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CHAMPION
circular bio-based polymers

Introducing the CHAMPION Project

Circular High-performance Aza-Michael Polymers as Innovative materials Originating from Nature

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This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 887398. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

Key facts about the project

- Four-year Horizon 2020 BBI JU project running until May 2024 involving **14 partners** from 6 European countries
- Aims to replace conventional polymers with **novel bio-based polymers** that are:
  - *More sustainable*
  - *Safer*
  - *Equal or superior in performance than the current materials*

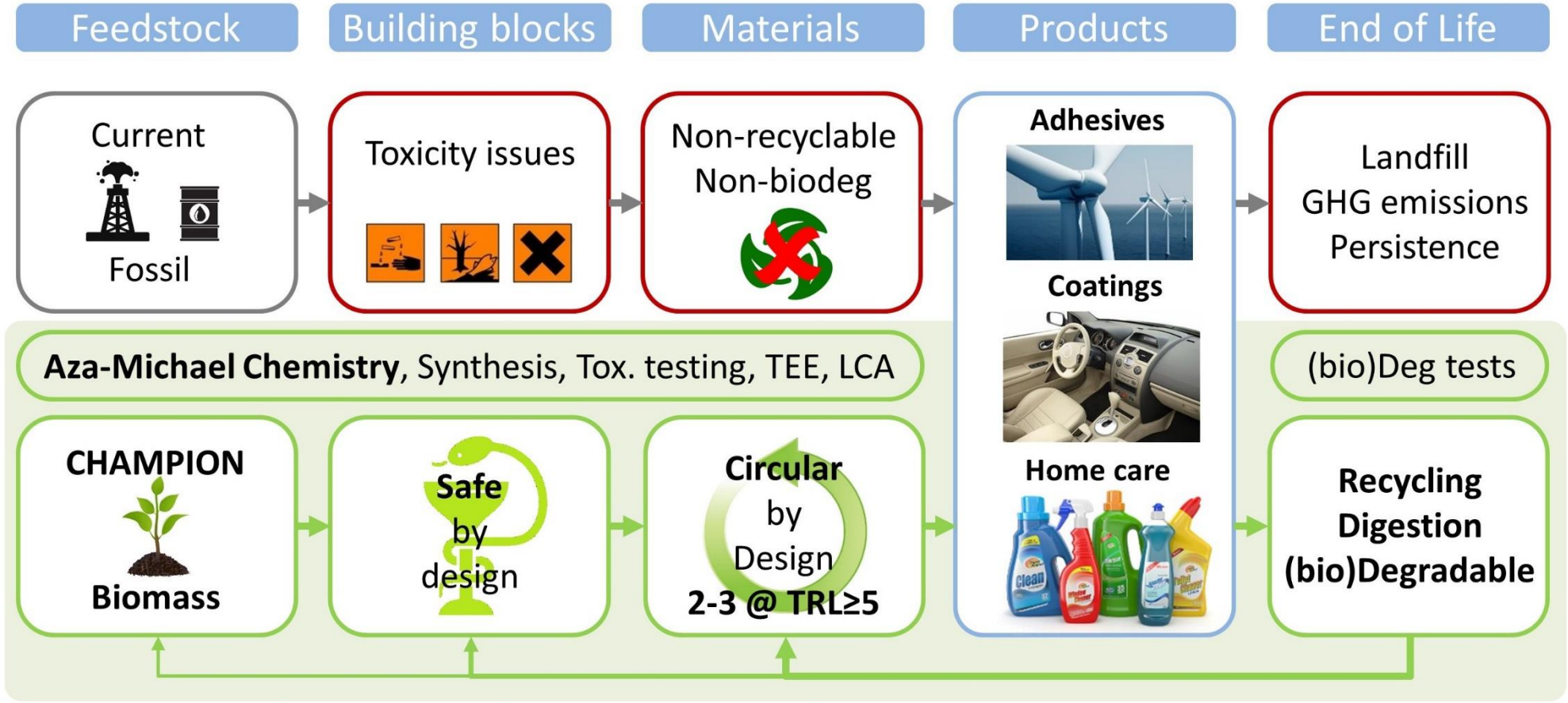
Surface coatings

Automotive interiors

Structural adhesives

Home care

The Concept


Feedstock
Building blocks
Materials
Products
End of Life
Current
Fossil
Toxicity issues
Non-recyclable
Non-biodeg
Adhesives
Coatings
Home care
Landfill
GHG emissions
Persistence
Aza-Michael Chemistry, Synthesis, Tox. testing, TEE, LCA
(bio)Deg tests
CHAMPION
Biomass
Safe
by
design
Circular
by
Design
2-3 @ TRL≥5
Recycling
Digestion
(bio)Degradable

CHAMPION project

- **C**ircular – Use of reversible chemistry to give **recyclable thermoset polymers** (for coatings and adhesives)
- **H**igh-performance – **Tested in industry** applications by partners
- **A**za-**M**ichael Polymers – From monomers that are **safe by design**
- **I**nnovative materials – Industrially relevant materials that are **scalable**
- **O**riginating from **N**ature – Innovative reagents from **bio-based** platforms

Methodology

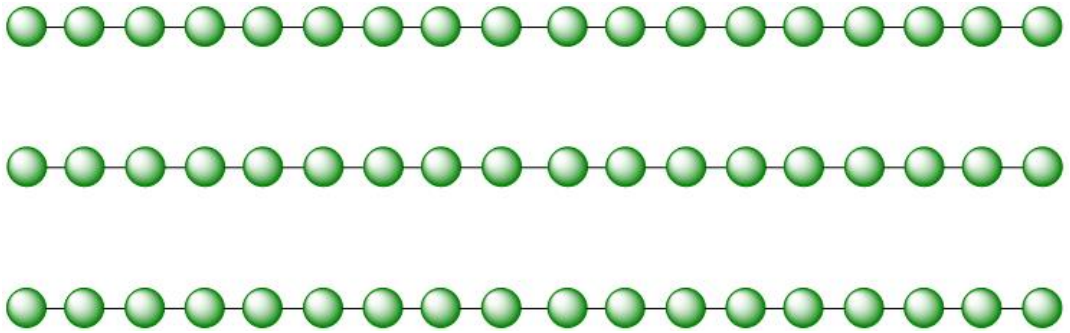
SUSTAINABILITY	SAFER	INDUSTRIALLY RELEVANT	PERFORMANCE
• Bio-based platform materials • Determine circularity and renewability of different end-of-life options	• An innovative testing strategy to rapidly evaluate toxicological safety issues	• Scale up the most promising options • Environmental and economic performance based on industry (not lab-scale) processes	• Materials tested in relevant applications by industry partners

Aiming for 1 new bio-based polymer for each application benchmarked against current materials

Thermosetting Polymers

Thermoplastics

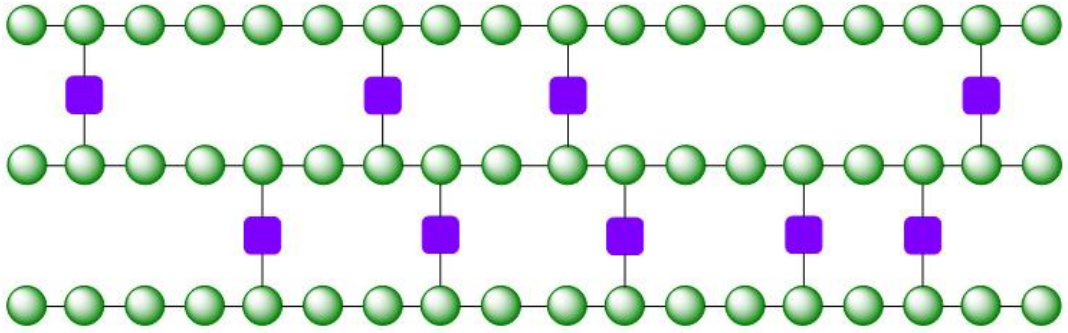
- Held together by intermolecular forces
- Can be re-moulded/melted by heat processing
- E.g. polyesters, polyamides, TPUs
- Applications include packaging and sealants



How to functionalise for target applications?

Thermosets

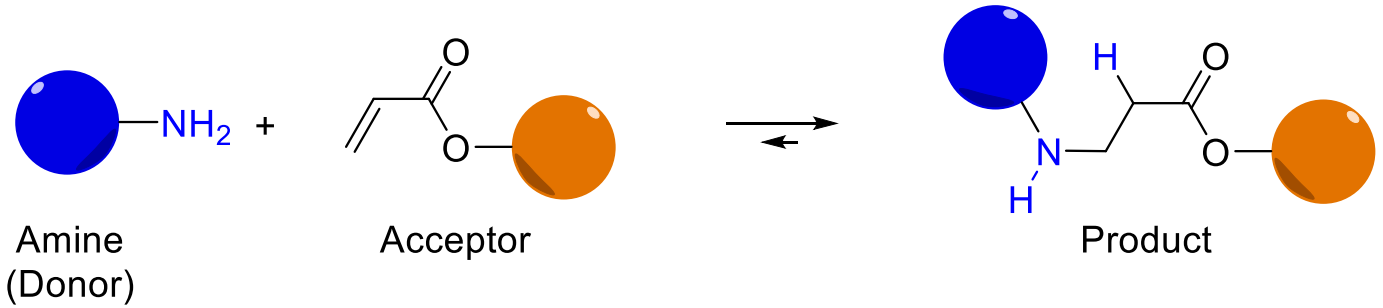
- Held together by strong, covalent bonds
- Irreversibly cured
- E.g. epoxy resins, polyacrylates, polyurethanes
- Applications include coatings and adhesives



How to cross-link reversibly to improve recyclability?

Aza-Michael Chemistry: Functionalisation and cross-linking of unsaturated polyesters

- The **aza-Michael reaction** occurs between a primary or secondary amine and a double bond attached to an electron-withdrawing group to give an N-C bond:



- **Diversity** in the structures of the reagents
- **Reversible** reaction under certain conditions
- **Bio-based** donors and acceptors are available
- **Catalyst** not always necessary

- Unsaturated polyesters can be **functionalised** to impart new properties, e.g. stain removal for home care products.
- Diamines create **crosslinking** to from hard materials for adhesives or coatings.

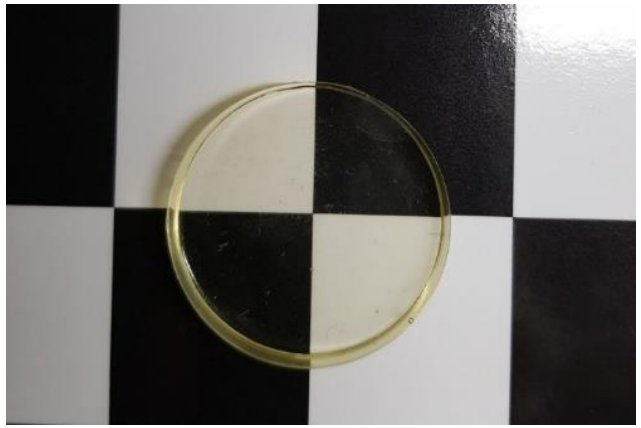
A. Pellis, P. A. Hanson, J. W Comerford, J. H. Clark, T. J. Farmer, *Polym. Chem.*, 2019, **10**, 843-851.

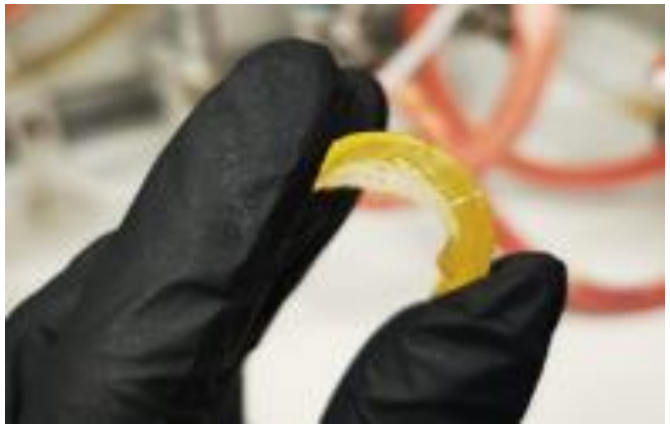
D. M. Day, T. J. Farmer, J. Sherwood, J. H. Clark, *Tetrahedron*, 2022, **121**, 132921.

CHAMPION Resins

- Several **novel bio-based amines and Michael acceptors** have been prepared
- These have been polymerised with a view towards producing coatings and adhesives
- Hardness and flexibility is tuned by varying the crosslinking density

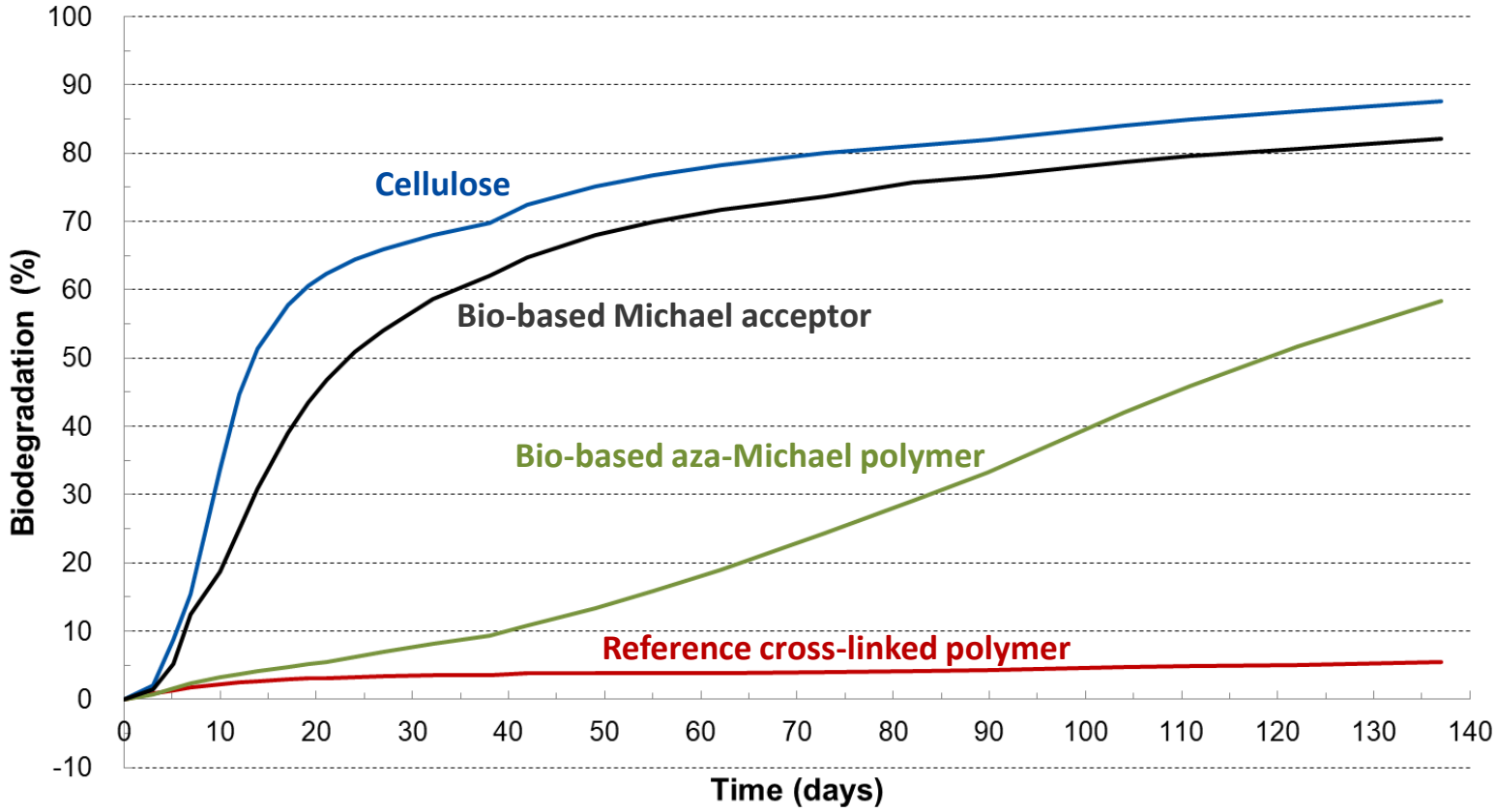
Post-curing of aza-Michael polymers





Biodegradation of Aza-Michael Polymers

- Soil biodegradation of aza-Michael polymers has been studied in comparison to conventional radical-cured polymers



Project partners and main roles