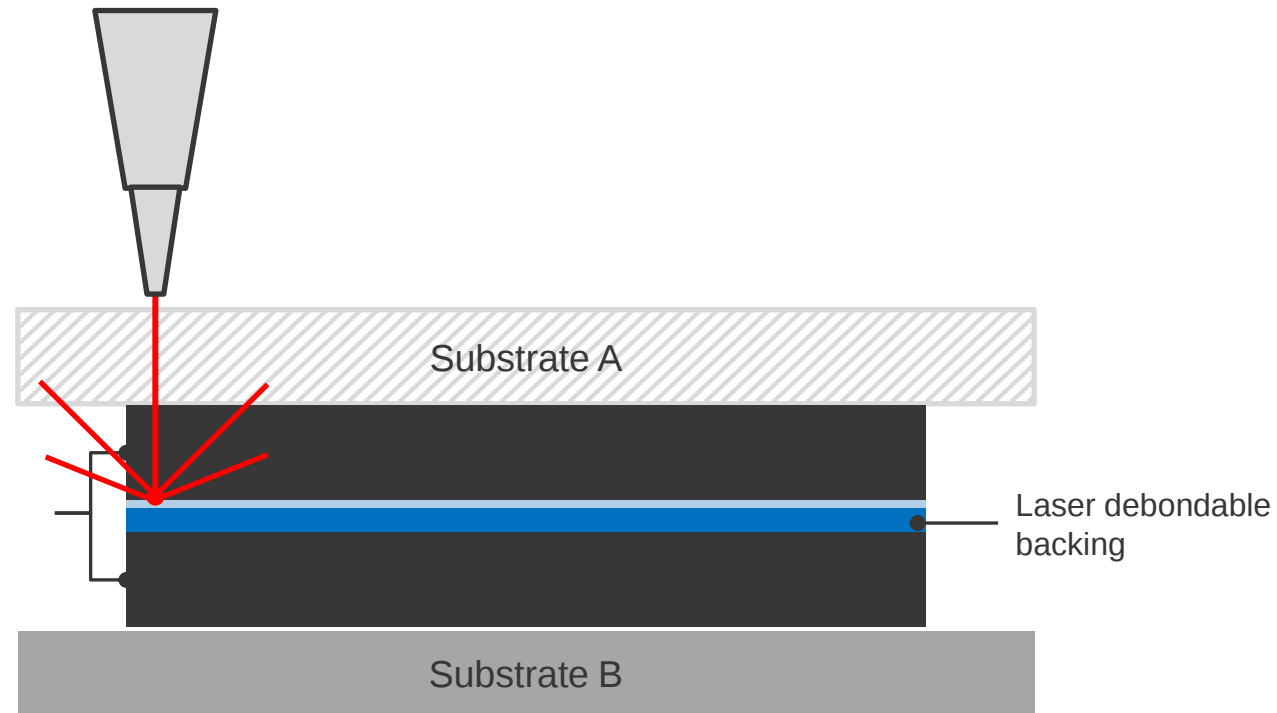


Laser debonding



Laser debonding

Concept



How does the concept work?

- Substrate A or B must be laser permeable
- Incorporated absorption layer is removed by Laser
- Transparent plastic substrates, like PC, can also be considered

Laser debonding

Video



- **Adhesives**
 - Traditional adhesives are permanent by design, creating major barriers for recycling, repair, and rework.
 - Growing demands for sustainability, circular economy, and product longevity challenge us to rethink bonding.
- **Sustainability & Economic Impact**
 - Enhances recycling efficiency (e.g., EV batteries, electronics, packaging)
 - Reduces waste, labor, and disassembly costs
 - Meets evolving regulatory requirements (e.g., EU Battery Regulation, Right to Repair)
- **Vision Forward**
 - DoD transforms adhesives from a waste problem to a sustainability enabler.
 - It's not just a material—it's a design philosophy for the next generation of products.

"Adhesives have always held things together—now, they can also help take them apart, cleanly and responsibly."



Contact Information

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