POLYOLEFINS
as
ENVIRONMENTALLY-FRIENDLY PLASTICS

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SYNTHETIC PLASTICS ARE ENVIRONMENTALLY FRIENDLY

- They convert low value oil fractions (otherwise flared) into high value polymers.

In typical applications, e.g. packaging, compared to alternatives like paper:

- They reduce energy costs by up to 40%.
- They reduce waste by 75 - 80%.
- They reduce emissions by 70%.
- They reduce water pollution by up to 90%.

Bio-derived/Biodegradable Plastics

Rapidly growing market but:

- Still very small volume
- High energy input – plant growth and polymer recovery
- High pollution associated with recovery – e.g. delignification of wood pulp
- Price depends heavily in some cases (e.g. cornstarch) on farming subsidies
- Competition from bio-fuel use in future? (e.g. bio-ethanol from cornstarch?)

Bioplastics

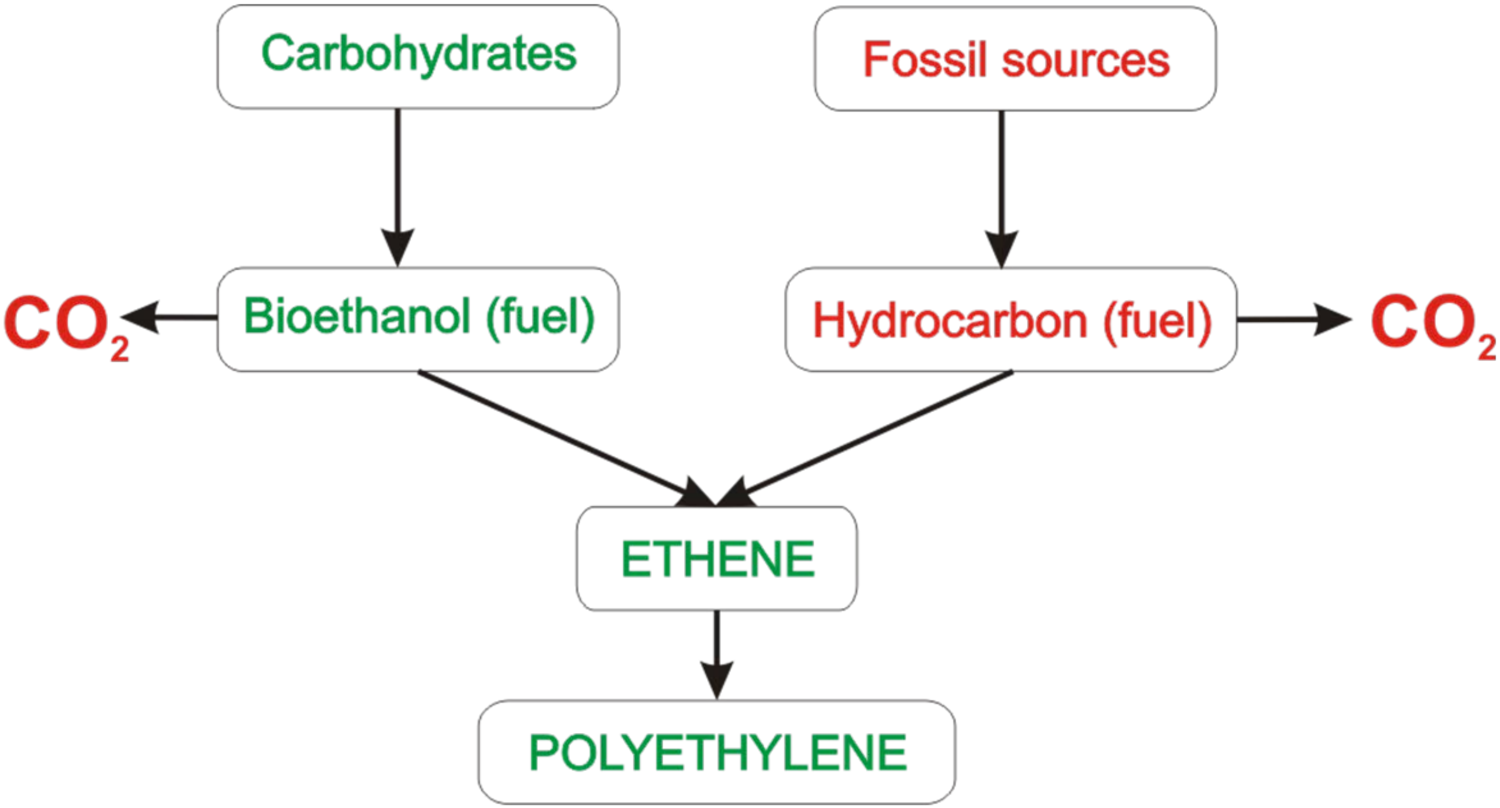
- Denser than polyolefins
- Problematic in recycle
- Poor water and oxygen barrier properties
- Require thicker material – higher packaging weight
- Expensive

POLYOLEFINS IN THE MARKET PLACE

- Polyolefins will dominate the market for commodity plastics for the foreseeable future
- They are very highly developed and there is major R&D investment in new technologies
- They combine excellent properties with very low price and very easy processing
- Their low water absorption and good barrier properties make them ideal for many packaging applications

But: as normally produced they are too durable for short-term applications

Polyethylene sources

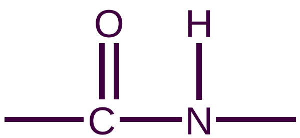


PLASTIC PACKAGING IN LITTER

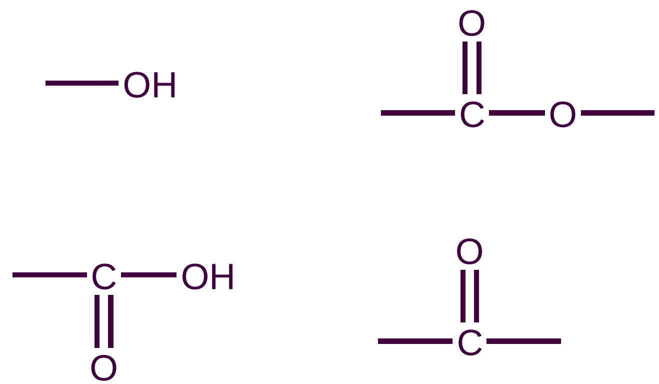
- **In landfill, plastic film slows equilibration and compaction**
- **Unmodified polyolefin film is not acceptable in composting because it does not break down**

REQUIREMENTS FOR POLYMER BIOASSIMILATION

- Hydrophilic surface – allows water to spread
- Functional groups susceptible to attack



α-amino acid
(protein)



Oxygen-containing groups
Alcohol, acid, ester etc

- Can be introduced during manufacture or after use

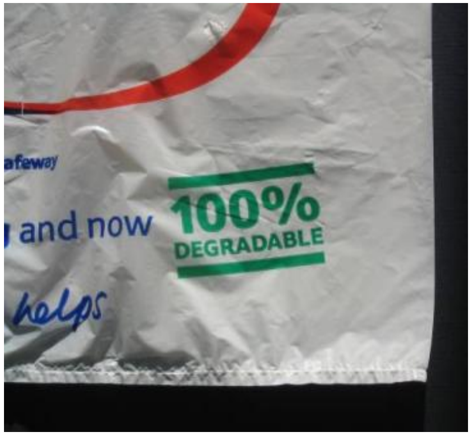
OXO-BIODEGRADABLE TECHNOLOGY

- Pro-oxidant additives
  - Low level oxidation catalysts
  - Promote **oxidation** to low molecular weight fragments
    - Fragments similar to those from condensation polymers
    - Oxidation rate controllable to suit use and/or disposal
  - **Biodegradation** of low molecular weight fragments
    - Measurable and quantifiable by biometer tests

Current Applications

Daily landfill cover

Mulching film



Packaging

FRAGMENTATION IN LANDFILL BURIAL

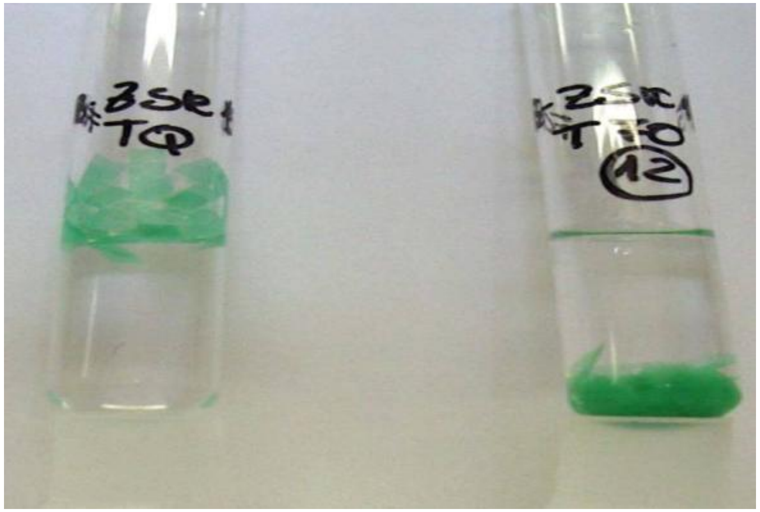
PE films with (right) and without (left) TDPA® before (top) and after (bottom) 10 months burial in a UK landfill.

Properties of LDPE film with and without additive, before and after 10 months landfill burial

Sample	MFI /g/10min[a]	$A_{C=O}$ [b]	M_w [c]
Control unburied	0.75	0	114,000
Control recovered	1.11	0.15	107,000
TDPA unburied	0.76	0	115,000
TDPA recovered	13.3	2.31	4,250

a: Melt flow index according to ASTM D1238
b: Infra-red absorbance at 1715 cm^{-1}
c: Weight average molecular weight measured by GPC

OXIDIZED PE SINKS IN WATER

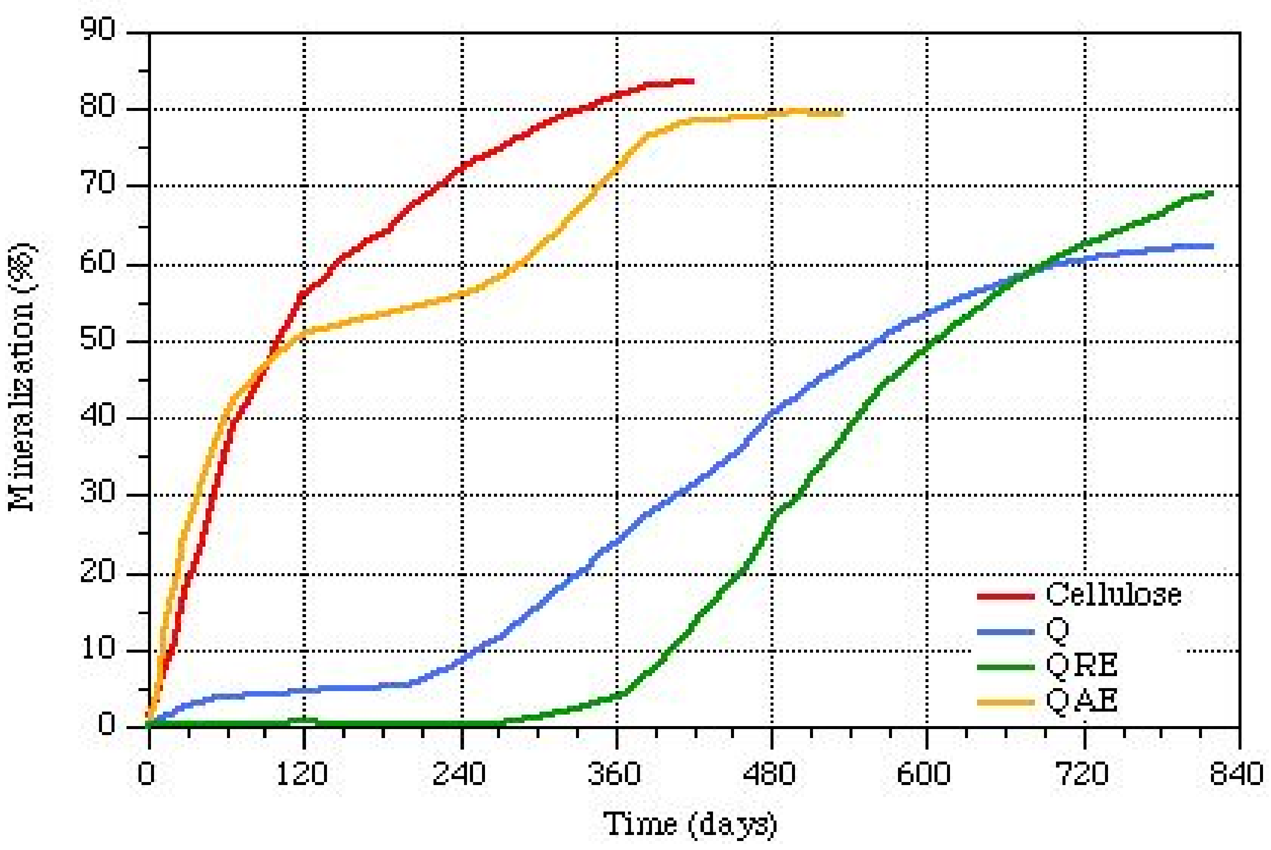


A: FCB-ZSK15 untreated sample (<5% acetone soluble)

B: FCBZSK15 sample after 24 days at 70°C (dry) (>25% acetone soluble)

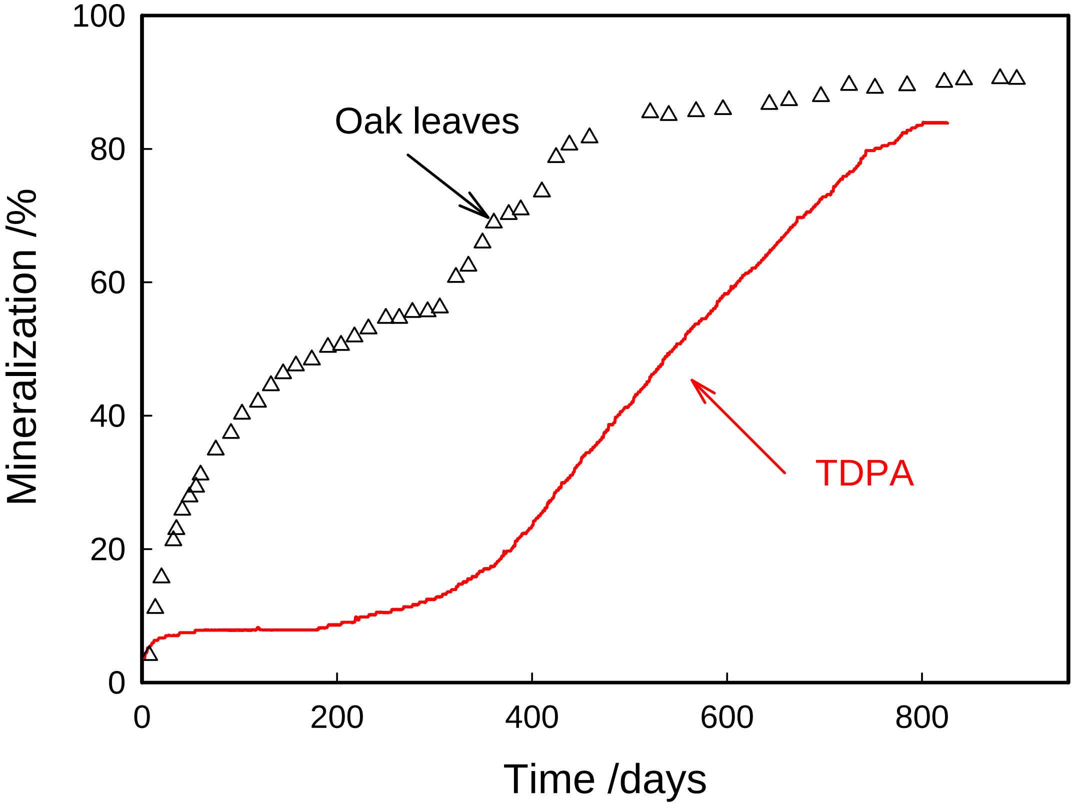
Data from Prof Emo Chiellini Univ. of Pisa

MINERALIZATION ON SOIL BURIAL



Q is original film
QRE is residue
QAE is acetone extract

COMPARISON WITH NATURAL “RECALCITRANT” MATERIALS



Oak leaf data from B. DeWilde, OWS Belgium

CONCLUSIONS

- “Environmentally-friendly plastics” need careful definition and LCA
- Oxo-biodegradable plastics degrade by a combination of oxidation and biodegradation in times which are long compared to many bio-plastics but acceptable for many applications
- Oxo-biodegradable plastics are compatible with existing recovery/recycle processes
- Oxo-biodegradable technologies have the potential to reduce the environmental impact of polyolefins and to create new markets in agriculture and packaging.

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You for Listening

Thank You!