



# Towards Polyurethane Circularity

An Assessment of Polyurethane Pyrolysis: Degradation Mechanisms, Products and Recycling Potential



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[www.wasteeng.org](http://www.wasteeng.org)



# Why is Polyurethane not circular already?



Rigid Polyurethane  
Foam (RPUF)



Flexible Polyurethane  
Foam (FPUF)



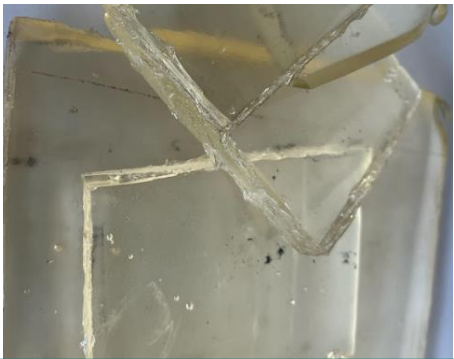
## Mechanical Recycling

- Thermoset properties
- Variety of PUR
- Additives
- Downcycling



## Chemical Recycling - Solvolysis

- PUR type-dependent processes
- Additives
- Product Yield



Cast Elastomer (CE)

- Coatings
- Adhesives
- Thermoplastic PUR
- ...

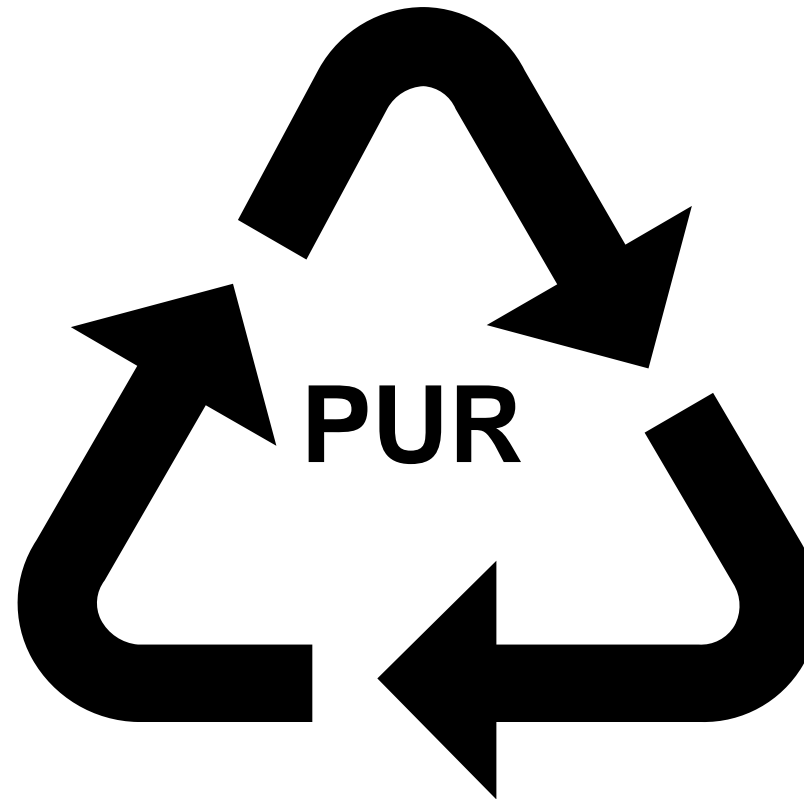
many more...

Can Pyrolysis make PUR circular?

# Can Pyrolysis make Polyurethane circular?

Yields 

Products 

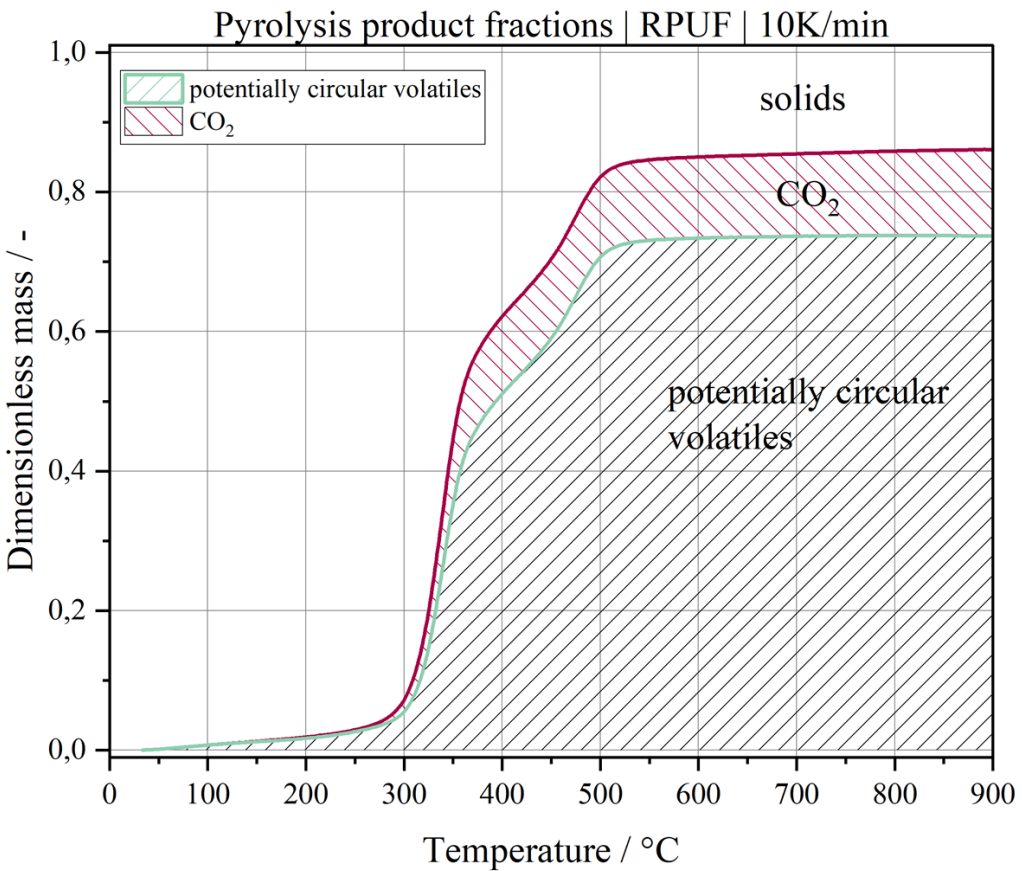


Mechanisms

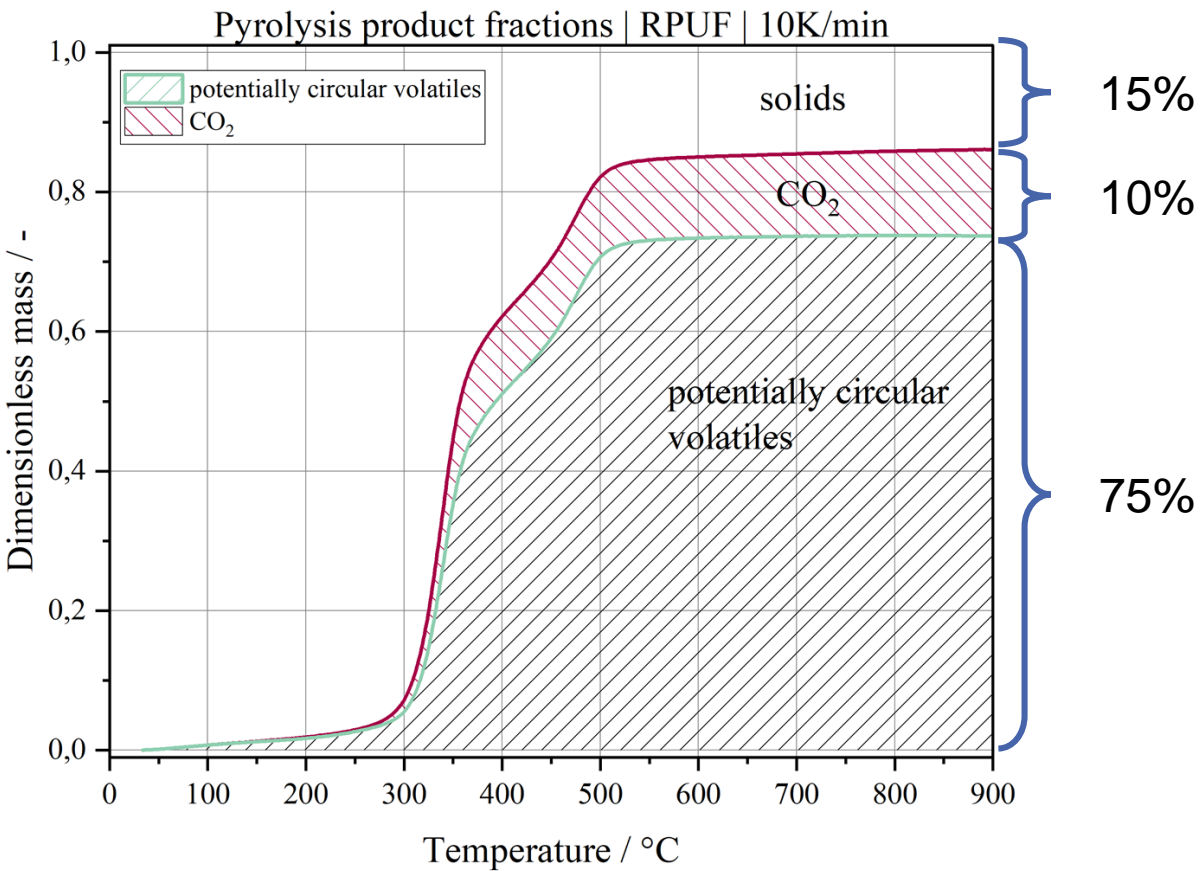


# Yields

### Thermogravimetry

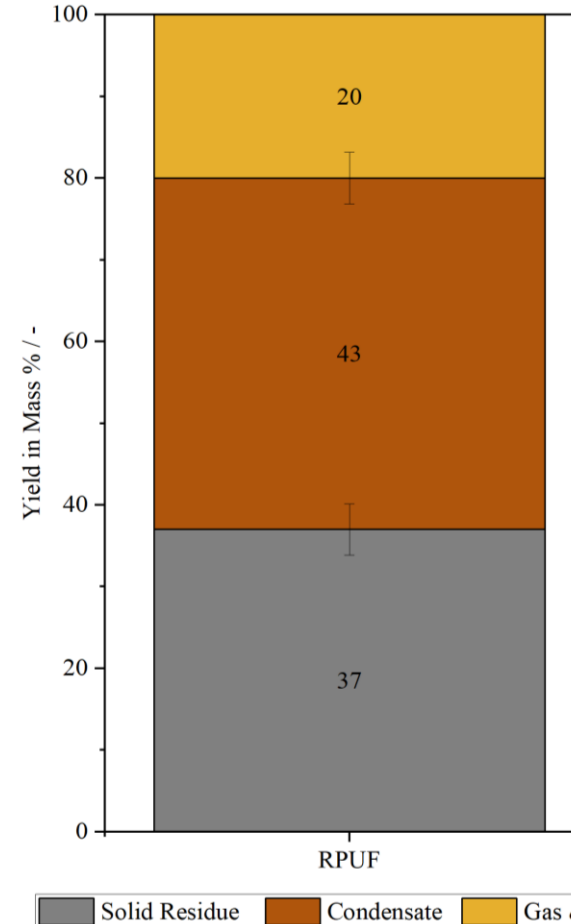
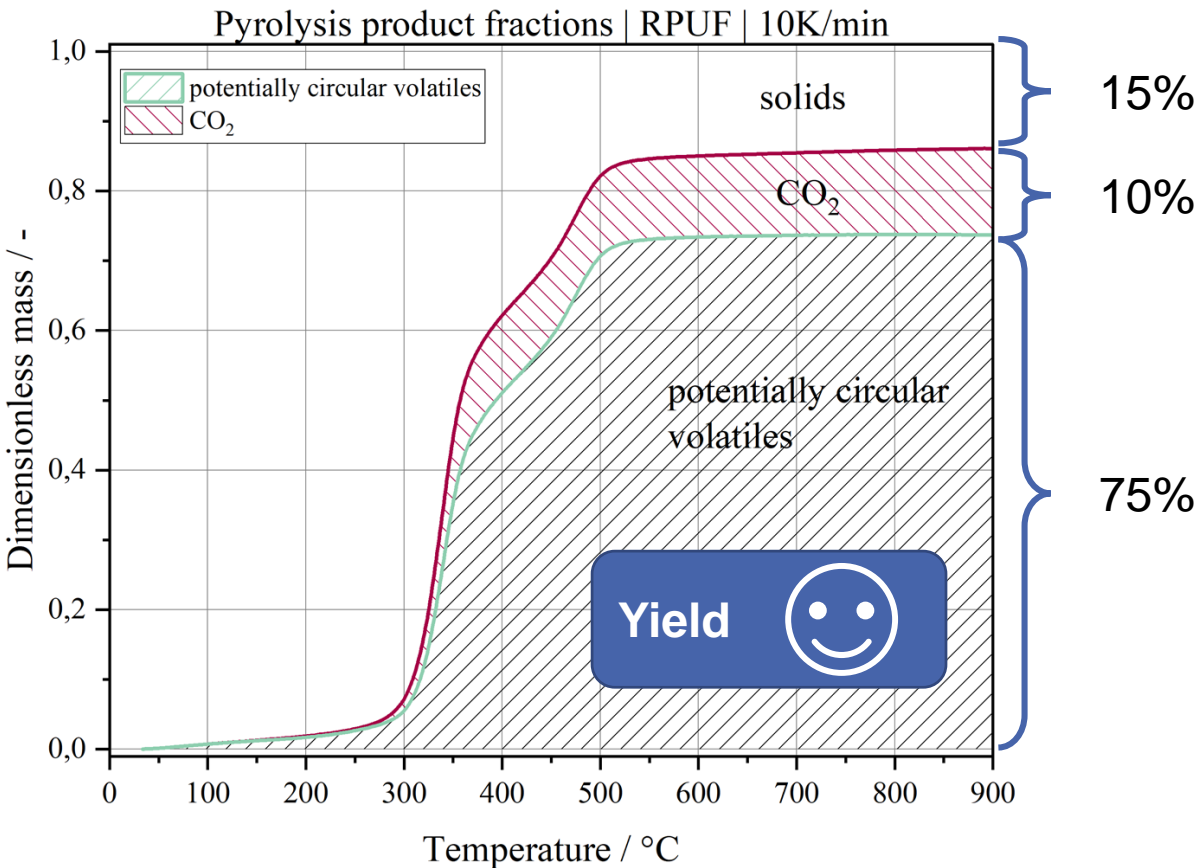


## Thermogravimetry



## Thermogravimetry

## Lab-scale Pyrolysis @ 450 °C

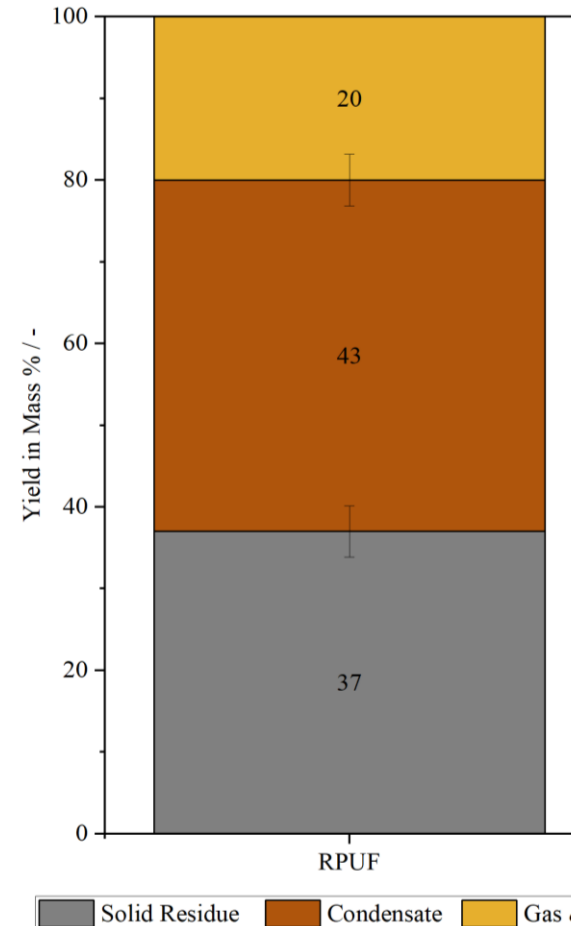
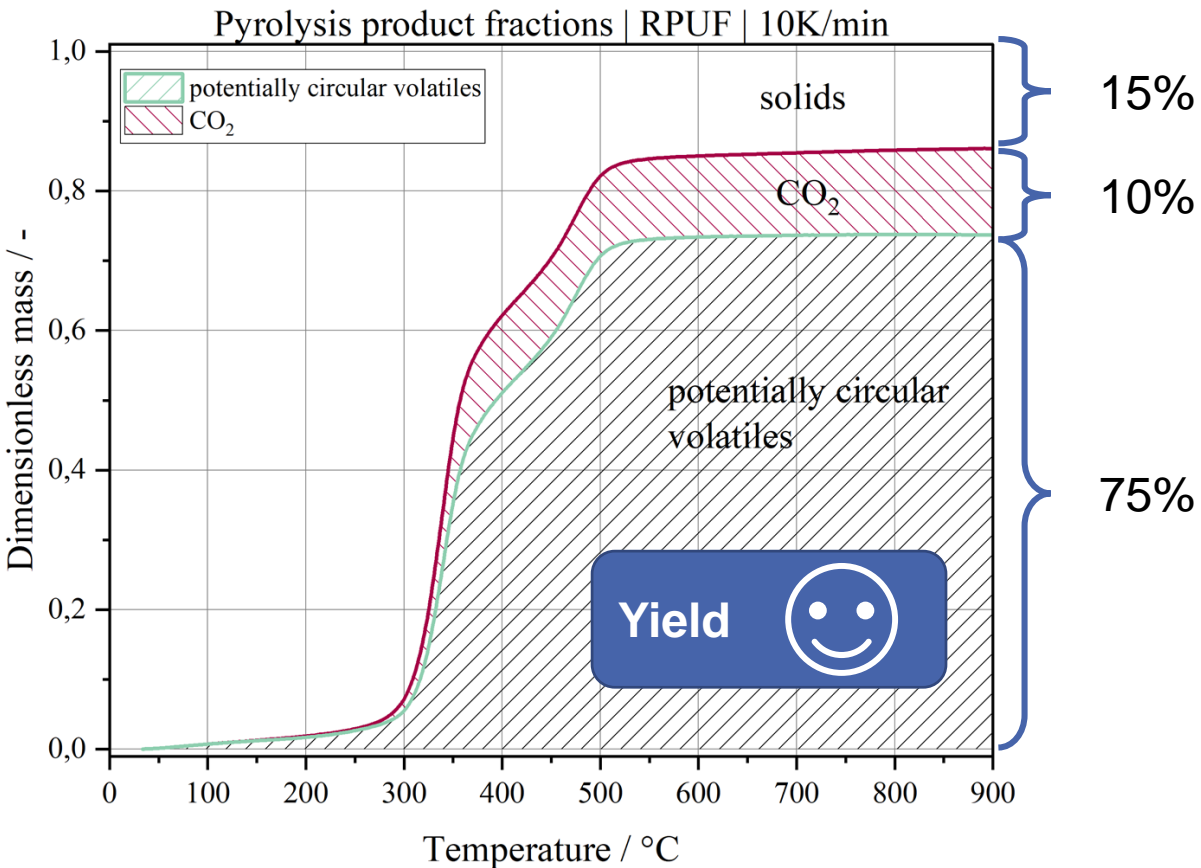


### Current research:

- Reaction Temperatures
- Temperature Profiles
- Residence Times
- Reactor Technologies

## Thermogravimetry

## Lab-scale Pyrolysis @ 450 °C



### Current research:

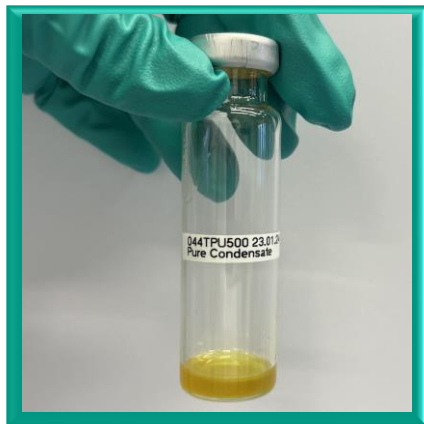
- Reaction Temperatures
- Temperature Profiles
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Yield





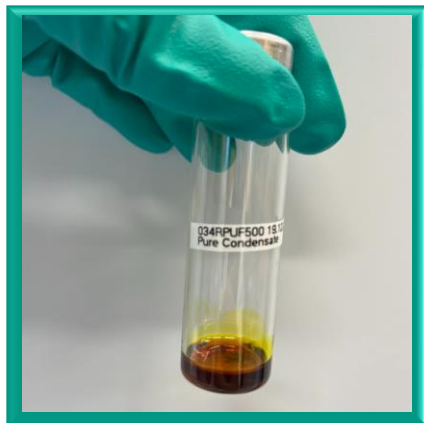
### Thermoplastic PUR



### Cast Elastomer



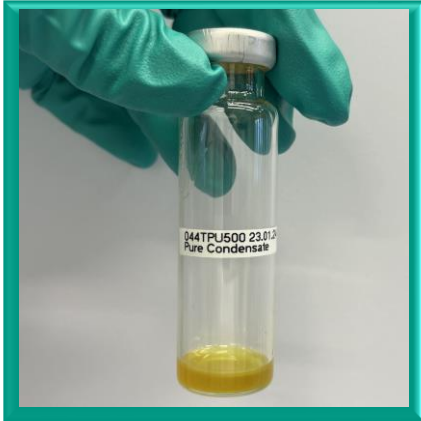
### Rigid PUR Foam (RPUF)



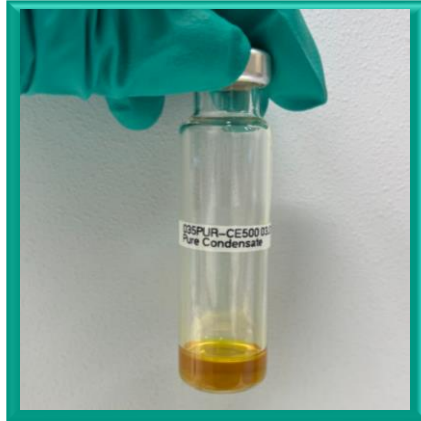
### Flexible PUR Foam



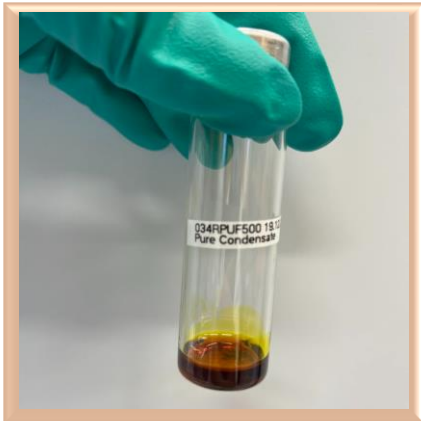
Thermoplastic PUR



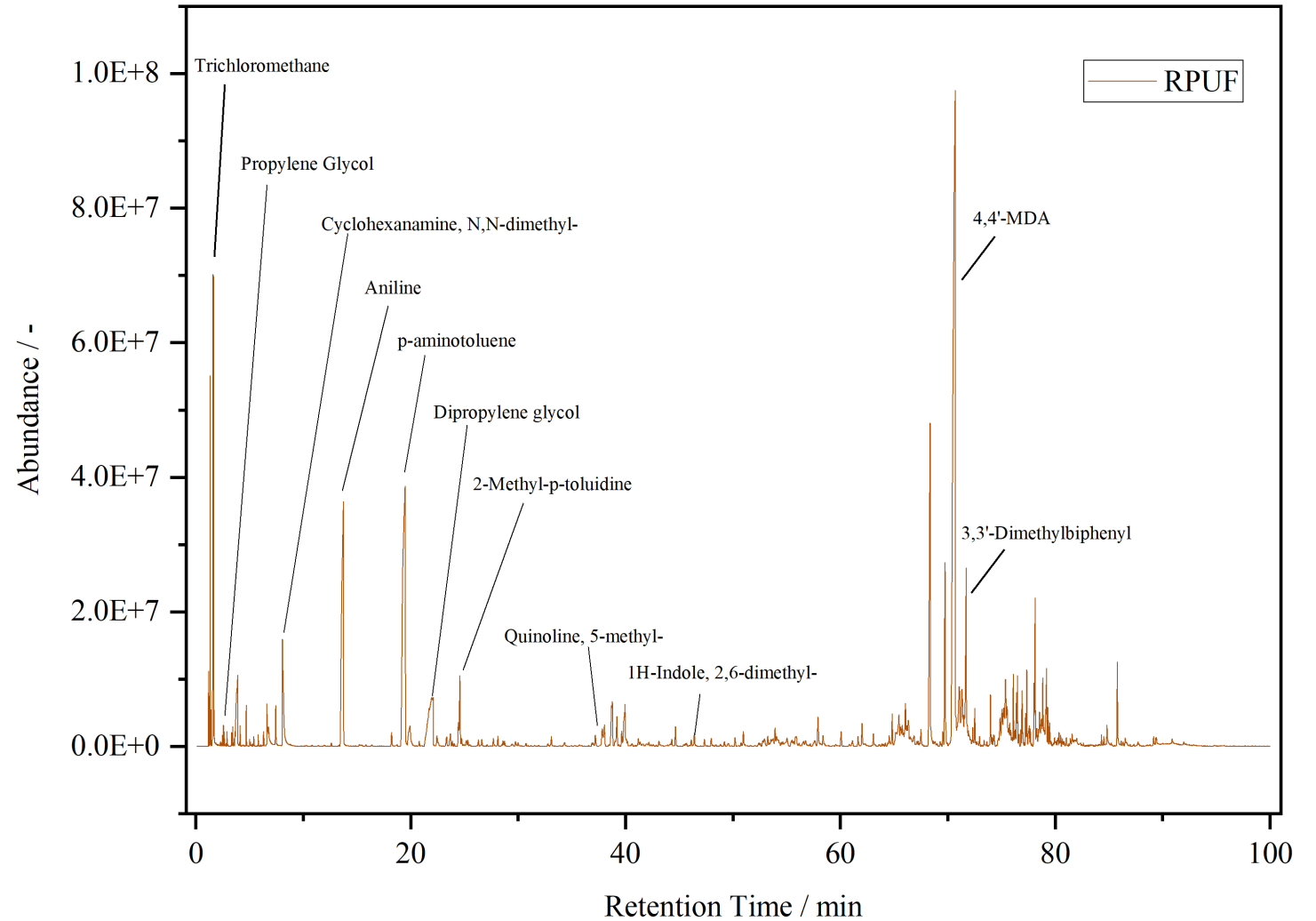
Cast Elastomer



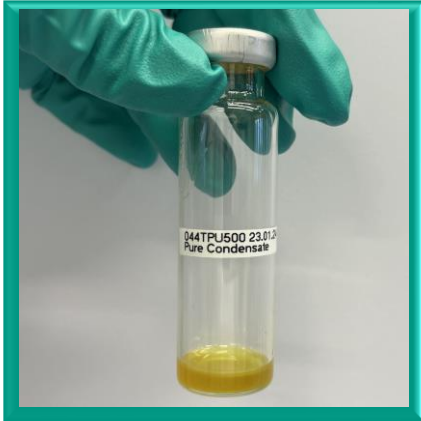
Rigid PUR Foam (RPUF)



Flexible PUR Foam



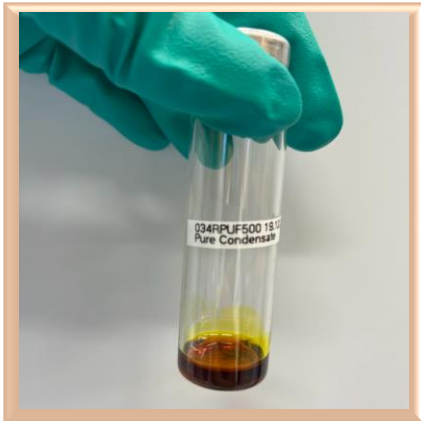
### Thermoplastic PUR



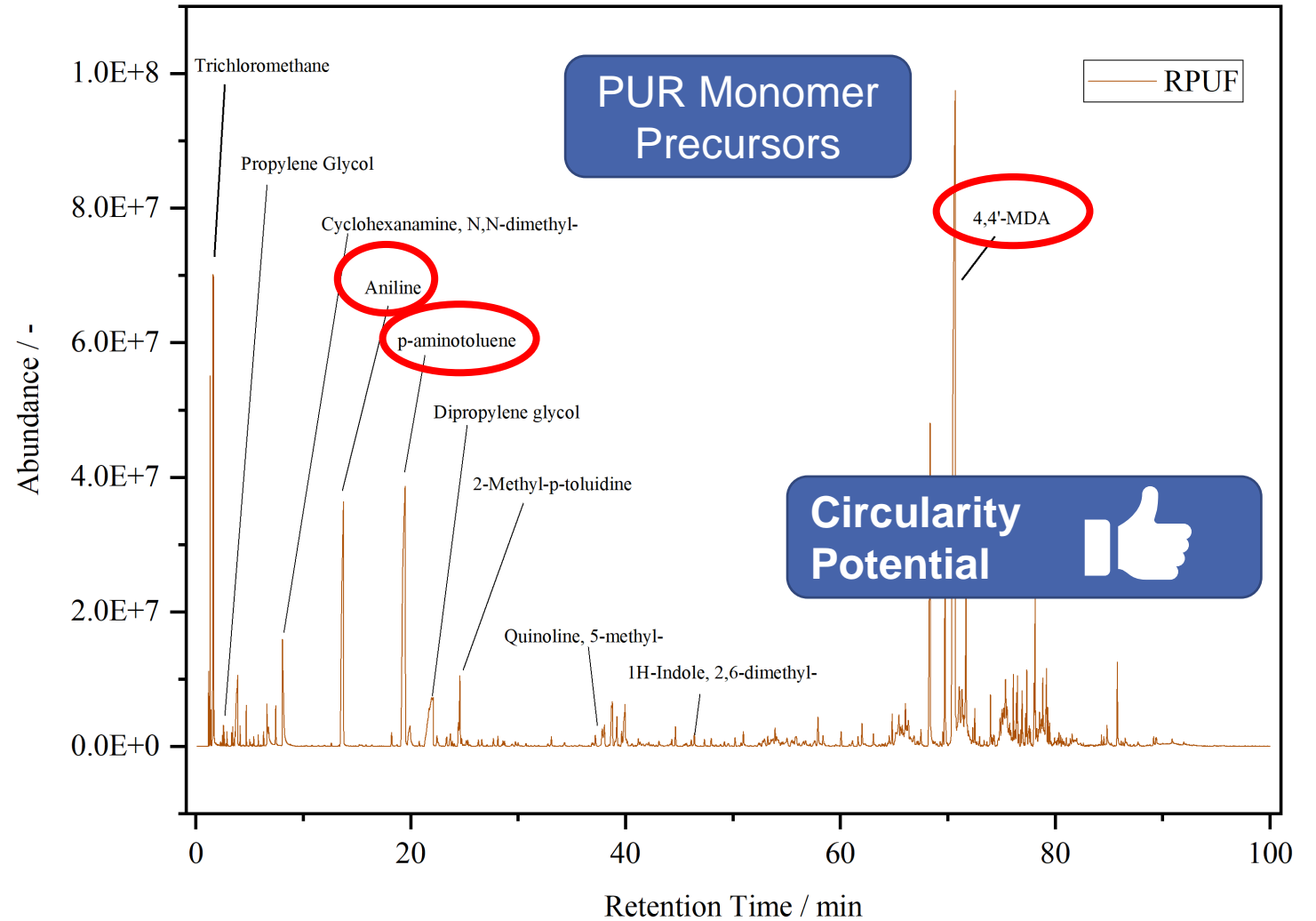
### Cast Elastomer



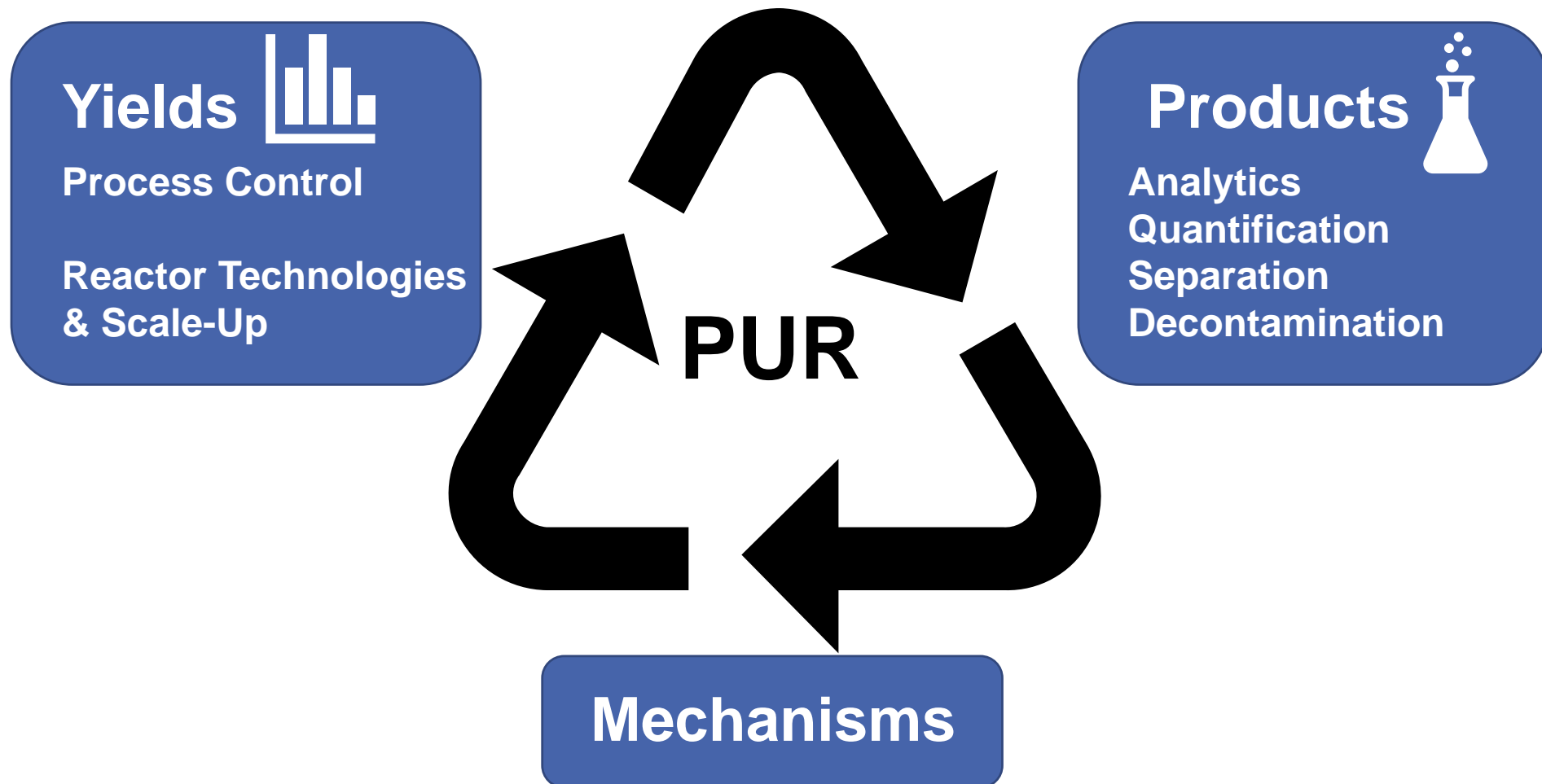
### Rigid PUR Foam (RPUF)



### Flexible PUR Foam



# Can Pyrolysis make Polyurethane circular?



# ITC @ WasteEng 2024

Scan me!



**Michael Zeller**

Oral Flash #54

Circular  
Polyurethane  
by Pyrolysis



**Niklas Netsch**

Oral #53

Mixed Plastic  
Pyrolysis



**Razan  
Alsharqawi**

Oral #52

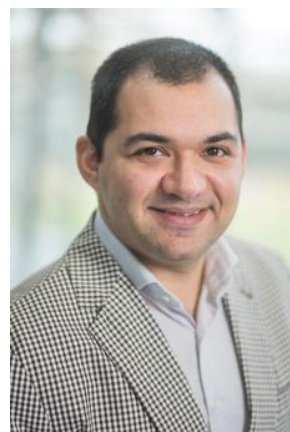
Brominated Flame  
Retardants  
in Pyrolysis



**Malte Hennig**

Oral #58

Value chain  
integration of  
pyrolysis  
products



**Dr.-Ing Salar  
Tavakkol**

Group Leader  
Pyrolysis  
Technology



**Prof. Dieter Stapf**

Head of  
Institute for Technical  
Chemistry  
KIT