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Circular recycling of polyurethane and polyester blends

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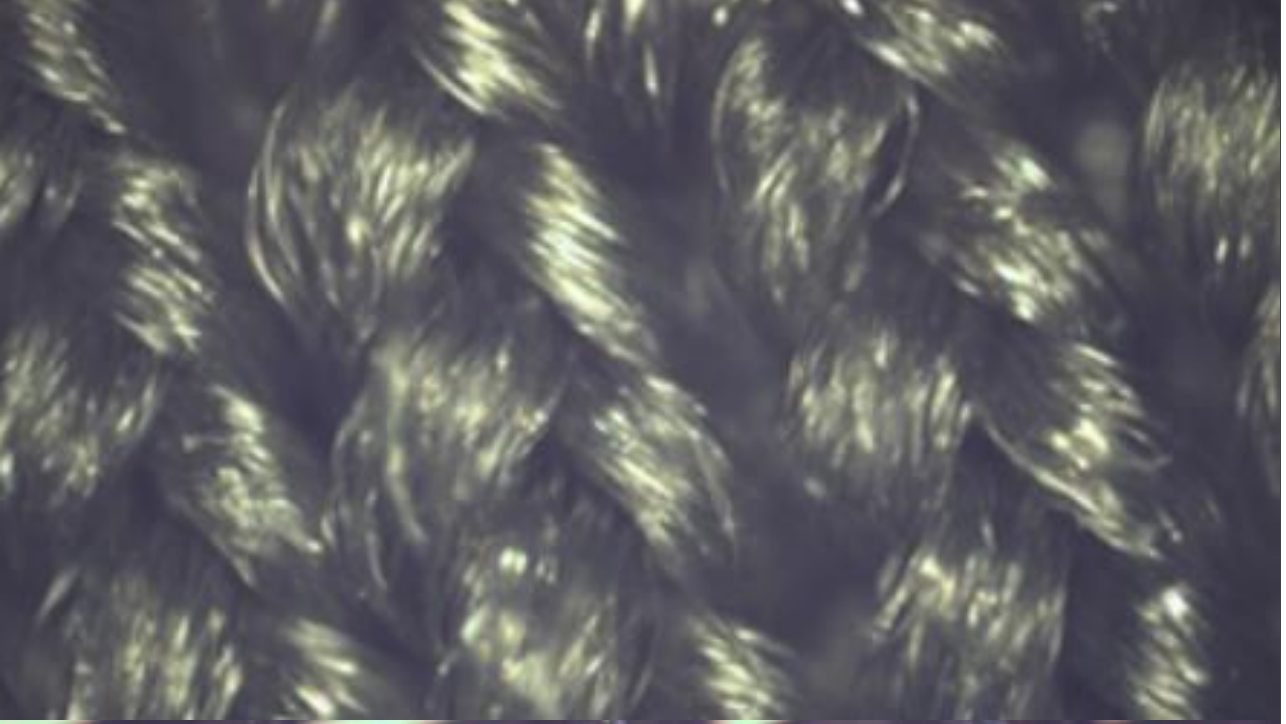
Polyester/polyurethane blends

Application	Form	
	Polyester	Polyurethane
Textiles	Fiber	Fiber/coating
Furniture	Fiber	Foam/glue
Packaging	Plastic	Glue



Aims

- ❑Selective breakdown or dissolution of one component (polyester/polyurethane)
- ❑Qualitative products from all materials
- ❑Alternative and safer monomers suitable for repolymerization
- ❑Environmental performance
- ❑Economic potential

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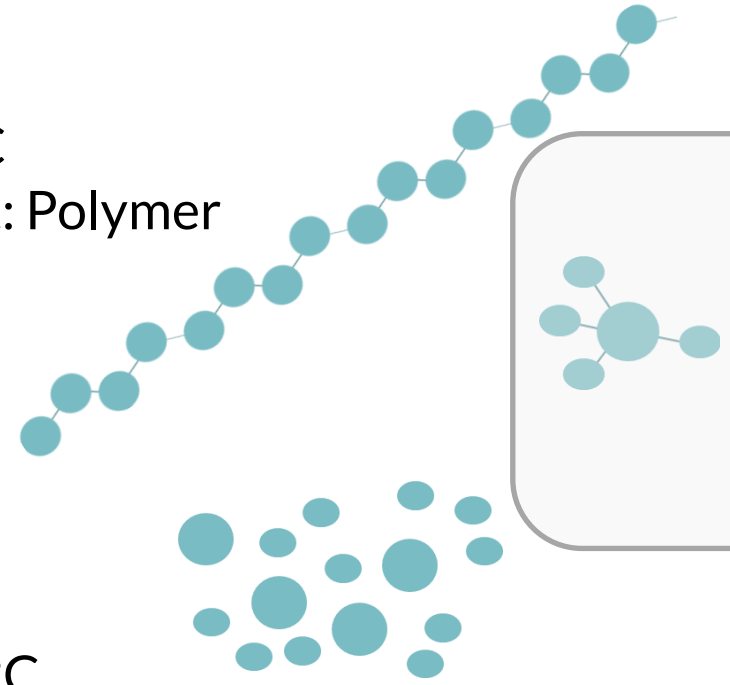
Chemical recycling

Dissolution
T: RT-250 °C
End product: Polymer



Depolymerisation/solvolysis
T: 100-300°C.
End product: Monomer
Hydrolysis, alcoholysis, glycolysis, amminolysis.

Pyrolysis
T: 400-600 °C
End product: Pyrolysis oil

Gasification
T: 700-1300 °C
End product: Syngas (CO:H2)

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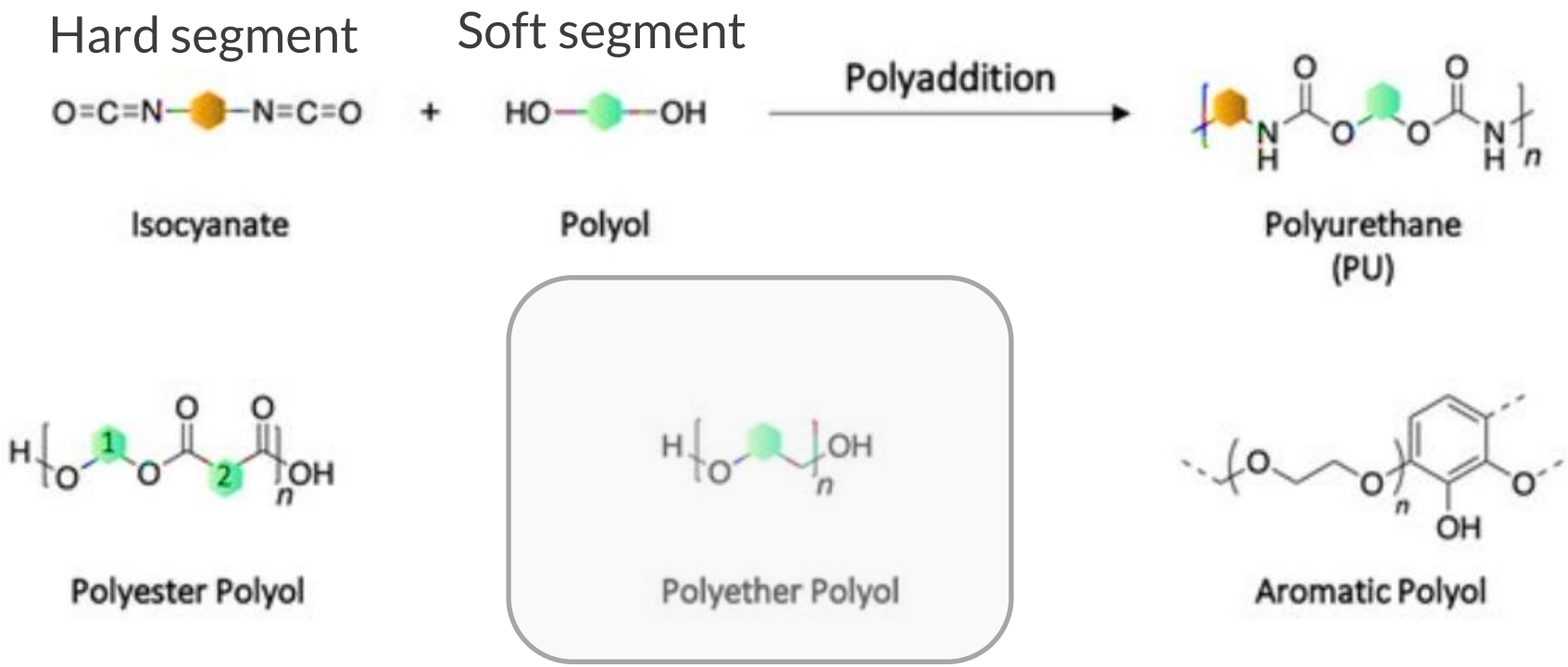
Polyurethanes and elastane

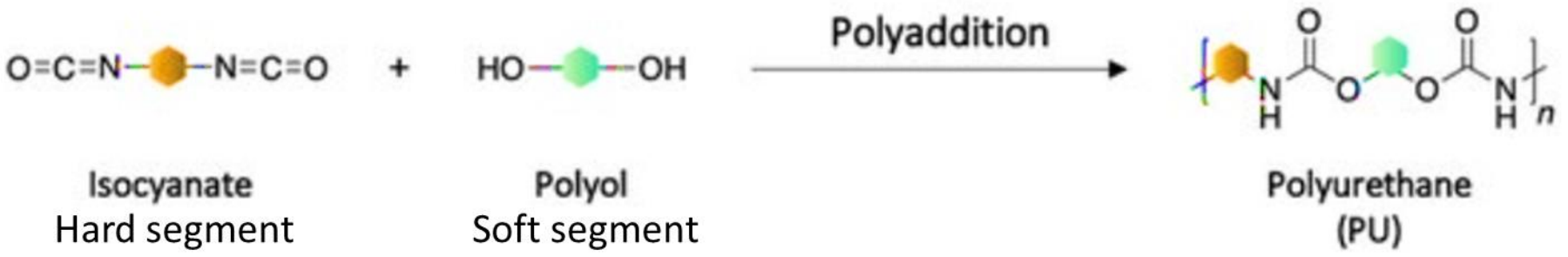


Elastane was chosen a model polyurethane. Elastane is an elastomeric polyurethane, meaning a large part (60-80wt%) is polyol, almost always of polyether type

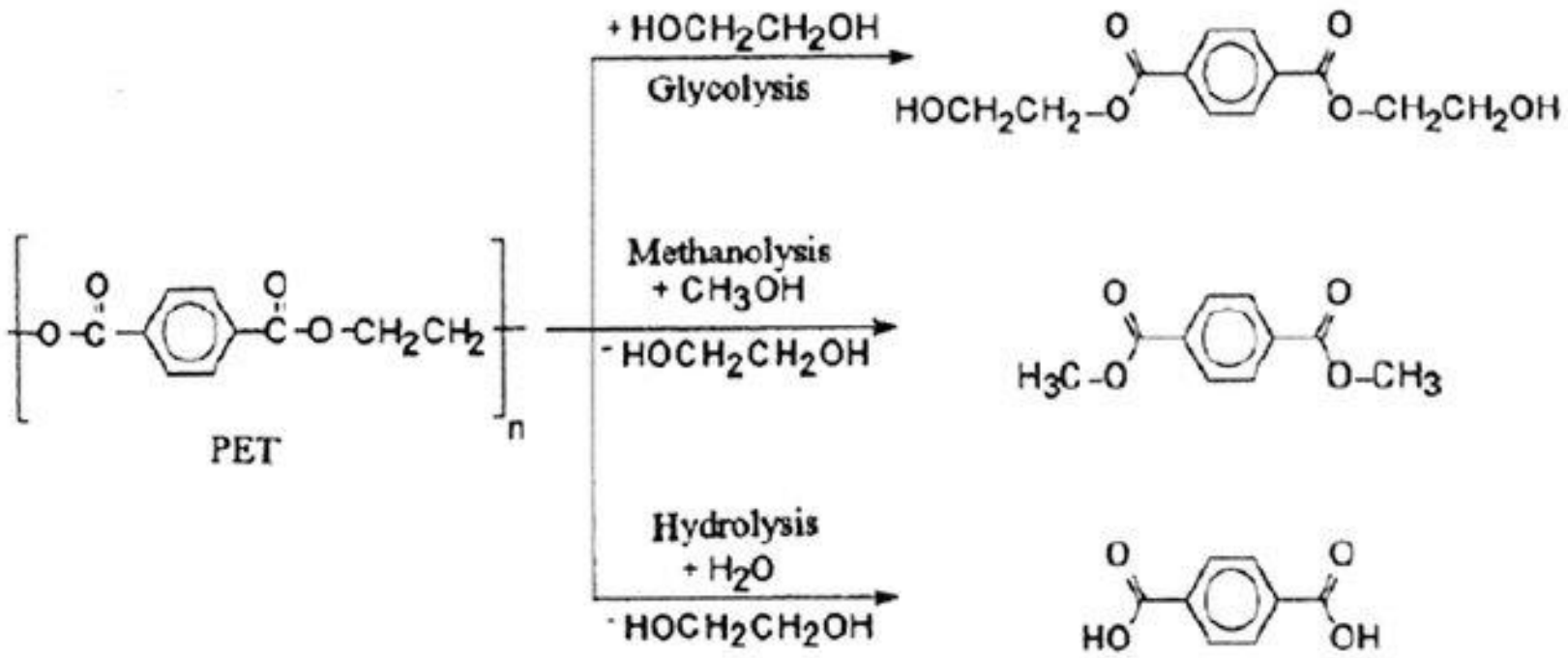
Recycling of elastane

Urethane (and urea) bonds are broken, liberating the hard and soft segments.

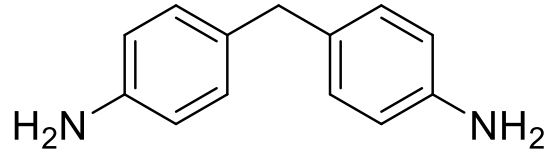
Hard segments are aromatic compounds, which, to some extent might form toxic arylamines. The soft segments are the polyols, which are recovered in the recycling process.



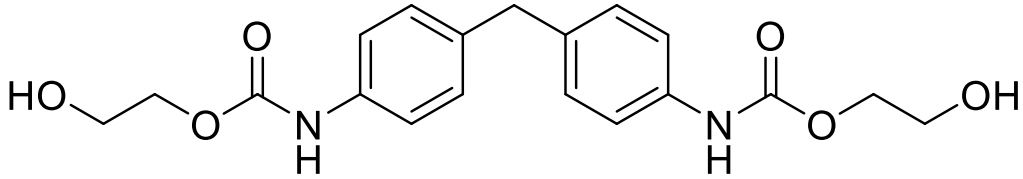
Recycling of PET



Aryl amine



MDA (4,4'-Methylenedianiline)
Toxic



Capped MDA
Nontoxic

The hard segments of elastane contains aromatic units. Different solvolytical conditions favor different end products.

MDA content was anlayzed in reaction solution. The starting material was ELA/PET in various ratios from 99/1 to 30/70.

ELA /PET ratio	MDA in reaction solution (wt%)
1/99	0.01
2/98	0.025
5/95	0.07
10/90	0.08
20/80	0.15

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Process A

- PET and PU are depolymerized simultaneously
- Polyol is recovered from elastane
- PET monomer is recovered from PET

Polyol yield: 50 wt%
PET monomer yield: 50 mol% (65 wt%).

Process C

- PET is selectively depolymerized
- Elastane is recovered as a solid

(Polyol yield: 55 wt%)
PET monomer yield: 95 mol%

Process B

- Elastane is dissolvd and discarded or used for polyol recovery
- Polyol (or nothing) is recovered from elastane
- PET monomer is recovered from PET

(Polyol yield: 55 wt%)
PET monomer yield: 75 mol% (100 wt%).

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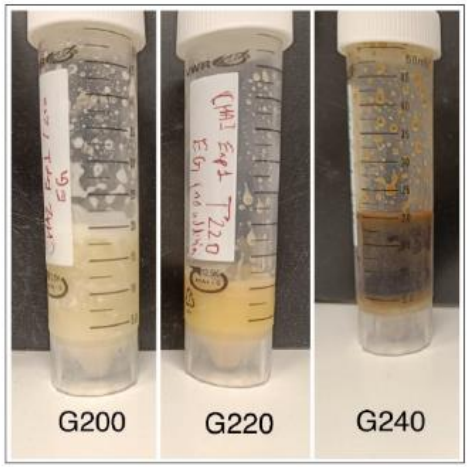
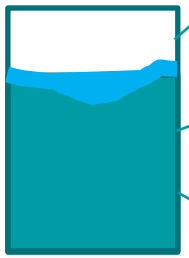


Figure 14 - Colour change for glycolysis after depolymerization



Solid oily phase → Crude PTMG → **Purification** → PTMG (Mw1800-2000)

Liquid → Diols in water mixture → **Recycling by distillation** → Diols (EG, PD)

Solid (when cooled) → BHET, HDS → **Purified by hot water** → BHET; HDS (waste)

HDS: hard segment of elastane
PTMG: poly(tetramethylene ether) glycol, soft segment of elastane
BHET: Bis(2-Hydroxyethyl) terephthalate, polyester monomer

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Outcome

- ❑Processes with selective degradation or dissolution are described
- ❑Polyol is not degraded during recycling
- ❑MDA contamination must be controlled
- ❑Catalysts should be optimized for the respective material streams
- ❑The initial LCA is not in favor of recovering minority material

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