



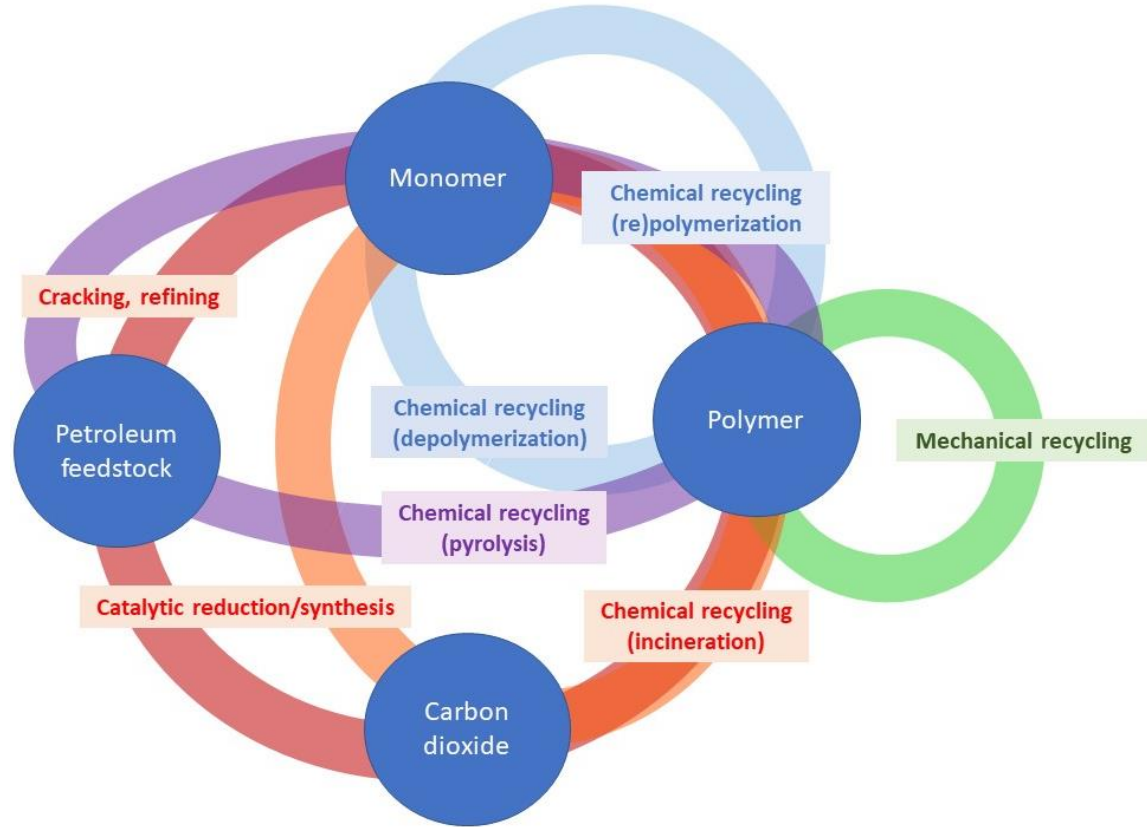
I would like to begin by acknowledging the Traditional Owners of the land that we're meeting on today, and pay my respect to their Elders past and present.





The Critical Importance of Adopting Whole-of-Life Strategies for Polymers and Plastics

Graeme Moad | 23 May 2023



Some Definitions

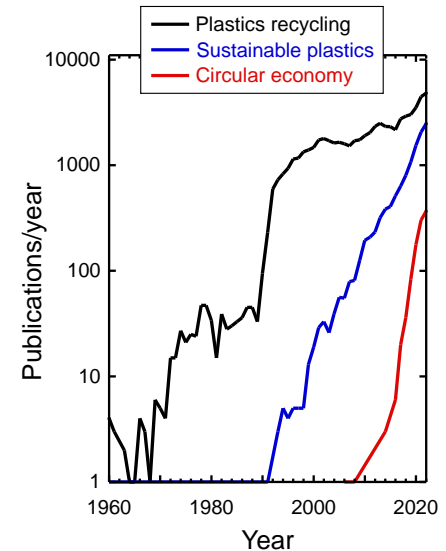
- **macromolecule** - a molecule of high relative molecular mass, the structure of which essentially comprises the multiple repetitions of units derived, actually or conceptually, from molecules of low relative molecular mass [IUPAC]
- **polymer** - a substance composed of macromolecules [IUPAC]
- **plastic** – a material that contains, as an essential ingredient, a high polymer and which, at some stage in its processing into finished products, can be shaped by flow [ISO]

Note: Plastics will typically contain additives – plasticisers, stabilizers, dyes, pigments, nucleating agents, ... Possibly up to 50 wt% of the composition

- **biomacromolecule** - a macromolecule formed by living organisms (includes proteins, nucleic acids, polysaccharides)
- **biopolymers** - a substance composed of one type of biomacromolecule.
- **biobased polymers** - composed of, or derived from, in whole or in part, biological products issued from the biomass

- **plastics recycling**
- **sustainable plastics**
- **circular economy**

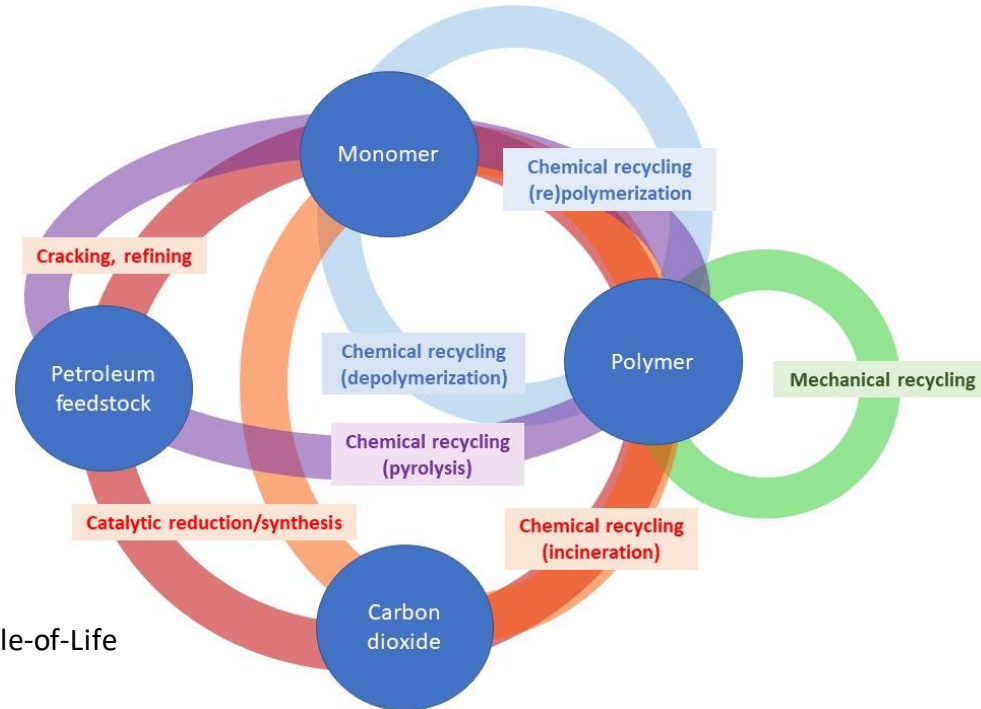
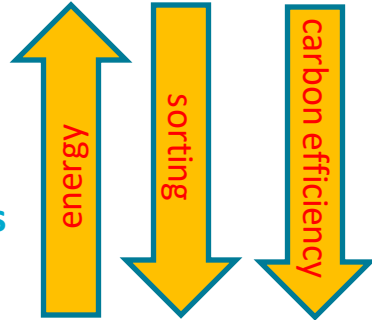
Data based on keyword search conducted using Scifinder-*n*



- **microplastics** - small particles of plastic with dimensions in the range of 0.1–100 μm [IUPAC]
- **nanoplastics** - small particles of plastic with dimensions in the range of 0.1–100 nm [IUPAC]

Plastics recycling strategies

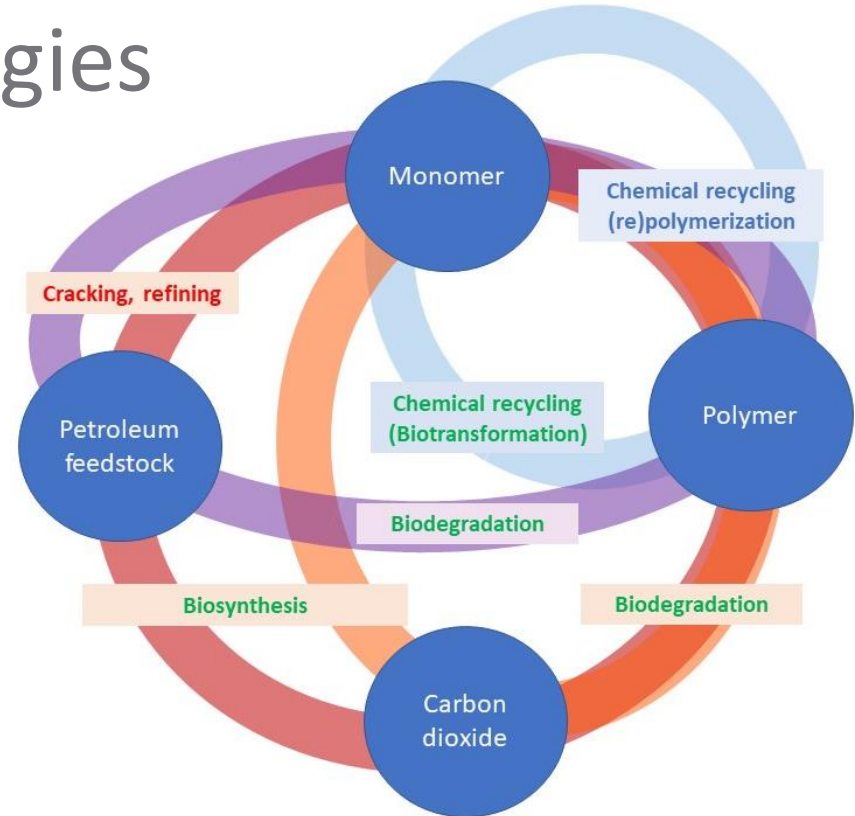
- **Chemical recycling**
- **Incineration with energy recovery**
 - and Upcycling of CO₂
- **Pyrolysis**
- **Hydrocracking**
- **Hydrothermal methods**
- **Catalytic hydrogenolysis**
- **Solvolysis, hydrolysis**



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<https://doi.org/10.3390/su13158218>

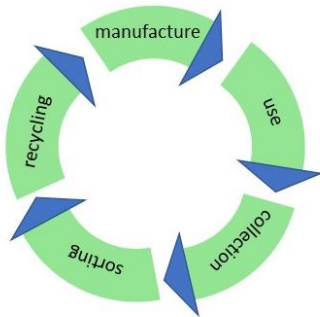
Plastics recycling strategies

- **Biocatalytic recycling**
- **Biodegradation**
 - With energy recovery
- **Biodegradation to biomass, CO₂, H₂O**
 - Biodiesel, chemical feedstock
- **Biodegradation to monomers**

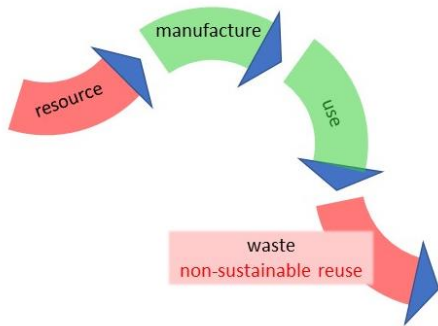


A (more) circular economy

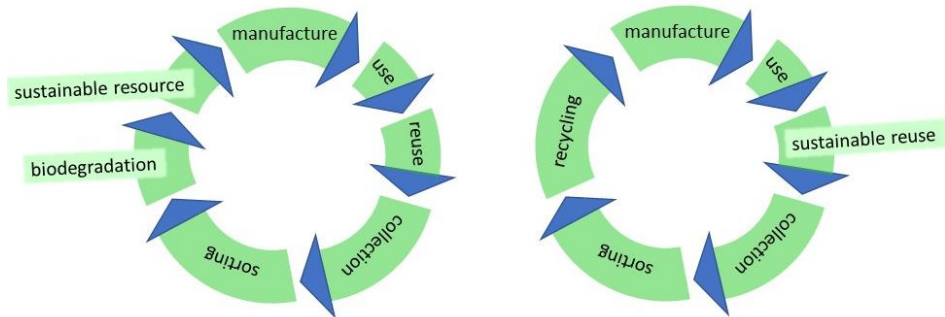
A circular economy



reuse in itself can be an issue



reuse adds another step in the circular economy





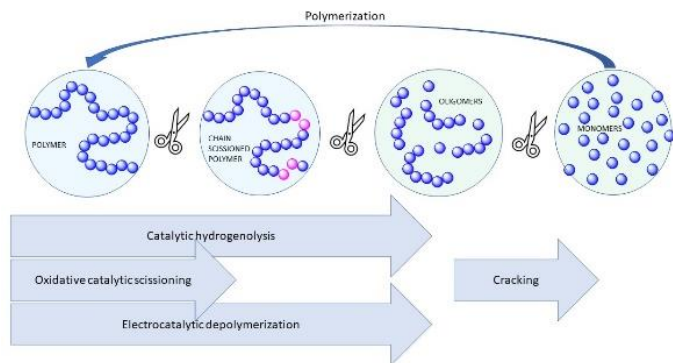
Steps that may be Part of Potential Solutions

- ‘Cradle to grave’ tracking of plastics
 - taggants and molecular barcodes
 - recycling issues
- A ‘whole of life’ price for plastics
 - stewardship schemes and levys
 - a tax on manufacturers (but there are few in Australia)
- Plastics reuse
 - continual assessment required

New CERC Post-doc Projects

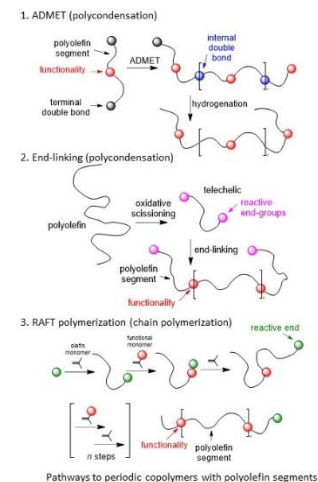
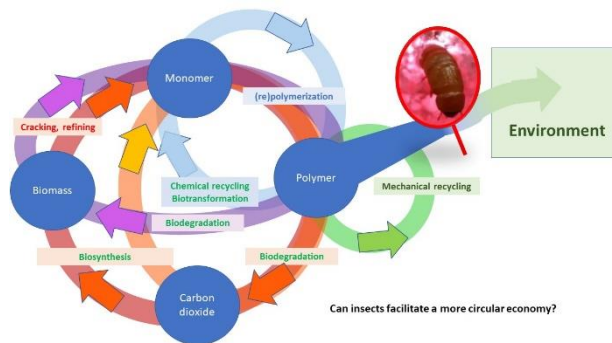
Continuous catalytic depolymerization of waste plastics

- (Sam Smith, Almar Postma, Graeme Moad, Krishnan Murugappan, Gerald Pereira)
- A continuous, low energy, process for chemical recycling of plastics
 - Catalytic hydrogenolysis in flow
 - Electrocatalytic depolymerization in flow
 - Oxidative chain scissioning by reactive extrusion



Insect edible plastics for a circular economy

- (Nick Chan, Richard Evans, Graeme Moad, Gerald Pereira, Almar Postma, Ranya Simons, Melissa Skidmore, Andrew Warden, Gene Wijffels)
- Methods to instil functionality in polymers that promote insect attack, biodegradability, recyclability and triggered degradation in polymers.





Thank you

Manufacturing

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