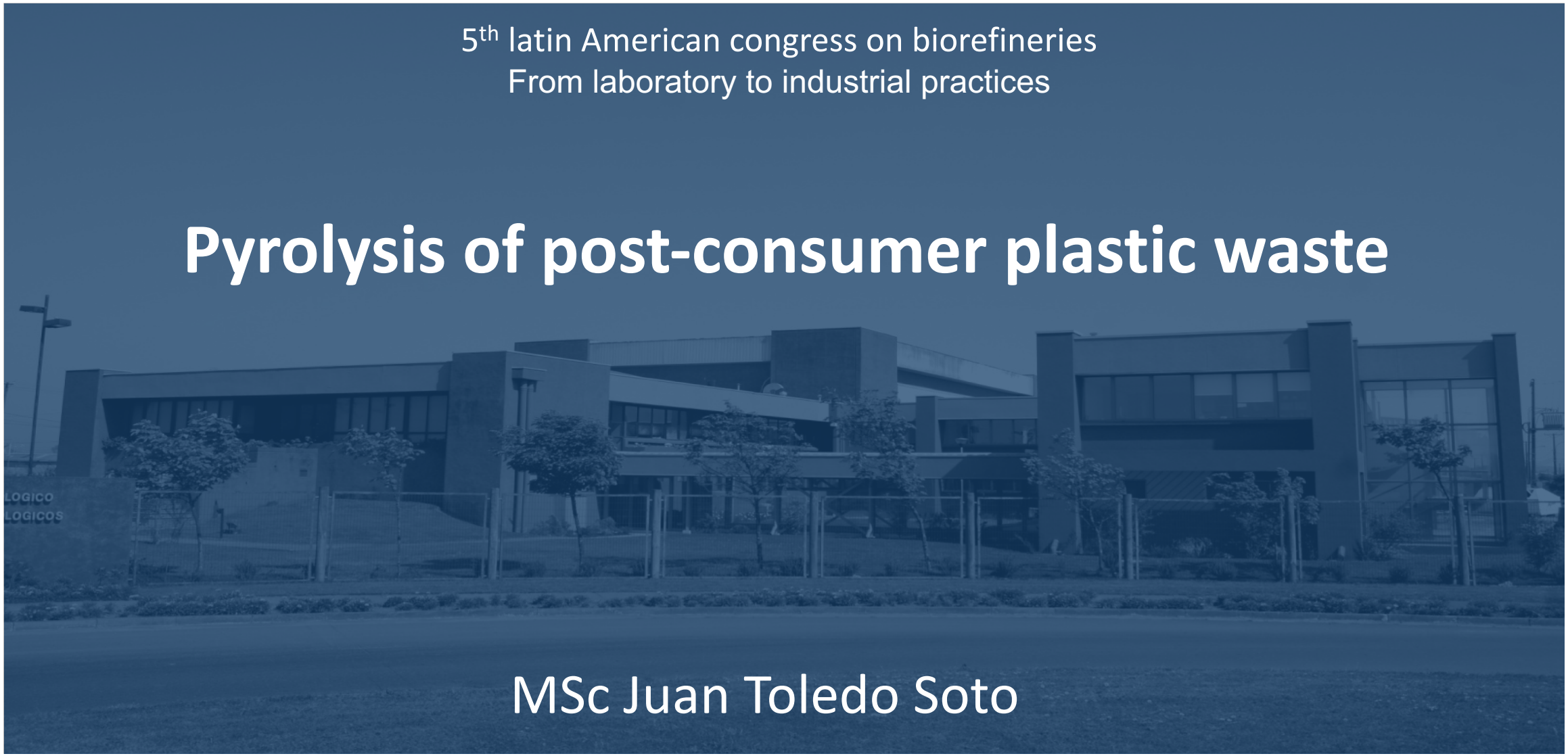
5th latin American congress on biorefineries
From laboratory to industrial practices

# Pyrolysis of post-consumer plastic waste



MSc Juan Toledo Soto

# Presentation content

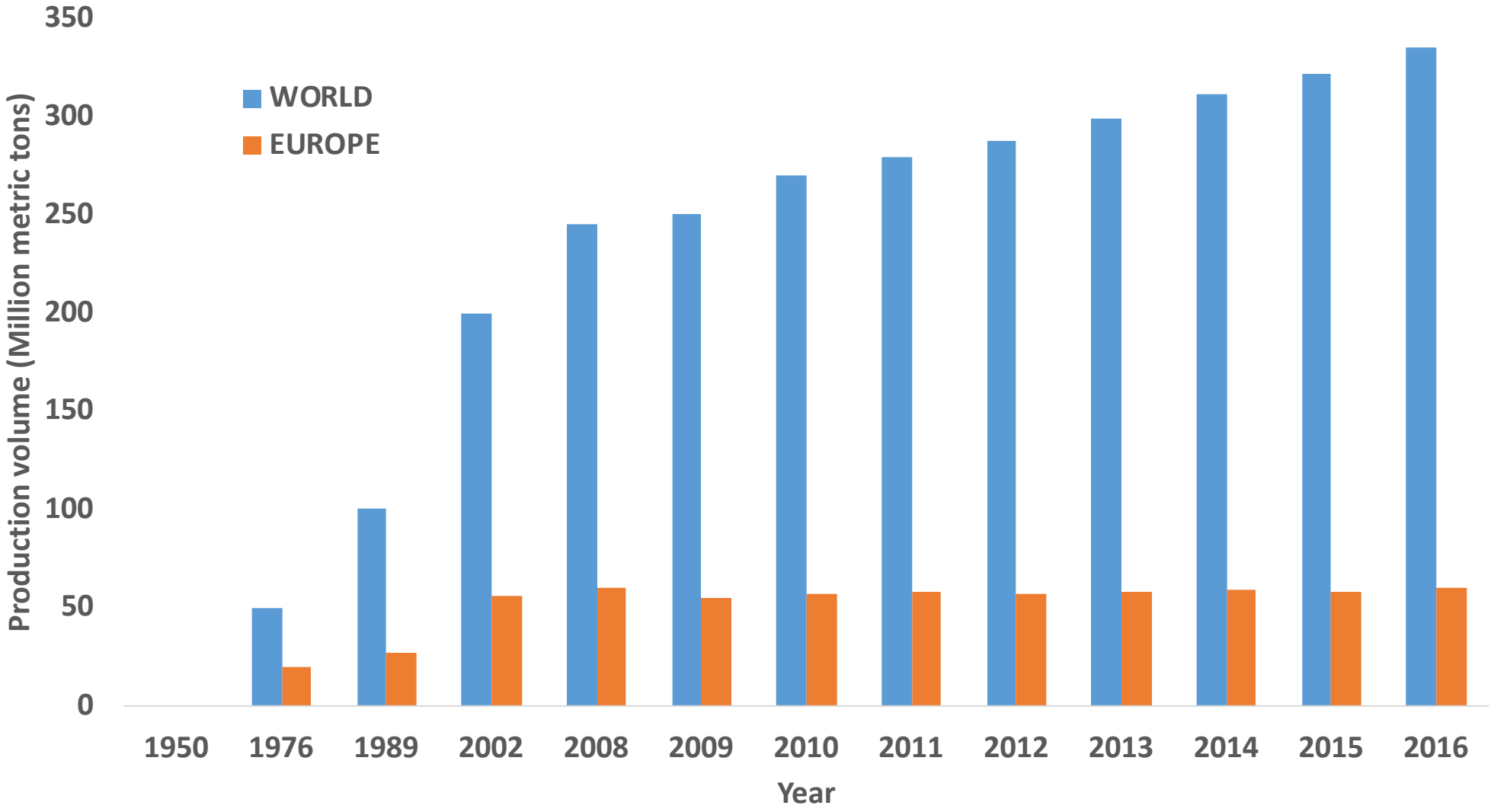
1. Plastic production and management
2. Pyrolitic degradation
3. Technology developed by UDT
4. Different products and applications

Nestlé

# Plastic production and management

# Plastic production and management

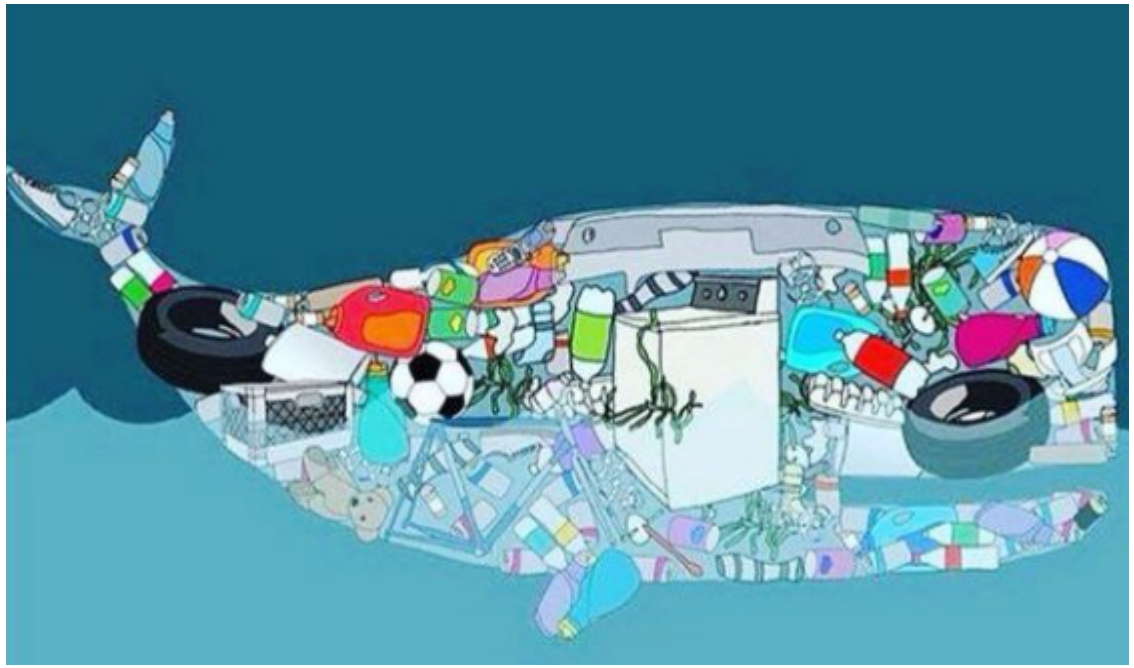
- Worldwide plastic production




Source: Adapted from https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/

# Plastic production and management
## Non sustainable plastic use…

Source: https://www.geosynthetica.net/india-vertical-expansion-landfill-strata/



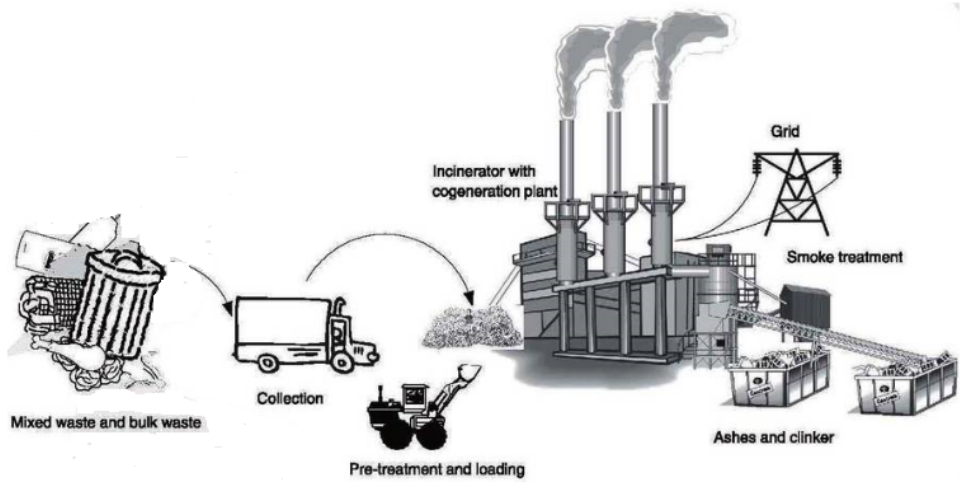
Source: http://msascienceonline.weebly.com/plastic-oceans.html

# Plastic production and management
## What developed countries do with plastic?

Landfilling

1 PETE
2 HDPE
3 V
4 LDPE
5 PP
7 OTHER


Mechanical recycling facilities



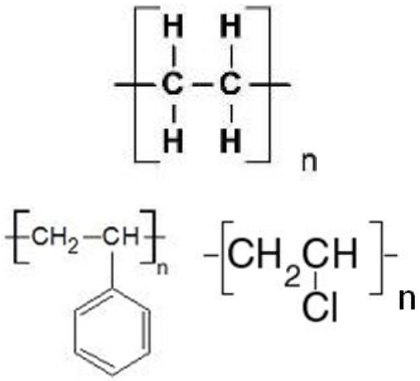

Energy recovery facilities

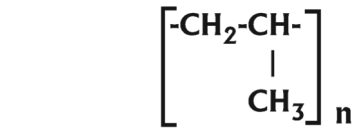
# Plastic production and management

## Plastic pyrolysis

Energy

Oxygen free atmosphere

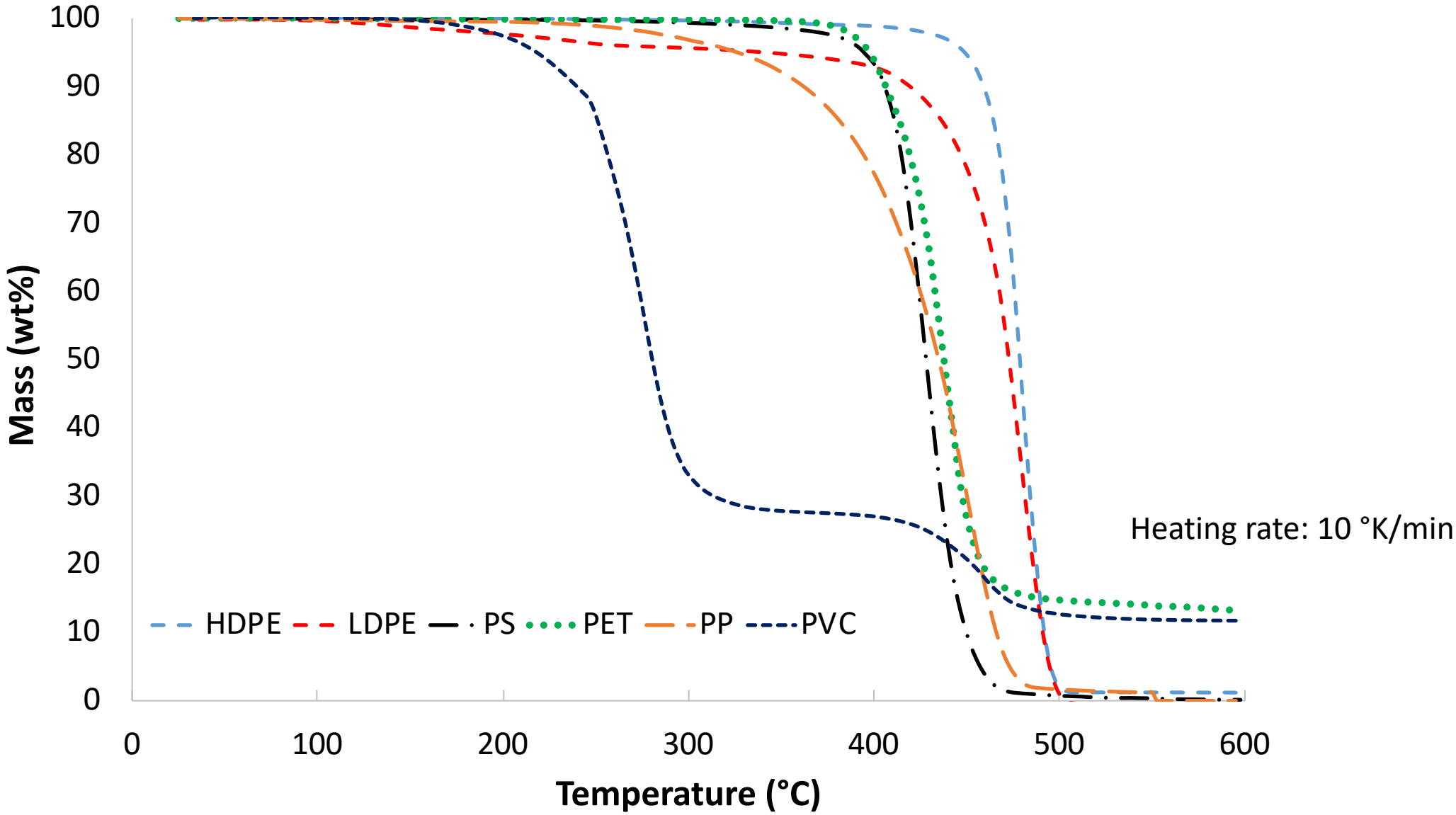




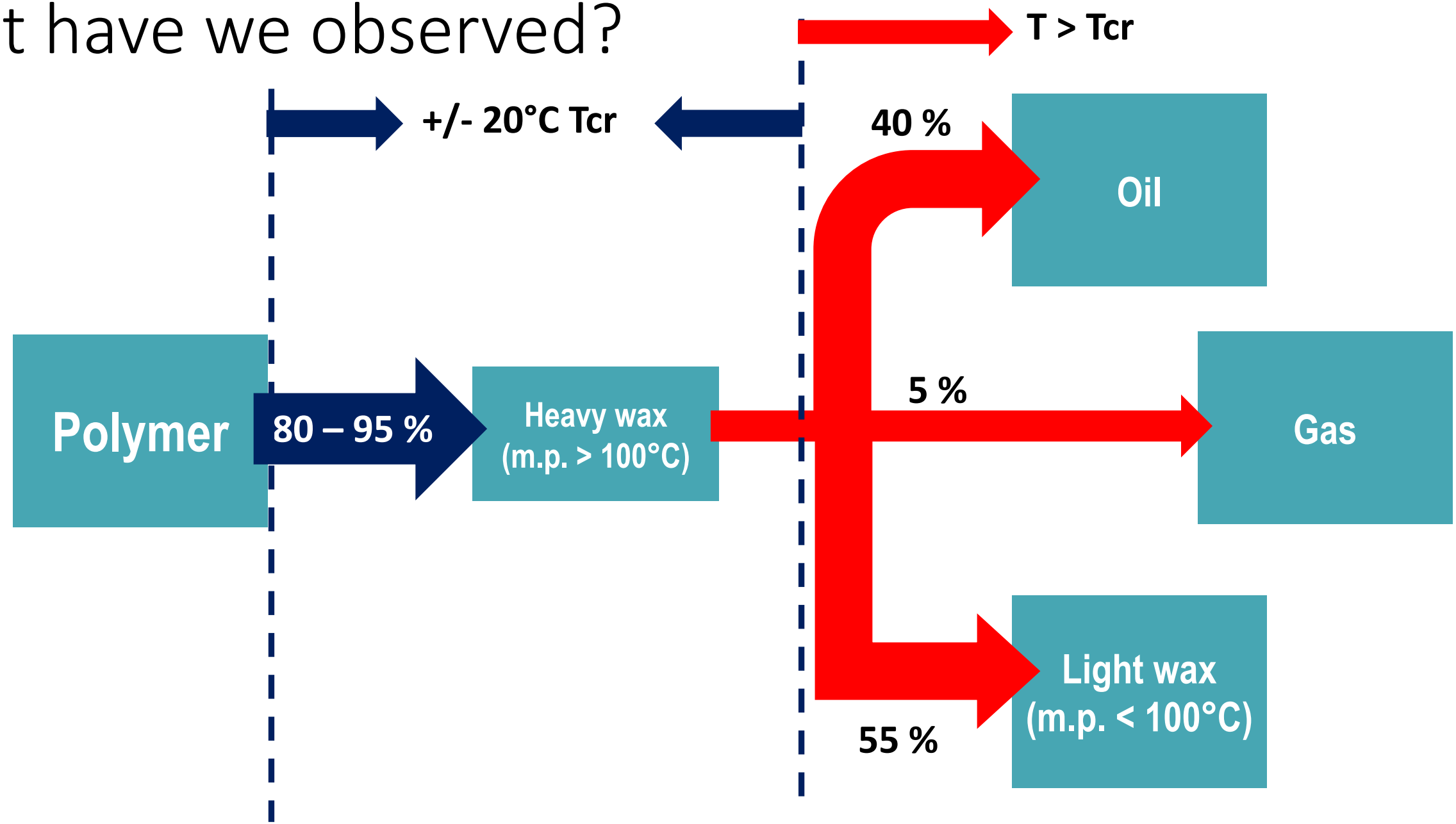
# Pyrolysis degradation mechanism

# Pyrolysis degradation mechanism

## what have we observed?

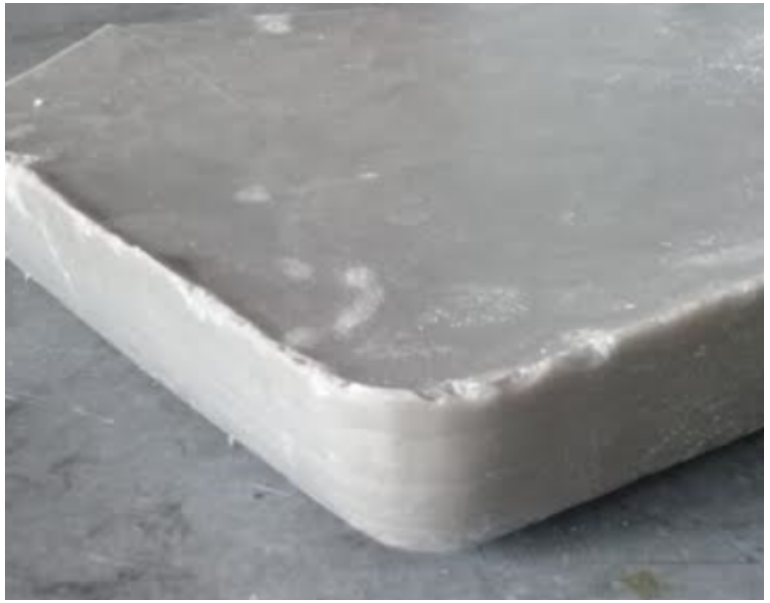


# Pyrolysis degradation mechanism what have we observed?



# Pyrolysis degradation mechanism

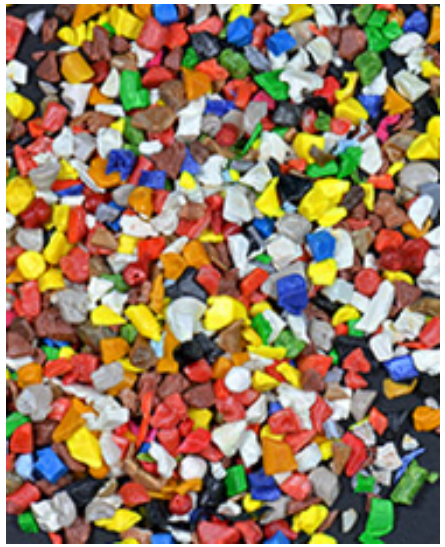
Typical products obtained from HDPE, LDPE and PP pyrolysis


Source: UDT – Chile.

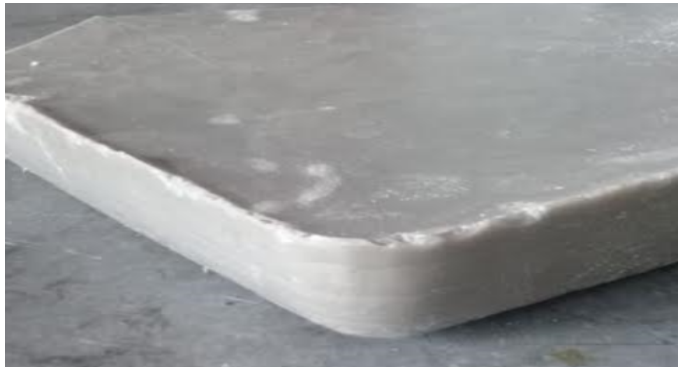
# Technology developed by UDT

# Global picture… different challenges



Raw materials market

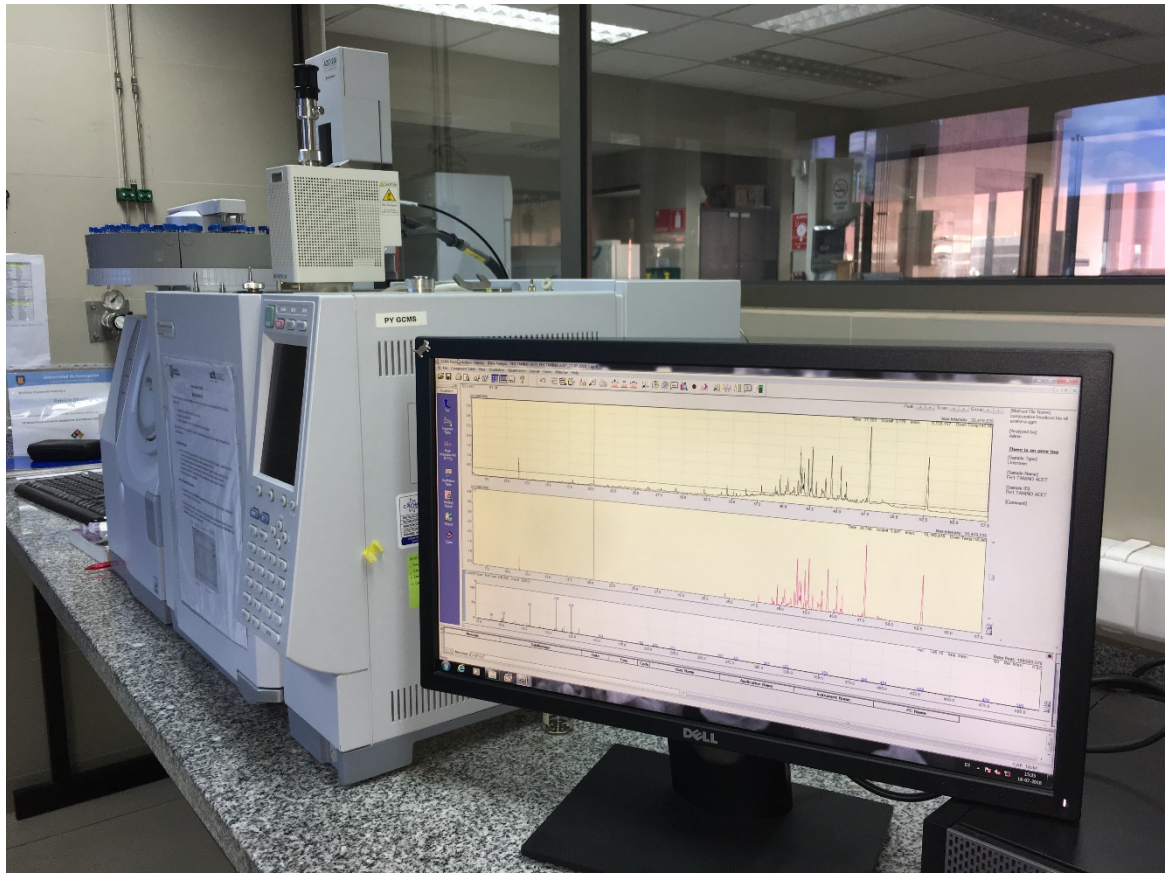
Pyrolysis reaction (400-500 °C) 50-100 mbar

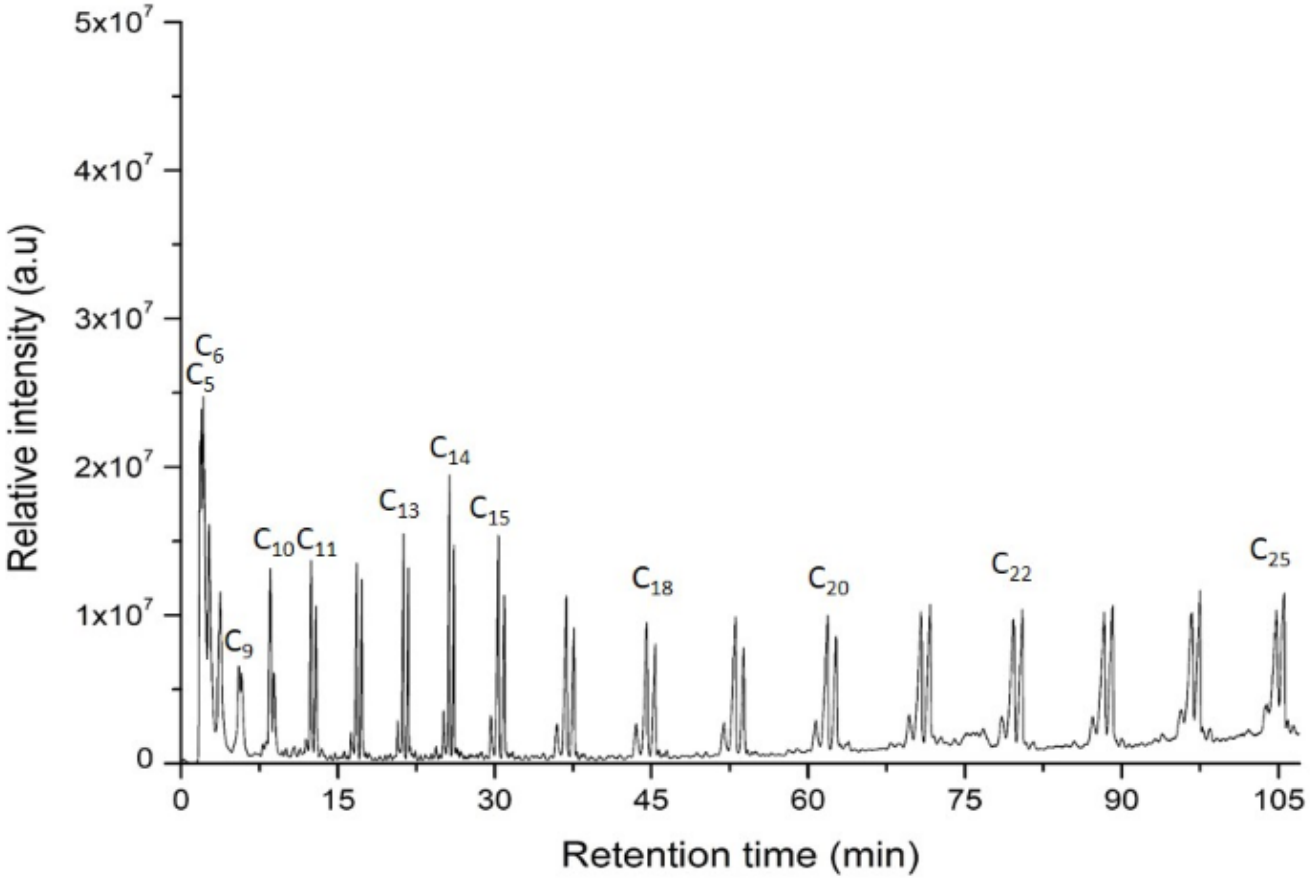


Products market

# From the laboratory to the industrial plant

- Py-GC-MS



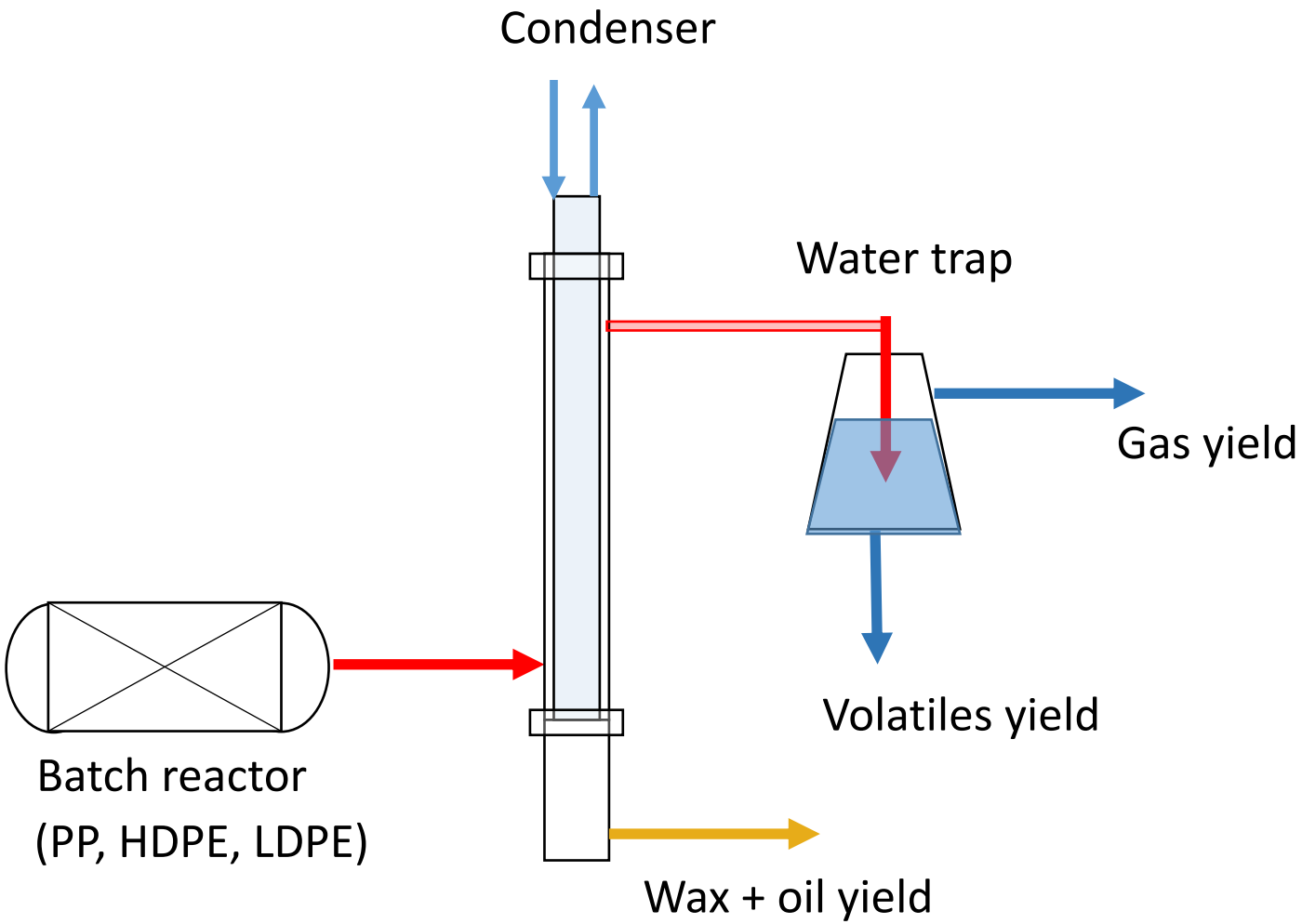




Source: UDT – Chile.

# From the laboratory to the industrial plant

- Bench scale (Batch)

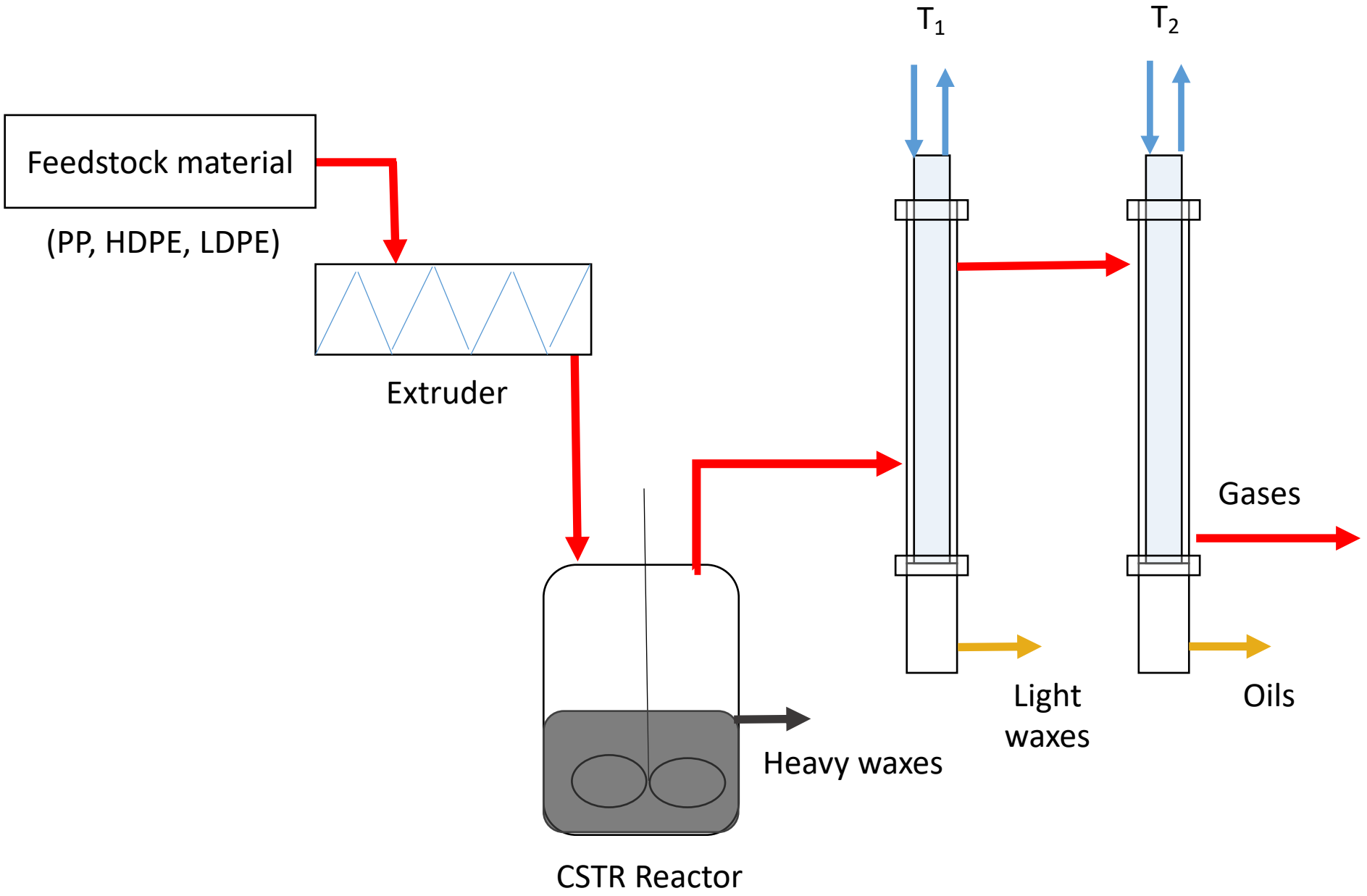

Source: UDT – Chile.


Condenser
Water trap
Gas yield
Volatiles yield
Batch reactor
(PP, HDPE, LDPE)
Wax + oil yield

# From the laboratory to the industrial plant

- Pilot plant (continuos process)

Source: UDT – Chile.


Feedstock material
(PP, HDPE, LDPE)
Extruder
CSTR Reactor
Heavy waxes
$T_1$
$T_2$
Light waxes
Oils
Gases

# Different products and applications

# Products and applications

**Gases:**

- Process fuel

Table 2 Products from the Pyrolysis of Polyolefins (PE, PP) and mixed plastics (Mix) in wt%

| Temperature | 530 | 510 | 510 |
|---|---|---|---|
| Feed | PE | PP | Mix |
| Ethylene/Ethane | 2,8 | 1,5 | 1,1 |
| Propylene | 1,8 | 3,0 | 1,5 |
| Other gases | 3,0 | 1,8 | 2,1 |
| $C_5$-$C_{10}$ | 6,9 | 15 | 14 |
| $C_{11}$-$C_{20}$ | 9,9 | 13 | 5,7 |
| Aromatics | 0,3 | 0,1 | 0,1 |
| Waxes | 75,3 | 65,6 | 75,5 |

Source: Kaminsky “Feedstock recycling by pyrolysis of plastics in a fluidized bed”

Gases heat of combustion = 47 MJ/kg

# Products and applications

**Oils:**

- Diesel-like fuel
- Lubricant
- Industrial fuel

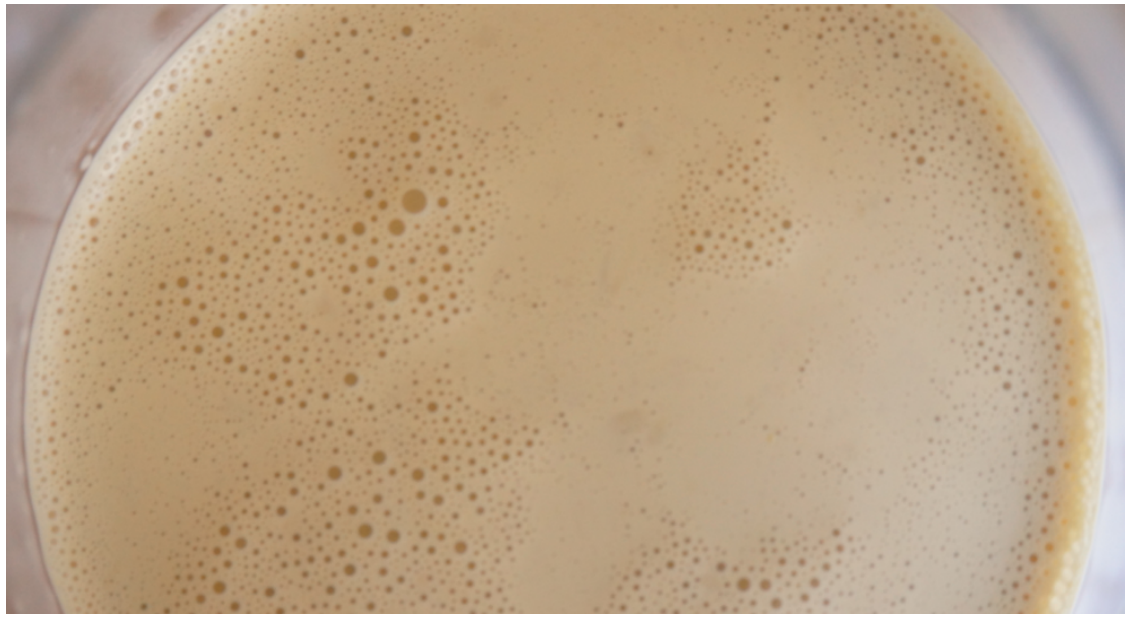
| | | Pyrolysis oil from: | | |
|---|---|---|---|---|
| | | HDPE | LDPE | PP |
| Water content | % | 3,6 +/- 1 | < 0,5 | <0,5 |
| Heat of combustion | J/g | 44.201 | 45.049 | 45.485 |
| | | +/- 67 | +/- 87 | +/- 120 |
| Ashes | % | < 0,05 | < 0,05 | < 0,05 |
| Sulfur content | % | < 2 | < 2 | < 2 |

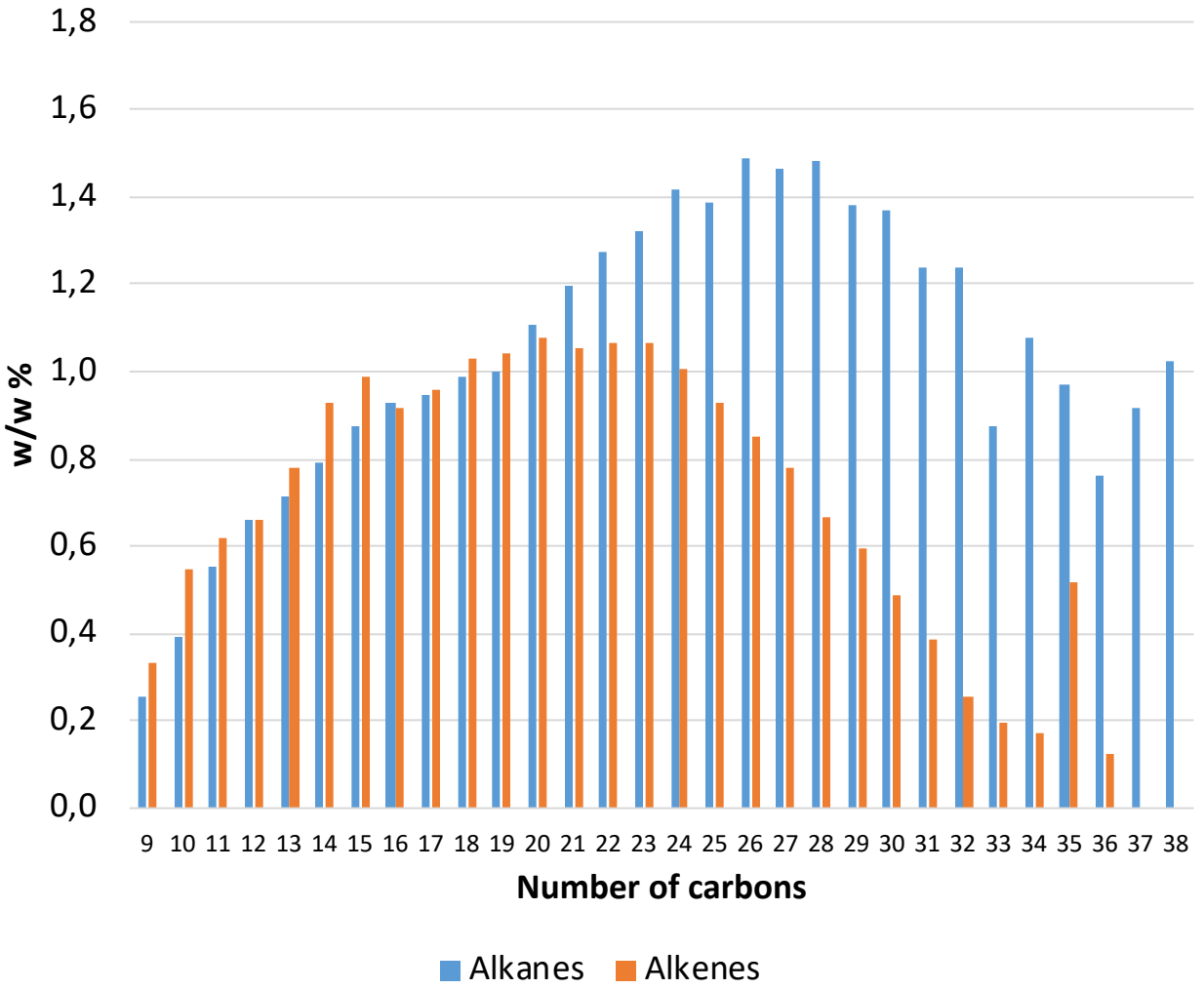
Source: UDT- CORFO, Chile. INNOVA 13IDL2-18714 Project final report.

# Products and applications

**Light waxes:**

- Emulsions for fiberboard industry.
- Phase change material.





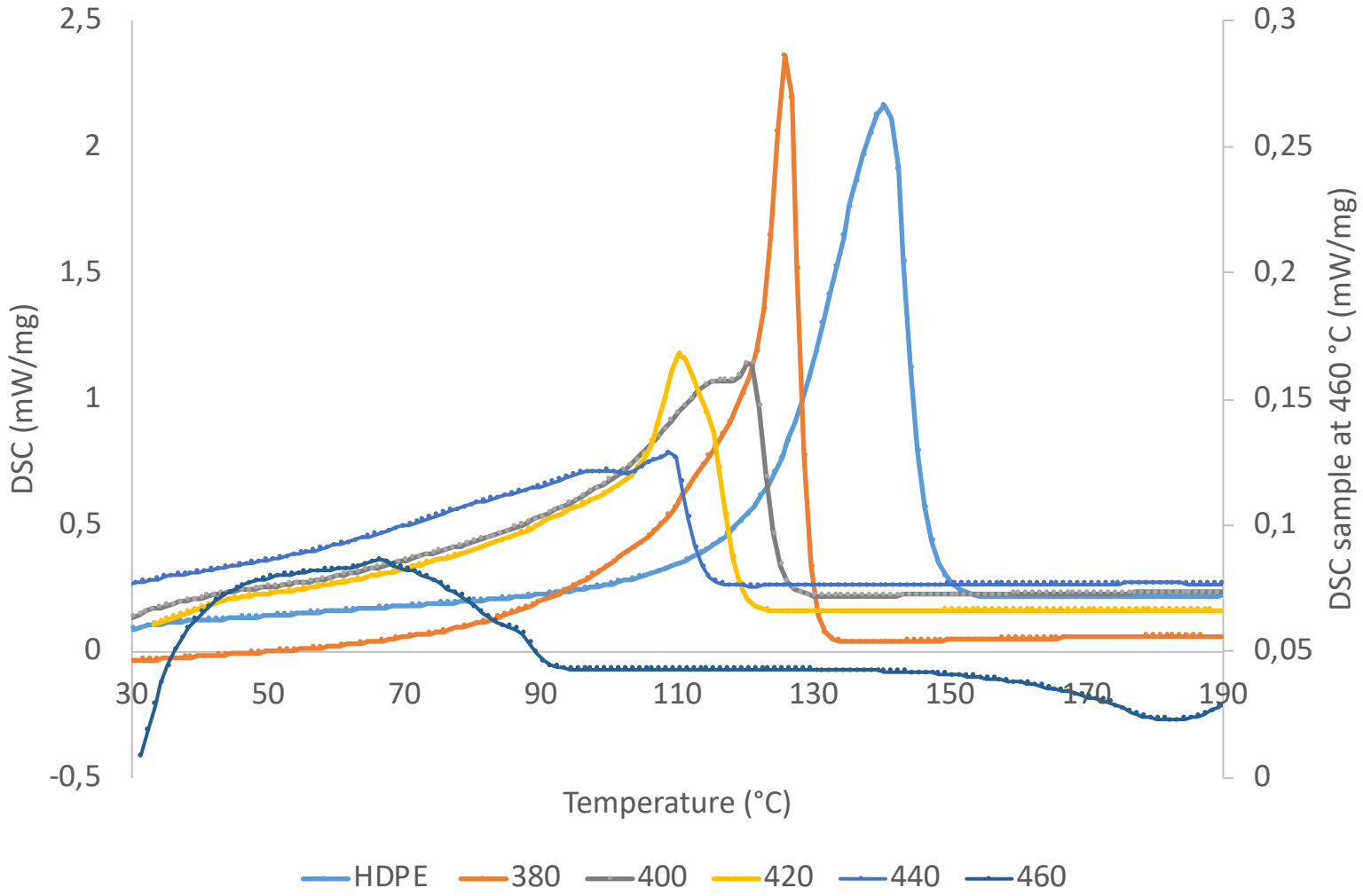

Source: Paraffin wax simple: HDPE Pyrolysis at 450 °C and 100 mbar.

# Products and applications

**Heavy waxes**

Additives in:

- Rubber industry.
- Adhesive industry.
- Masterbatch industry.




DSC results from HDPE pyrolysis at different temperatures
Source: UDT – Chile.

# Conclusions

What we have learned…

- How to do and control thermal degradation.
- How to obtain different product fractions from pyrolytic gases.
- How to scale up the technology.
- How to control safety risks.
- How to assess raw material and how to pre-treat them.

# Thank you


Source: https://www.flickr.com/photos/sepponet/1283094869

5° Congreso Latinoamericano sobre

# Biorrefinerías

**Desde el laboratorio a la práctica industrial**

7, 8 y 9 de enero de 2019, Concepción, Chile

# Bioeconomía

Ciencia, Tecnología e Innovación