

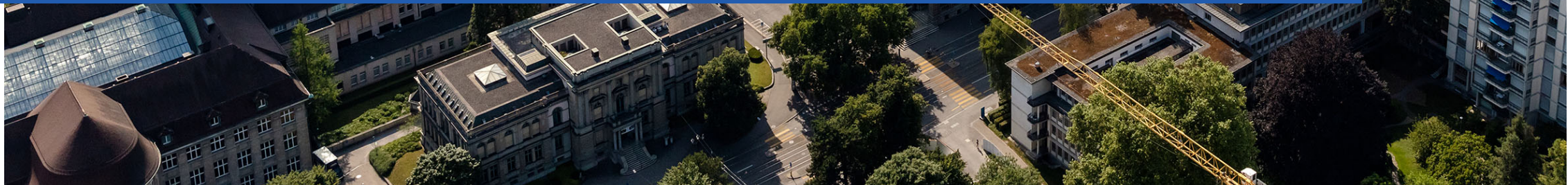


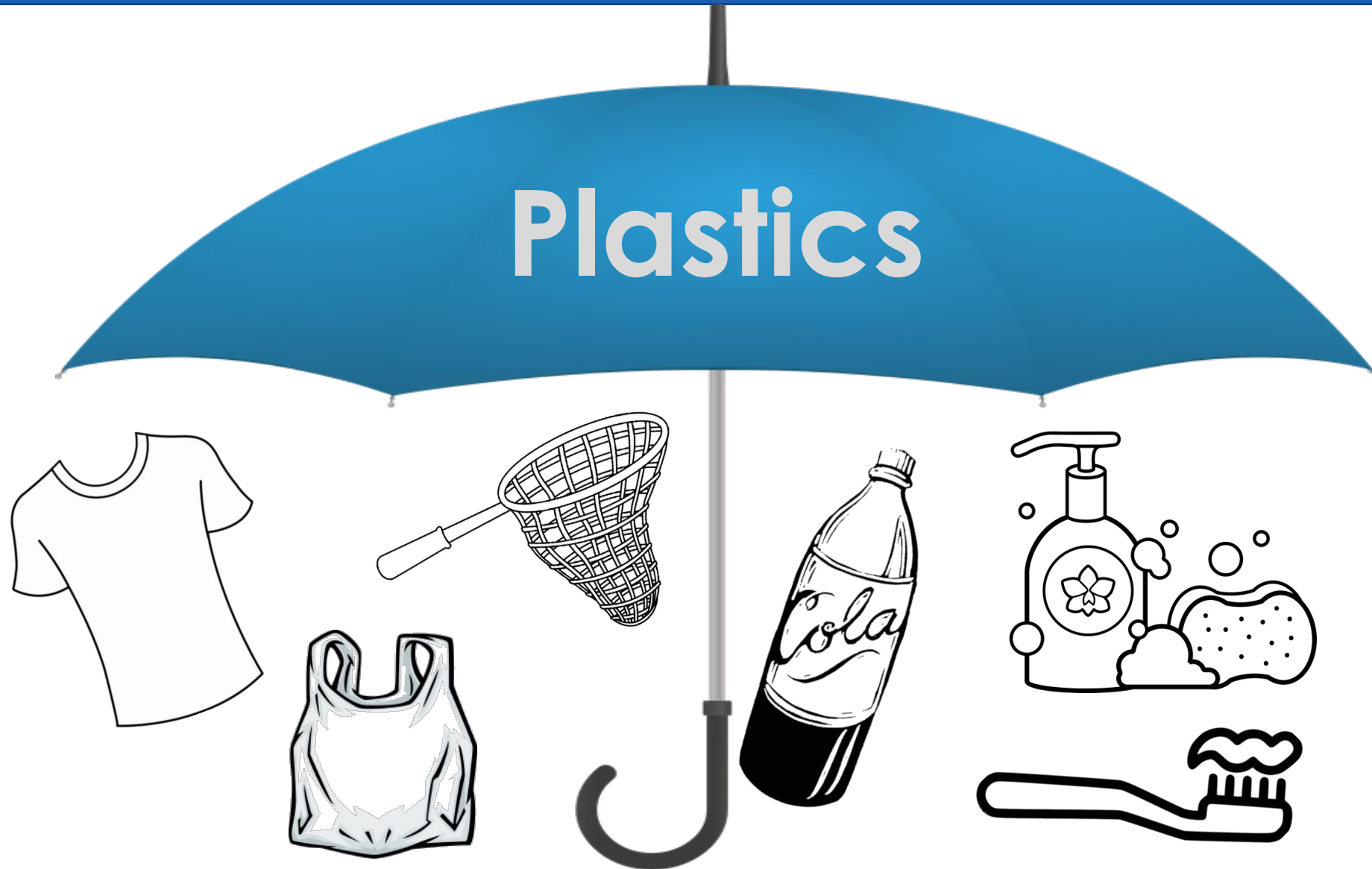
# Nano- and microplastics policy: Regulations for sustainable plastics use and design

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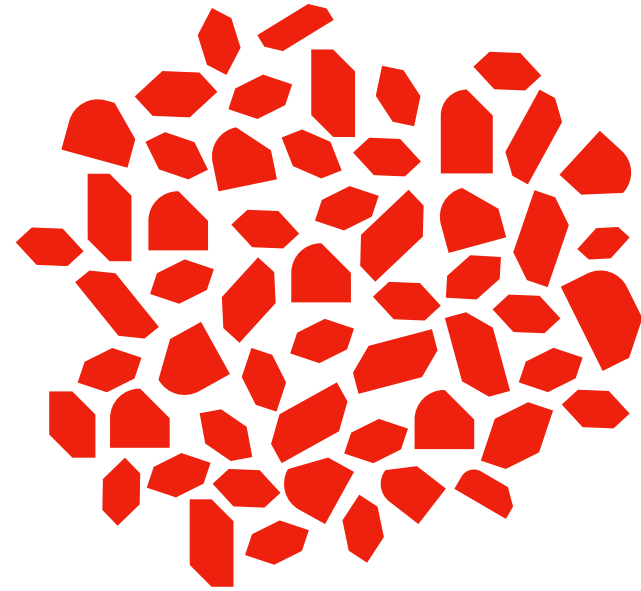
Intentionally added MPs



Plastic



Emulsion polymerization, milling, etc.

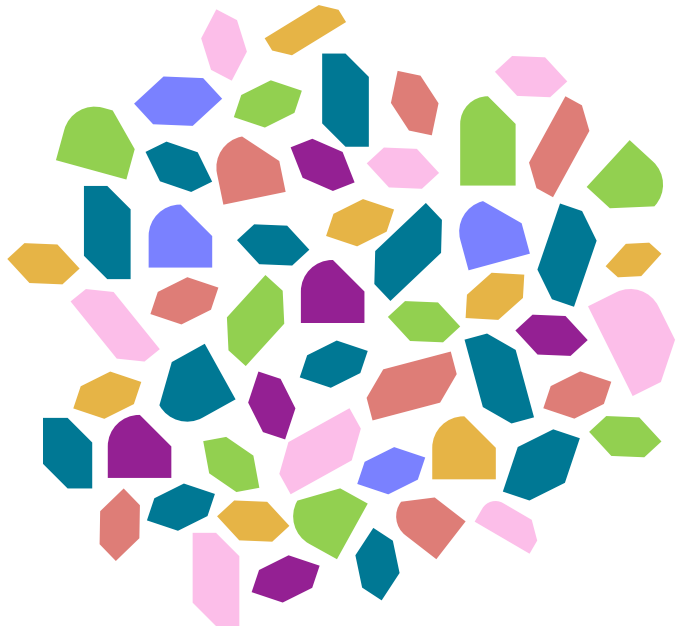


Formulation and mixing



Product

Unintentionally produced MPs



Mechanical Stress

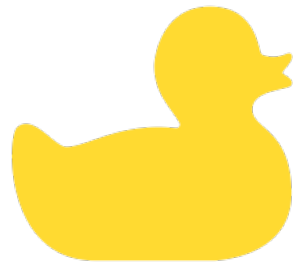
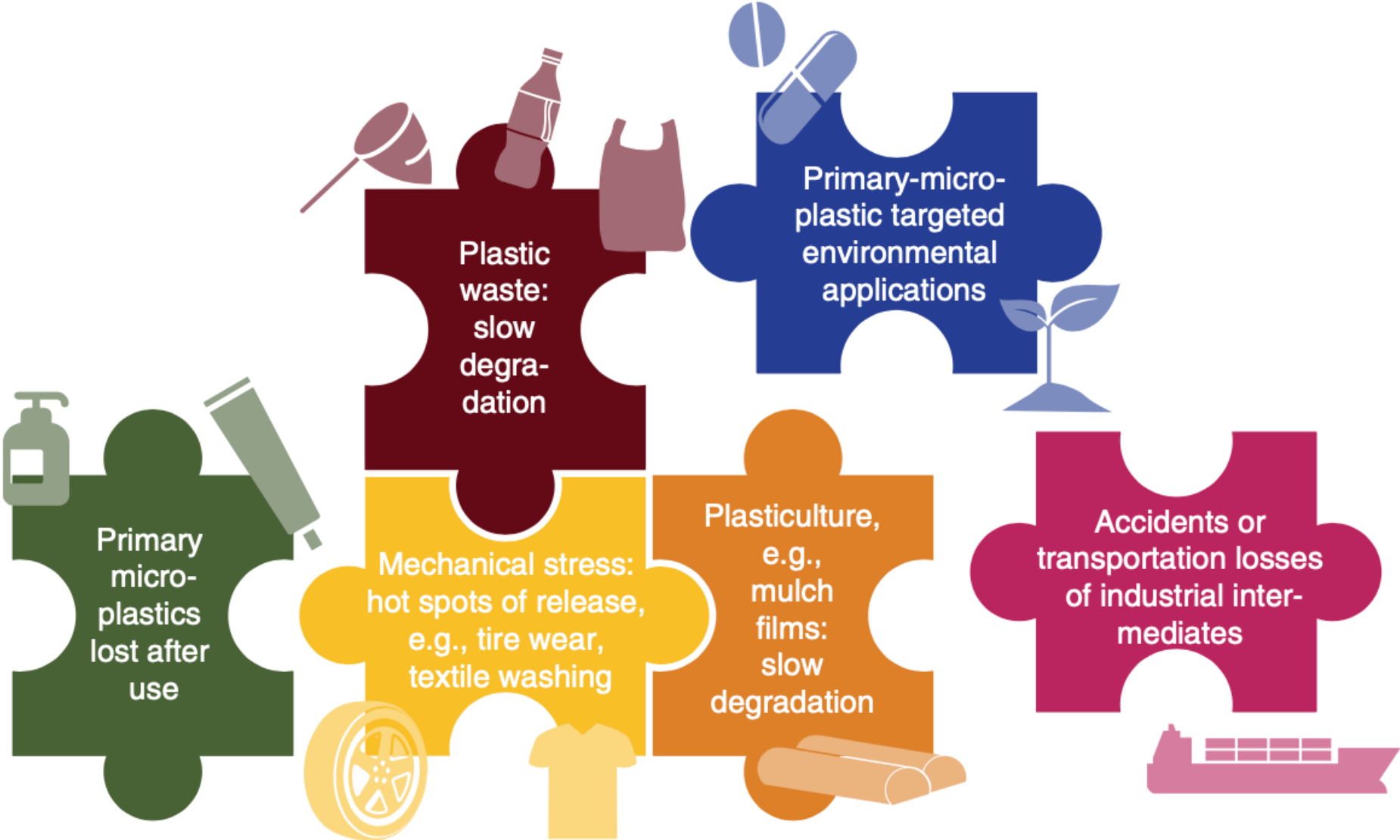


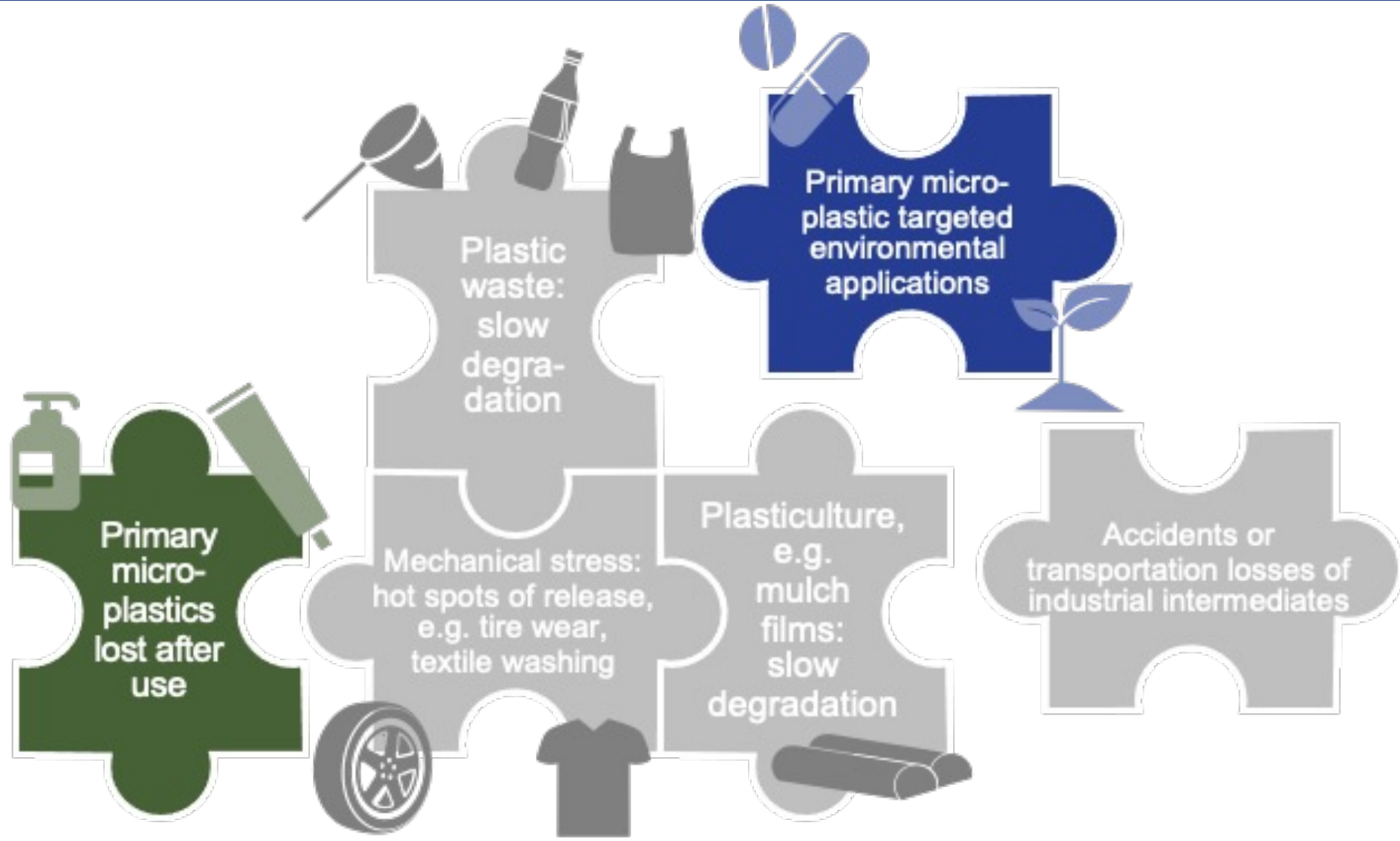
Photo-oxidation



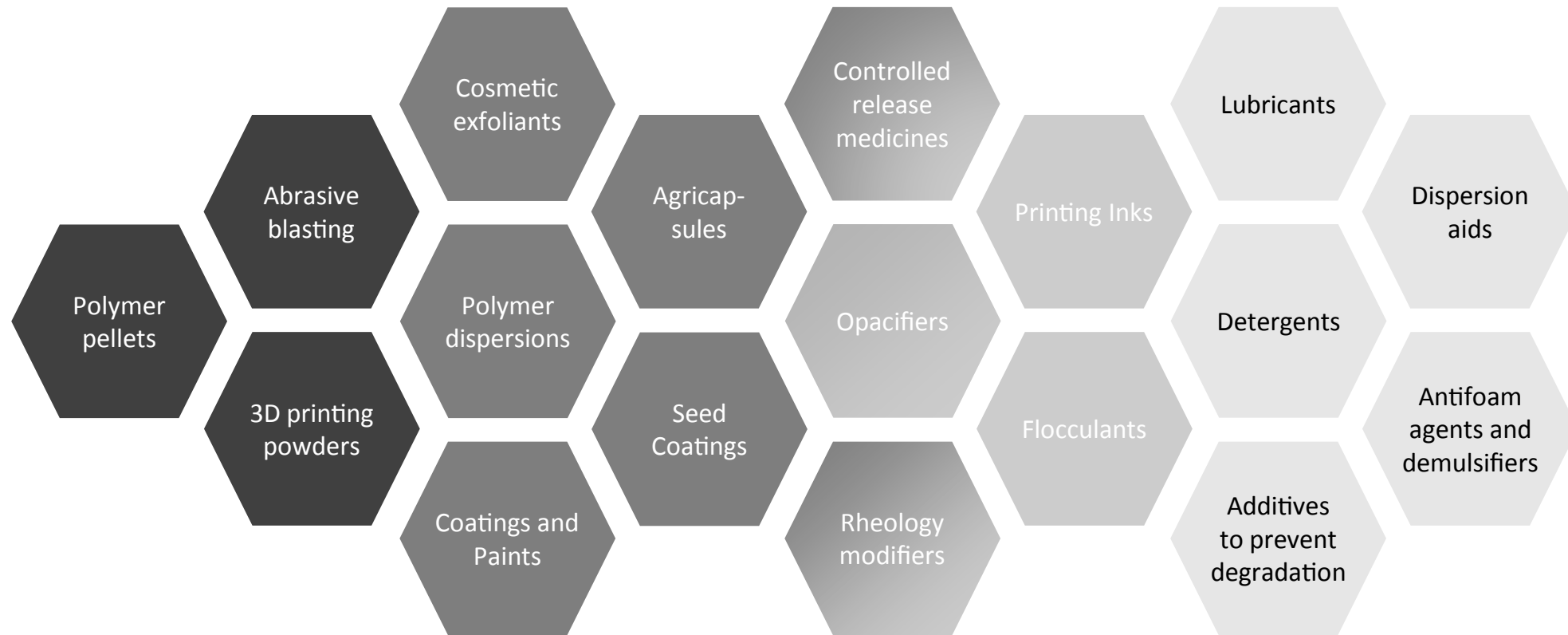
# Sources of environmental MPs



# Sources of environmental MPs



# A (short) tour of the polymer universe



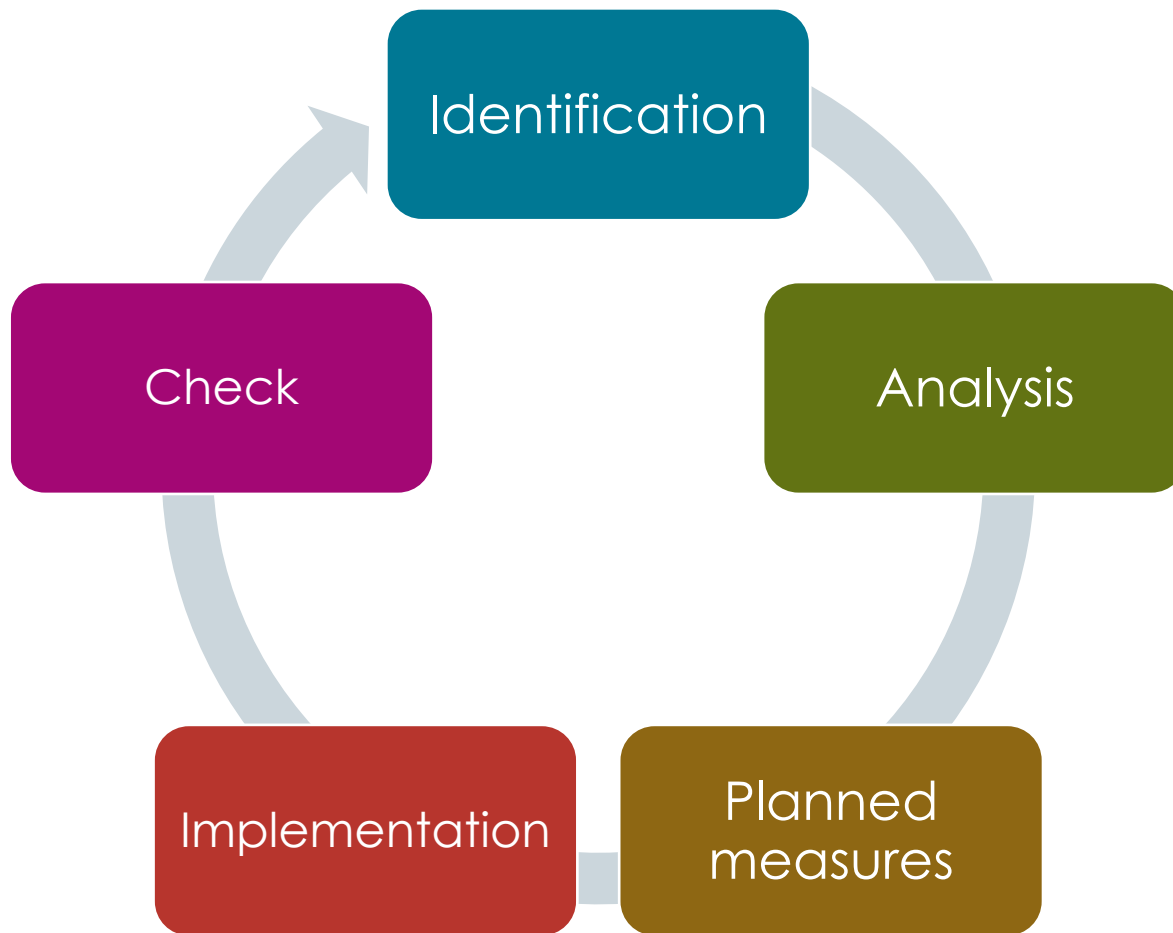
Polymer makes up bulk of product, and is solid.



Polymer is a major component, and is at least semi-solid.



Polymers enable functionality, but are not solid: indirect implications by microplastic regulation



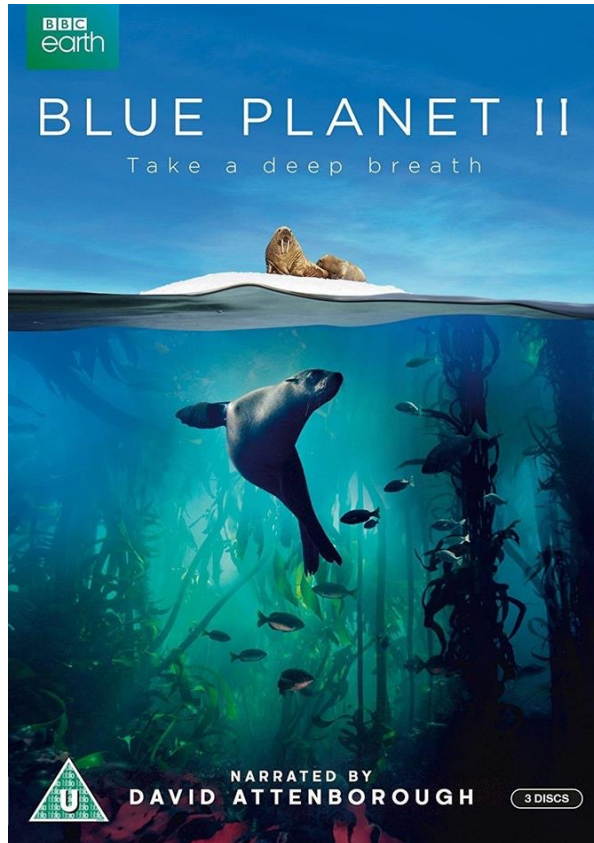
Create shared mental model  
→ (natural) scientists & policy makers & public

Quantitative model  
→ Where is change possible?

- ❖ Avoid
  - ❖ Prevent
  - ❖ Reduce
  - ❖ Develop alternatives
  - ❖ Increase longevity
  - ❖ Improve circularity
- Regulations and innovation



# Creating a shared narrative: Grass roots action and industry changes



- ◆ Significant public pressure and attention
- ◆ Voluntary conversion of formulations
  - ◆ Esp. when alternatives are technically simple and economically viable
- ◆ Partial bans on primary MPs in cosmetics, specifics depend on jurisdiction

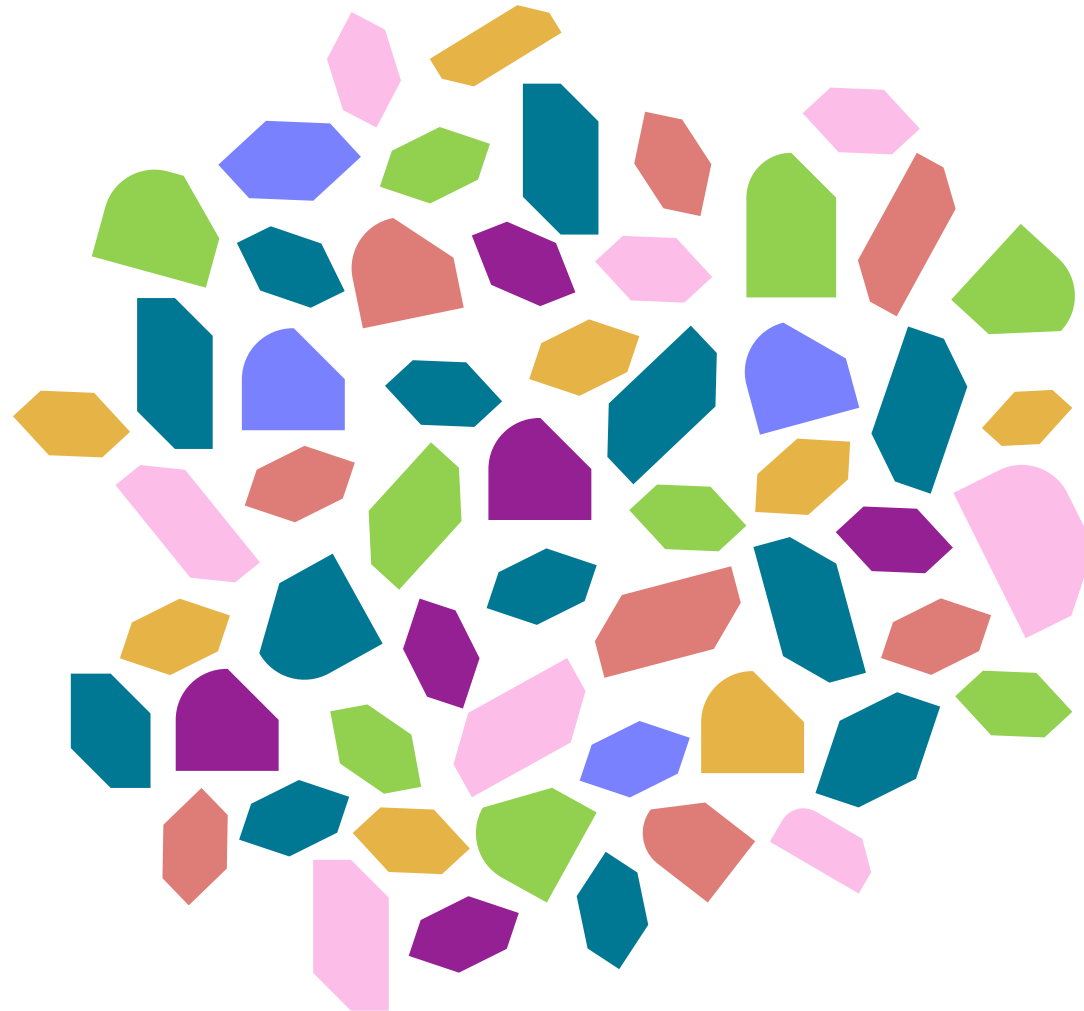
# Microplastics (MPs) properties reported by environmental scientists

Size

Polymer

Morphology

Concentration

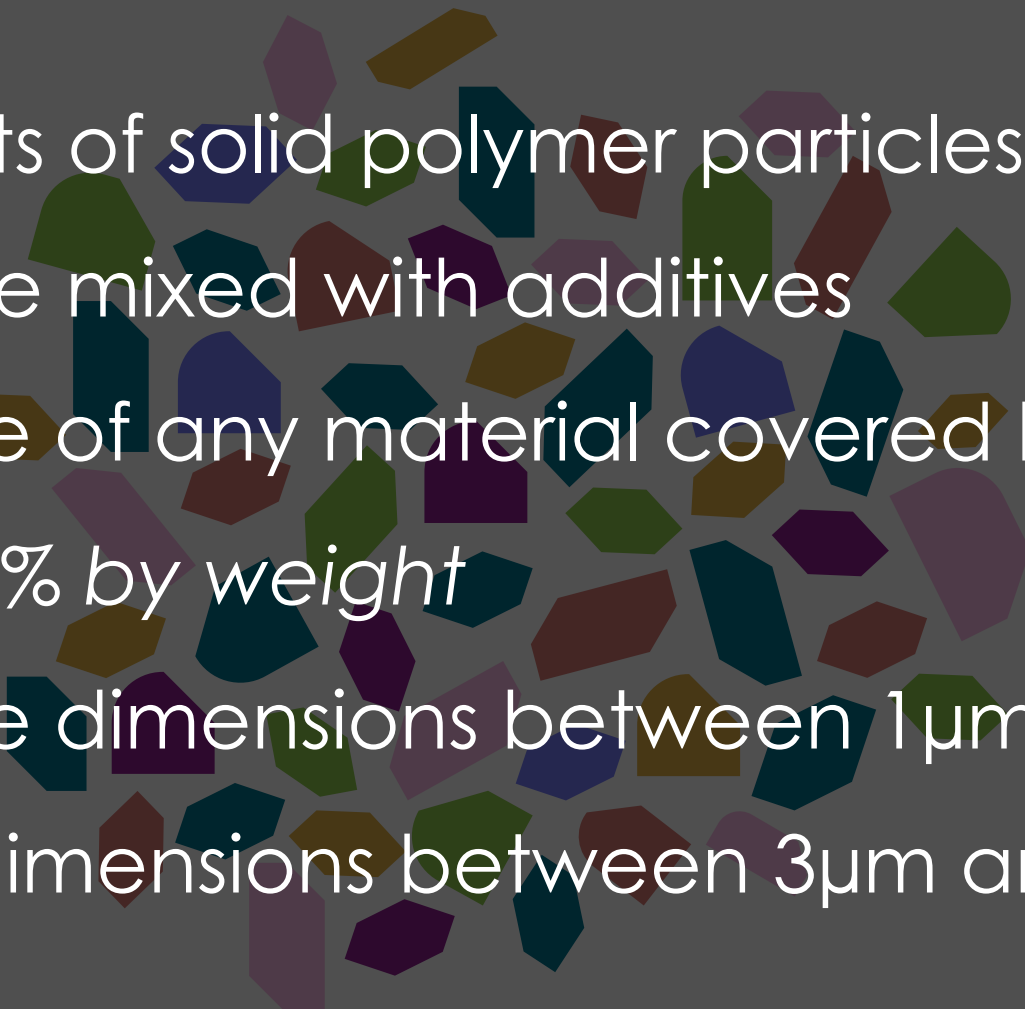


Plastic added  
chemicals

Surface  
chemistry

Sorbed  
metals

Aggregation  
state

- 
- Consists of solid polymer particles
  - May be mixed with additives
  - Particle of any material covered by polymer
  - From 1% *by weight*
  - Particle dimensions between 1 $\mu$ m and 5mm
  - Fiber dimensions between 3 $\mu$ m and 15mm



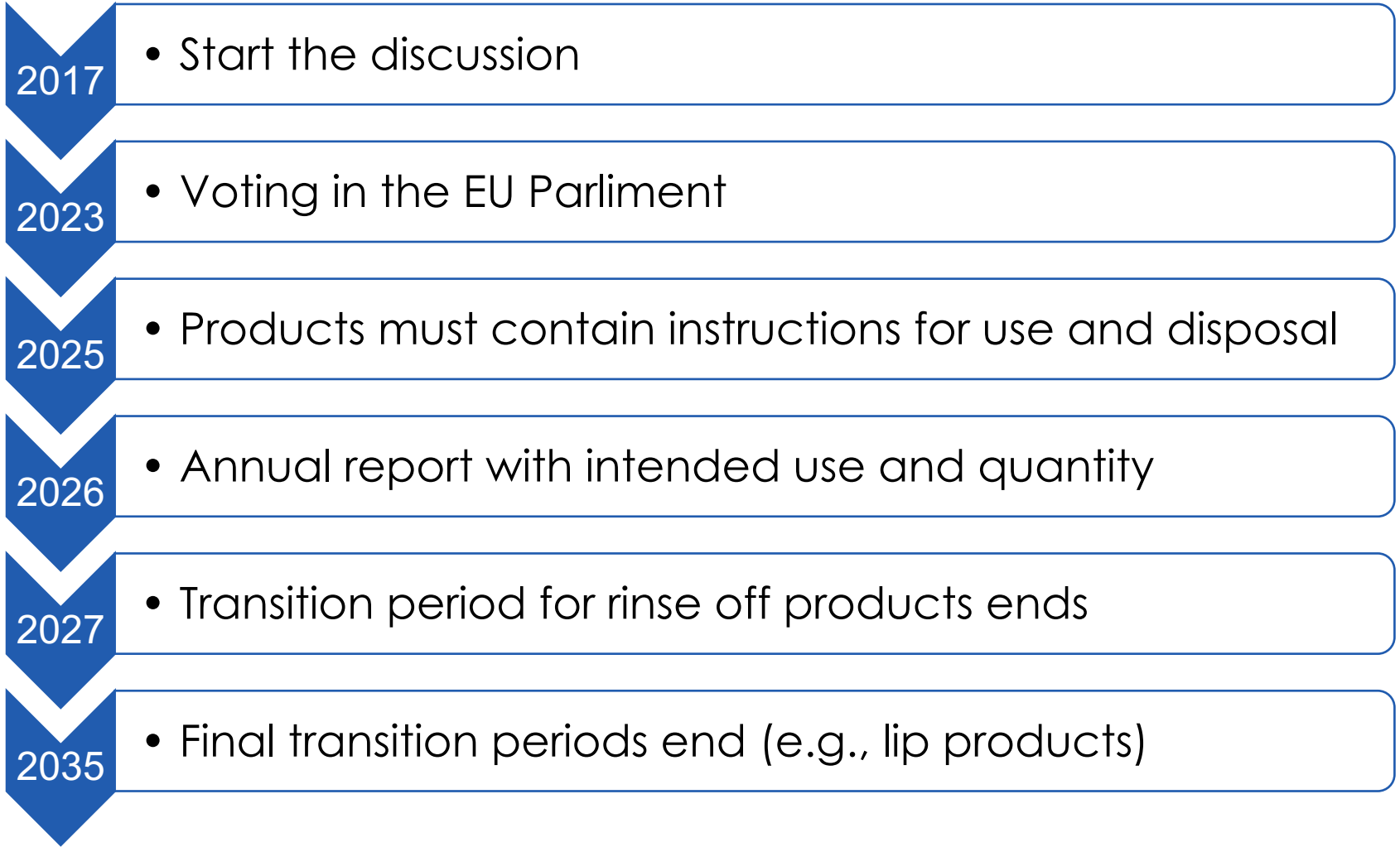
Waste Framework  
Directive

Circular Economy  
Action Plan

Chemicals Strategy  
for Sustainability

Legislative initiatives  
to restrict  
intentionally added  
microplastics

Legislative initiatives to restrict intentionally added microplastics



Use at industrial sites

Polymers that are permanently incorporated into a solid matrix during the intended end-use applications

Polymers whose physical properties are permanently altered during end use such that the polymer is no longer within scope

Polymers that have a solubility of more than 2 g/L

◆ Precautionary principal

## **Regulation of polymer**

Often exempted, low bioavailability  
Sector specific regulations apply

## **Regulation of additive**

EU, REACH, if > 1 ton manufactured  
US, chemical substance under TSCA

## **Regulation of primary solid MPs**

Various regulations and reporting in  
place or proposed regionally

- ◆ Precautionary principal
- ◆ Overarching chemical bans appropriate when there is clear evidence that targeted substances cause harm
- ◆ Normally regulations consider singular compounds, but (micro)plastics are considered collectively
- ◆ Can all microplastics be regulated the same way?

**A recipe for microplastics regulations**

**Precise definitions**

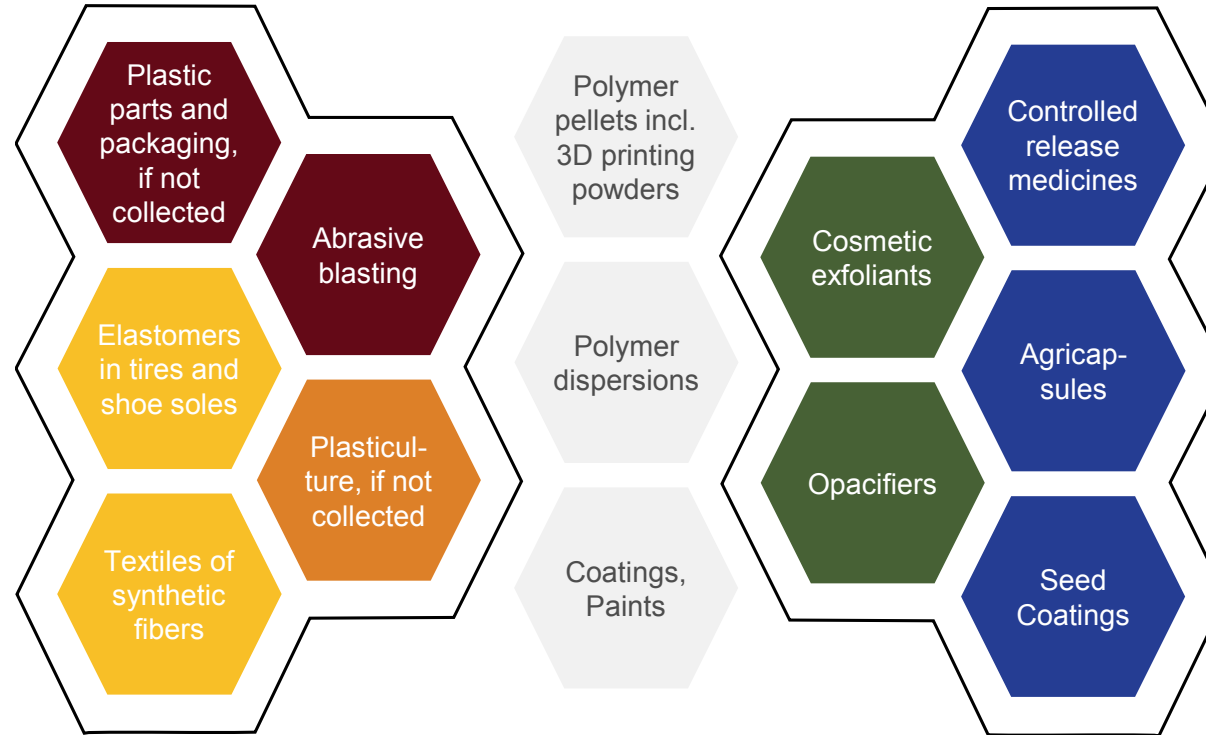
**Analytical capabilities**

**Link MPs to specific hazards**

**Enforceable and consistent**



# Does the solution (current regulation) solve the problem (major sources)?



Polymer makes up bulk of product, and is solid: secondary microplastic by degradation

Intermediates: microplastic, but particle nature lost through processing

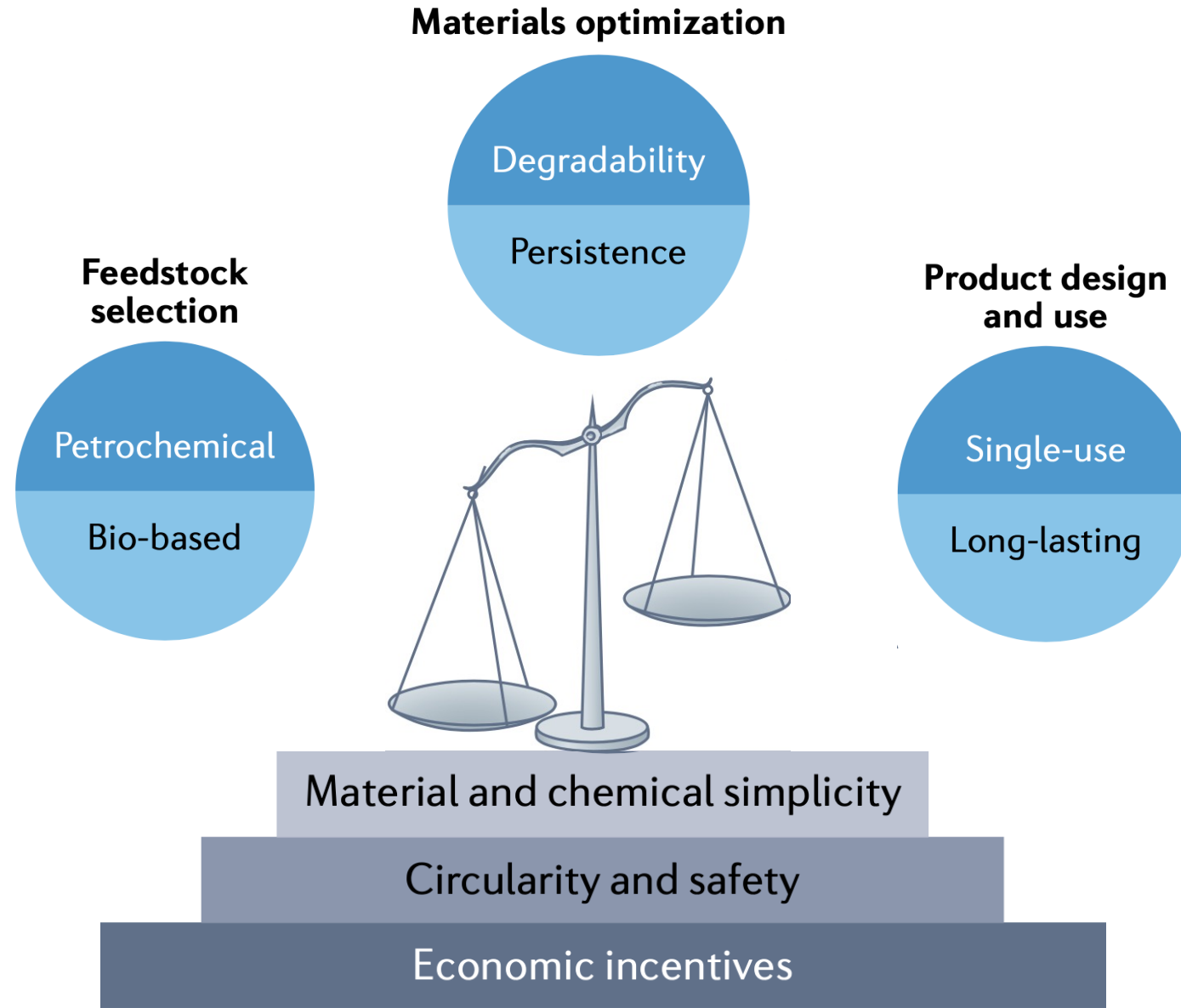
Primary microplastics, solid, constitute fraction of product. Use is open to environment

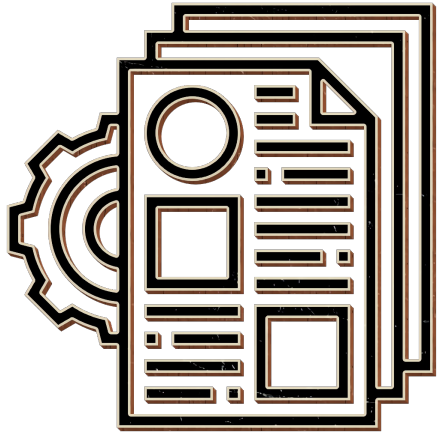


**Microplastic regulations do not apply**

**Regulations in place (regionally) or under discussion**

# Considerations for developing next generation plastics





- ◆ Measurable and enforceable regulations needed
- ◆ Current regulations leave little room for development except plastic-free alternatives
- ◆ More precise and directed regulations would allow industry to test/screen for most hazardous properties and opt for alternatives

## Can't be (micro)plastic regulation alone which solves pollution



- ◆ Develop sustainable materials and targeted (micro)plastic use
- ◆ Much research into current materials: their physical/chemical properties and costs, are optimized from the point of view of manufactures
- ◆ With additional research and development, alternative materials will catch up in terms of both price and performance

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