Recycling the 'Unrecyclable‘: compatibilisation of mixes plastic sources

Workshop Ghent – November 12th 2015

VKC-CENTEXBEL

At the service of the industry

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VKC
a division of CENTEXBEL

Centexbel

- Collective research and technical centre
  - Governed by the industry
- Membership organisation
  - Belgian textile companies
  - Associated (international) member companies and organisations
- Staff
  - 150 skilled and highly educated men and women

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VKC - Centexbel

- VKC, a division of Centexbel, expands our services to the plastic industry
  - Technological advice
    - materials, finished products and recycling
  - Material characterisation
  - Plastic processing platform
    - injection moulding, extrusion, thermo-forming
  - Training

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Expertise

- Materials
  - (Bio-based) polymers, (nano)additives,…
  - Material characterisation
  - Durability aspects
  - Processing: melt processing (compounding, injection moulding, extrusion, compression moulding,…), recycling, functionalization
- End products: light weight, multilayer & composites, design for recycling…
- Product & process optimization, applications

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PLASTIC INDUSTRY

Important sector of the European economy

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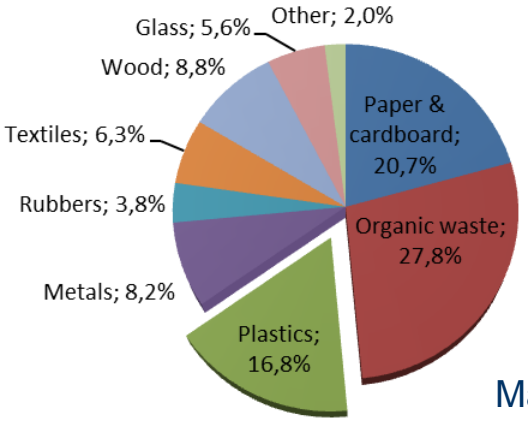
Plastic industry in Europe

- End-users
  - Packaging sector (39,4 %)
  - Automotive (8,3 %)
  - Electrical & electronic (5,4 %)
  - Building & construction (20,5 %)
  - Medical, leisure and other (26,4 %)

Plastic industry in Europe

- 5 high-volume families: PE, PP, PVC, PS, PET → 75 % of all EU plastic demand
  - Significant increasing influence on waste streams
  - 150 million tons (16,8 %) of the municipal waste generated EU-27 = plastics



Materials in discarded MSW (EUROSTAT)

PLASTIC RECYCLING

HOT TOPIC

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Plastics recycling

- Revised EU Waste Framework Directive
  - minimum recycling target of 50 % for household waste and 70 % for building and construction waste, which must be reached by all EU Member States, by 2020 for each of the different materials, including plastics

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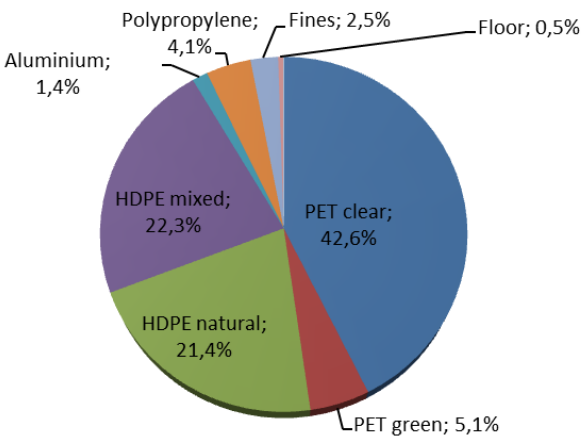
Plastics recycling

- In principle all resins are accepted for recycling
- Economics dictate that only PET, HDPE and PP are recovered for recycling purposes
- PET = most



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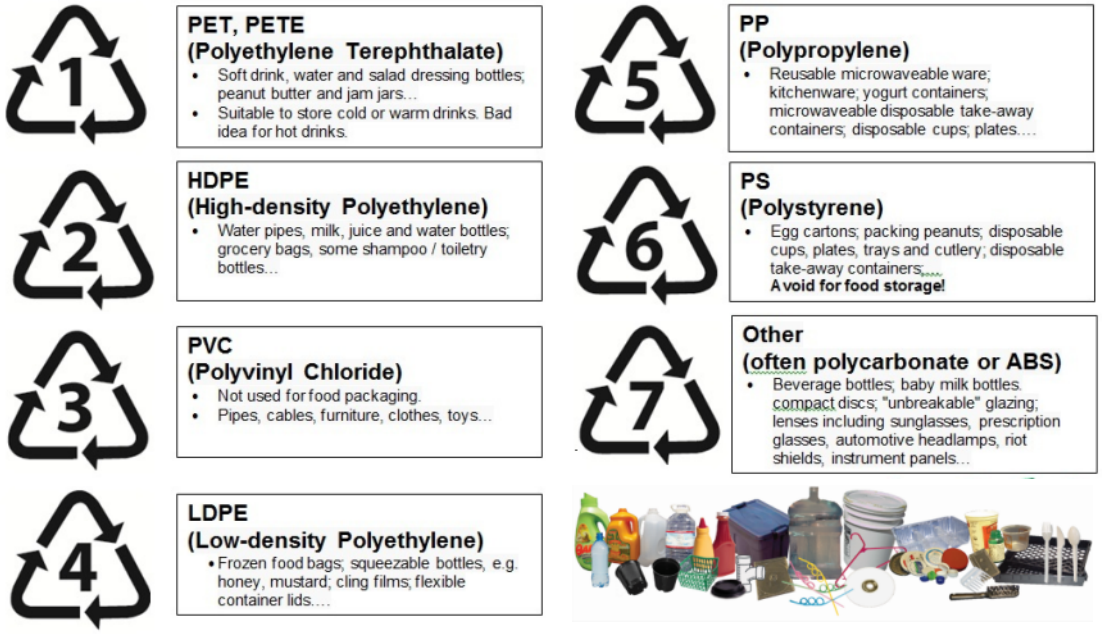
Plastics recycling

- Success of plastic recovery = proper collection of plastic waste



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Plastics recycling

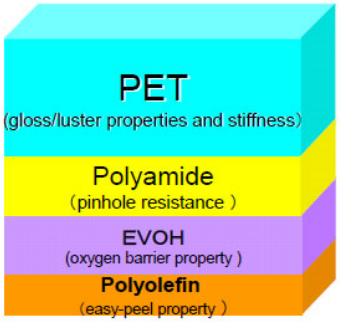
- Separation of resins is necessary → different polymers are generally non-miscible or incompatible
  - Inferior mechanical properties
  - Recyclates unsuitable for many applications

Polyester recycling

- Reclaimed post-consumer packaging, as bottles for drinks and beverage
  - high environmental, ethical and socio-economic value
  - high availability and low cost
  - easy recyclable

Polyester recycling

- Packaging films
  - Multiple layers
  - No single component: (L)LDPE, PP, EVOH, PA, ECPs, PET
  - Drivers: food protection and preservation, resource use, shelf appeal
  - 10 – 20% of plastic packaging waste !



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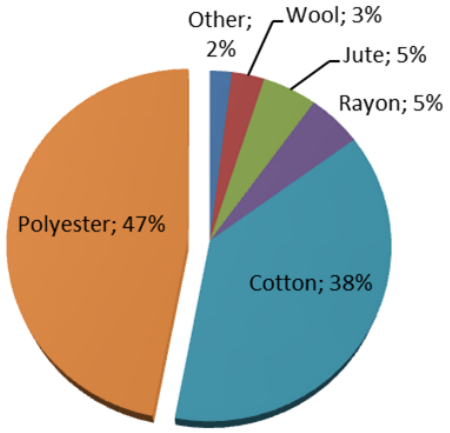
Polyester and textiles

- Polyester fibers dominated textile raw market since 1970
- Total polyester consumption = 4 million tons
  - used in apparel and furnishings
  - industrial polyester used in tire reinforcements, fabrics for conveyor belts, safety belts, coated fabrics,…



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Recycled polyester and textiles

- R-PET recovered from colourless bottle scrubs
  - multifilament extrusion feasible
  - same processing parameters as virgin PET
  - comparable mechanical properties are obtained

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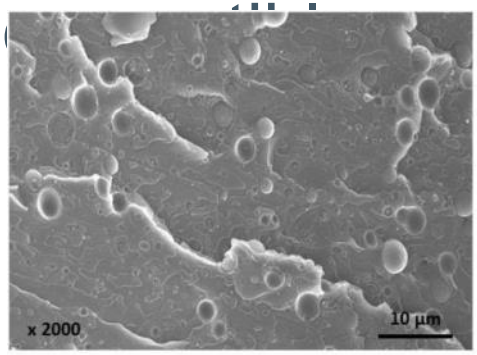
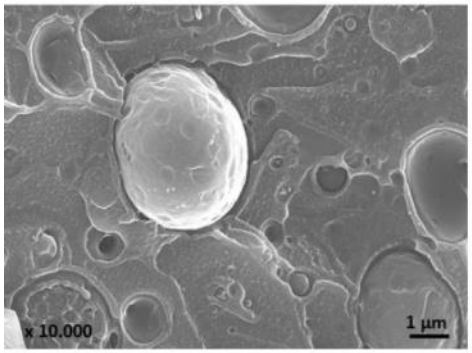
Recycled polyester and textiles

- R-PET recovered from packaging trays
  - Pet trays typically contain a PE layer (5–10wt %)
  - PET and PE are not
    → droplets of PE





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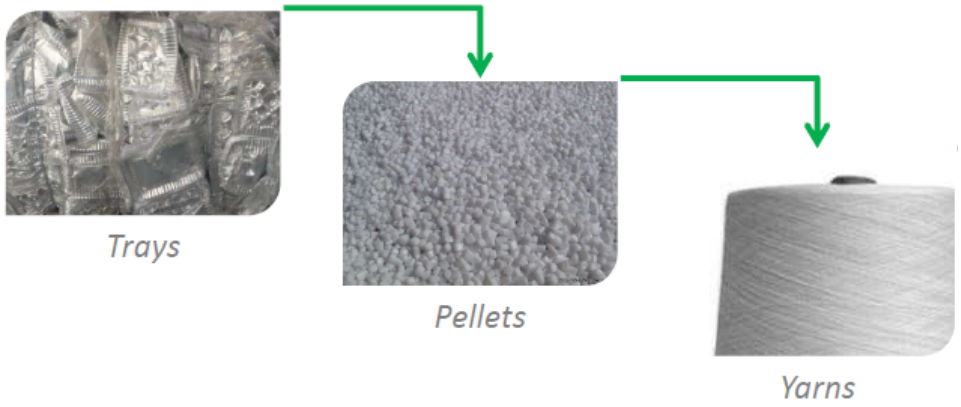
Recycled polyester and textiles



- multifilament extrusion trials
- adaptation processing parameters needed
- only small bobbin could be produced → very low mechanical properties
- no industrial relevance → **unrecyclable ?**

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RECYCLING THE UNRECYCLABLE

Not able to be recycled or made into a new product?

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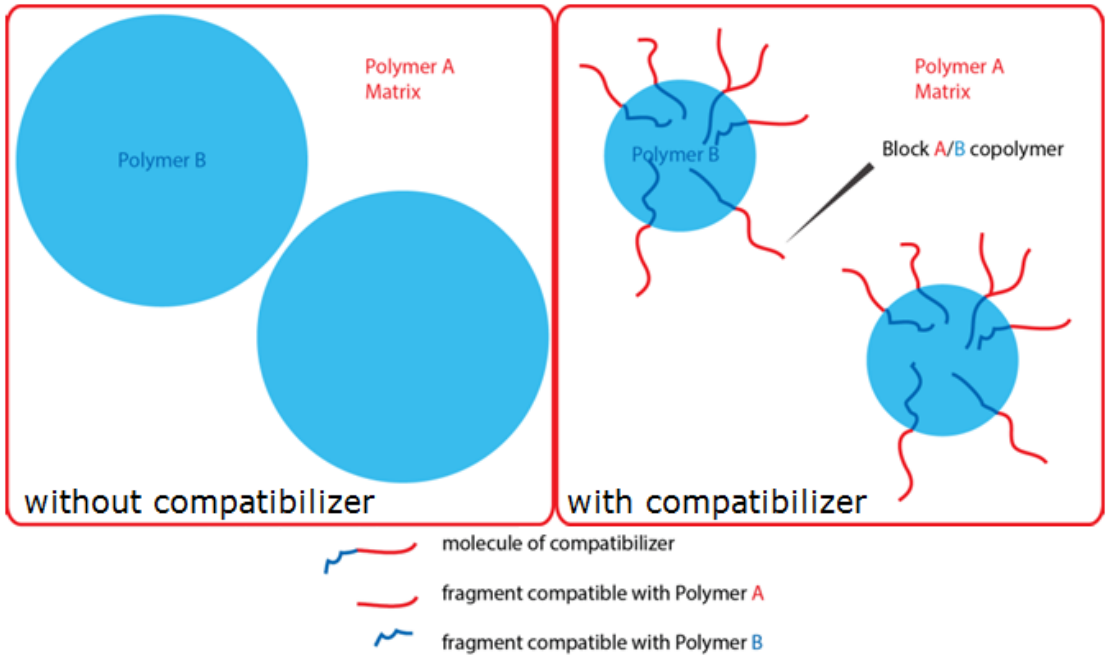
Unrecyclable?

- Use of compatibilisers
  - additives used to improve the poor properties of recycled mixed plastics → due to lack of compatibility
  - strengthening of weak interface between dispersed particles and continuous phase → higher strength and improved processability

Principle compatibiliser



- Compatibilisers reach full potential in plastic blends when effective mixing is achieved e.g. with a high shear screw

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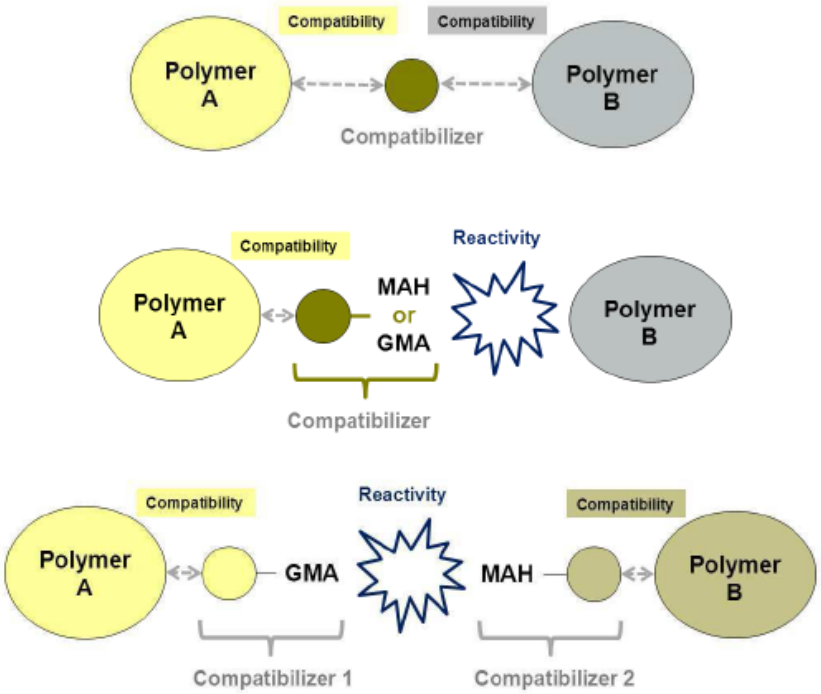
Principle compatibiliser

- 3 types of compatibilisation mechanism depending on polymers A & B



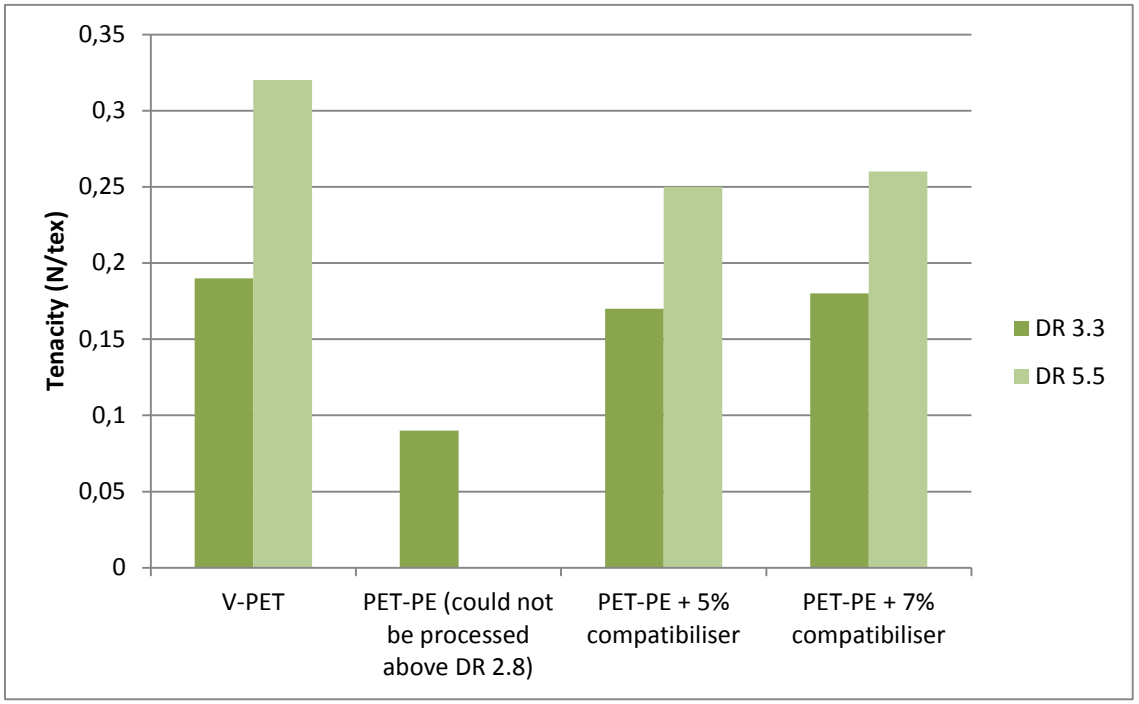
Source: Dupont

R-PET packaging trays

- Without compatibiliser → no stable extrusion process possible → unsuitable for textile multifilament extrusion
- With compatibiliser?
  - PET:PE = 92.5:7.5 wt/wt
  - Blend compatibilised with terpolymer

P-PET packaging trays

- With compatibiliser → increase in tenacity, comparable with virgin PET



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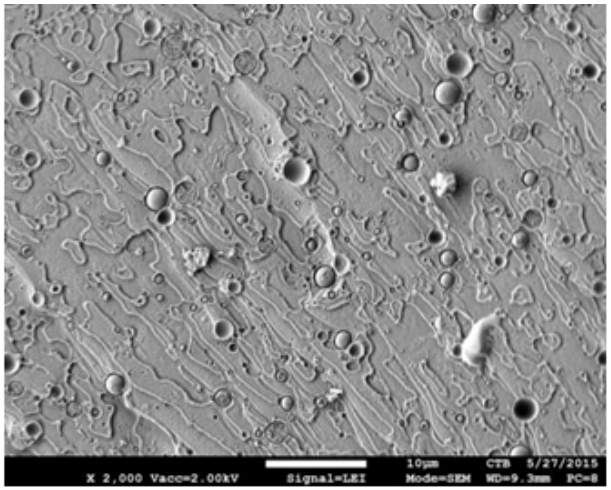
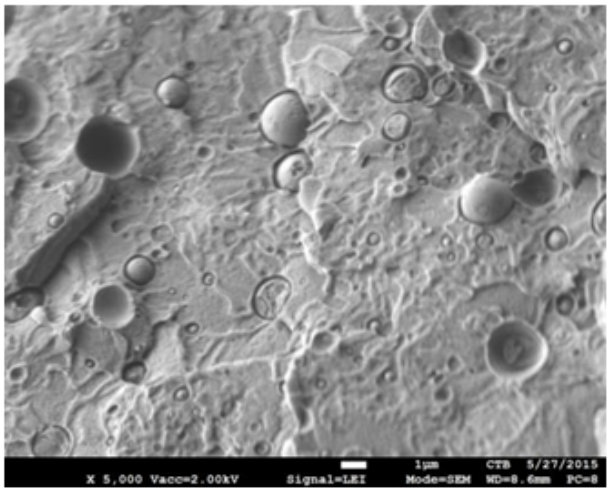
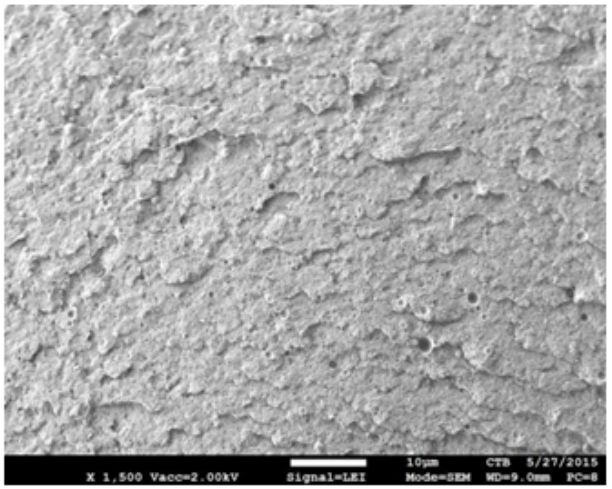
P-PET packaging trays

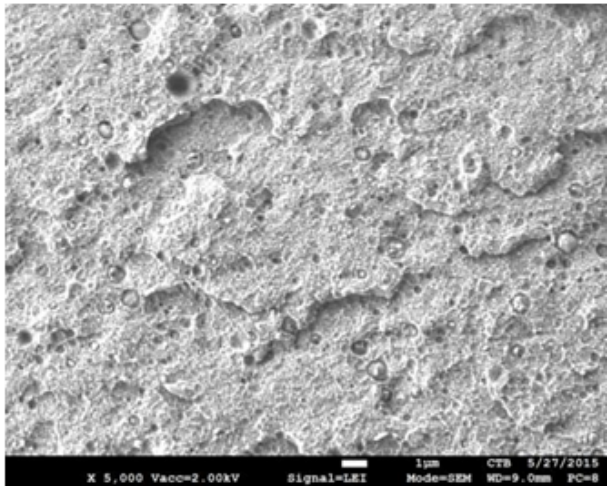
PET – PE **without** compatibilisation





PET – PE **with** compatibilisation





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CONCLUSIONS

Make the impossible possible

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Conclusions

- Multifilament extrusion is promising for reuse of recycled PET
- R-PET from bottle scraps → already successful
- Recovery and recycling of packaging films → limited across Europe
  - solutions to recycle multilayer films mechanically → use of compatibilisers

Questions?

Contact details

Wim GRYMONPREZ
Wim.Grymonprez@vkc.be
Mobile +32 491 151 458

Isabel DE SCHRIJVER , PhD
Isabel.DeSchrijver@centexbel.be
Mobile +32 488 999 226

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