TG ENVIRONMENTAL RESEARCH

# Microplastic Particle Reference Materials

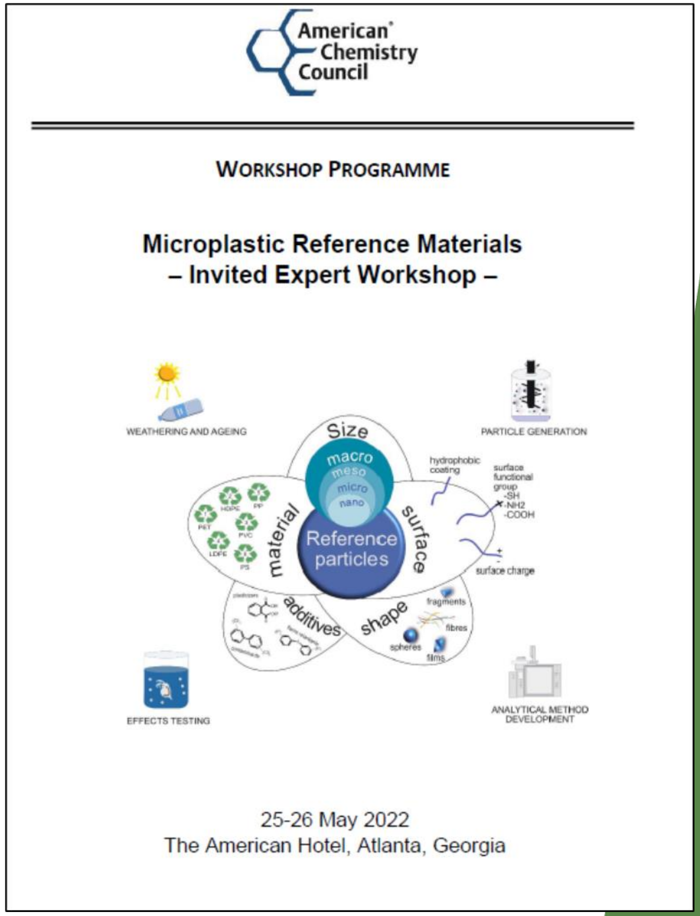
-

# Literature review

Todd Gouin

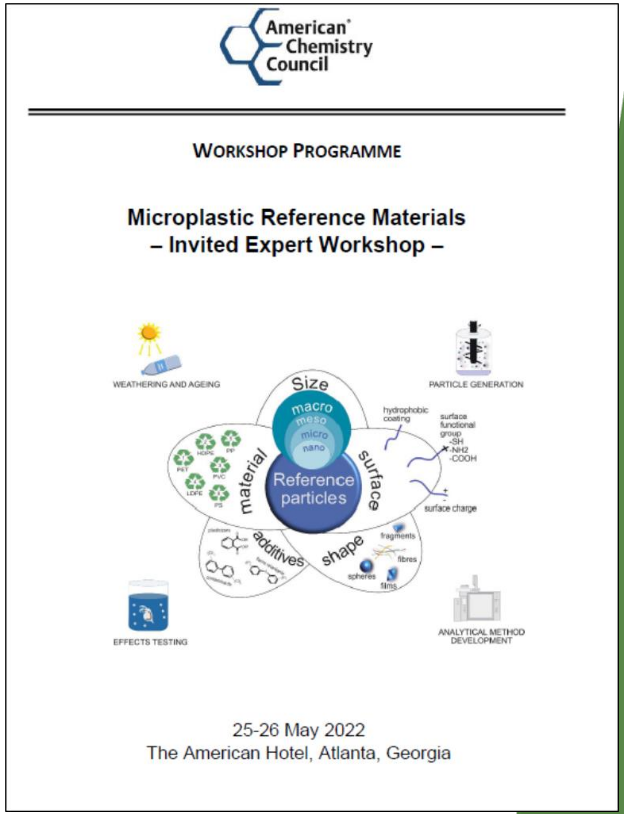
# ACC Microplastic Reference Materials Workshop

- What is envisioned by a suite of NMP reference materials?
  - Size
  - Shape
  - Polymer Composition
- Who will be responsible for generating and housing the materials?
  - Central organization(s) (industry, government, academic/research center)
- Should NMP reference materials include chemical additives, monomers, chemical residues, other contaminants?
  - If so, which ones with which types of polymers?
  - If not, why not?
- What are the best practices for generating NMPs?
- What are the best practices for weathering and aging plastic/NMPs?

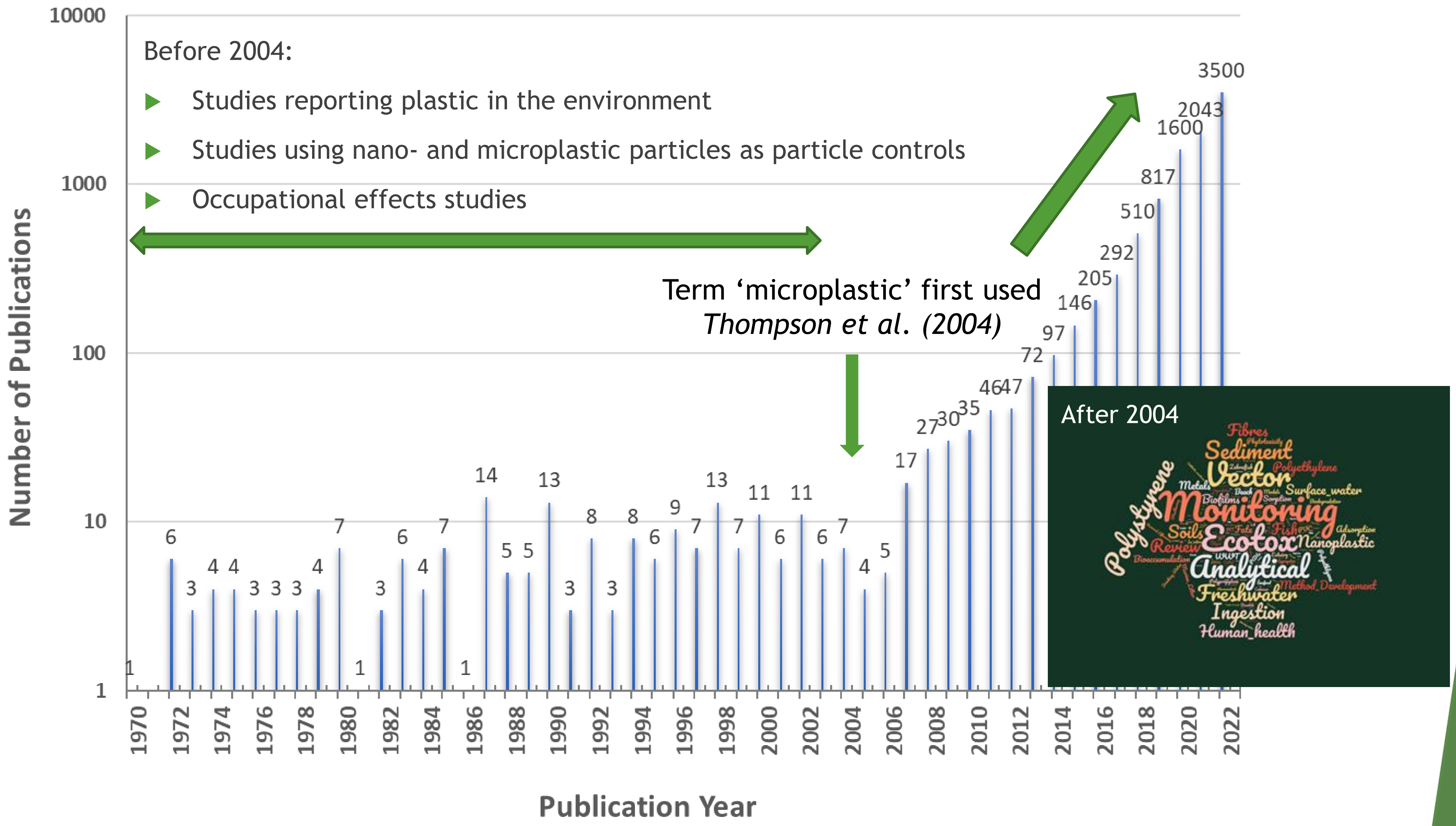


# Addressing the research needs for nano- and microplastic particles first requires access to REFERENCE MATERIALS

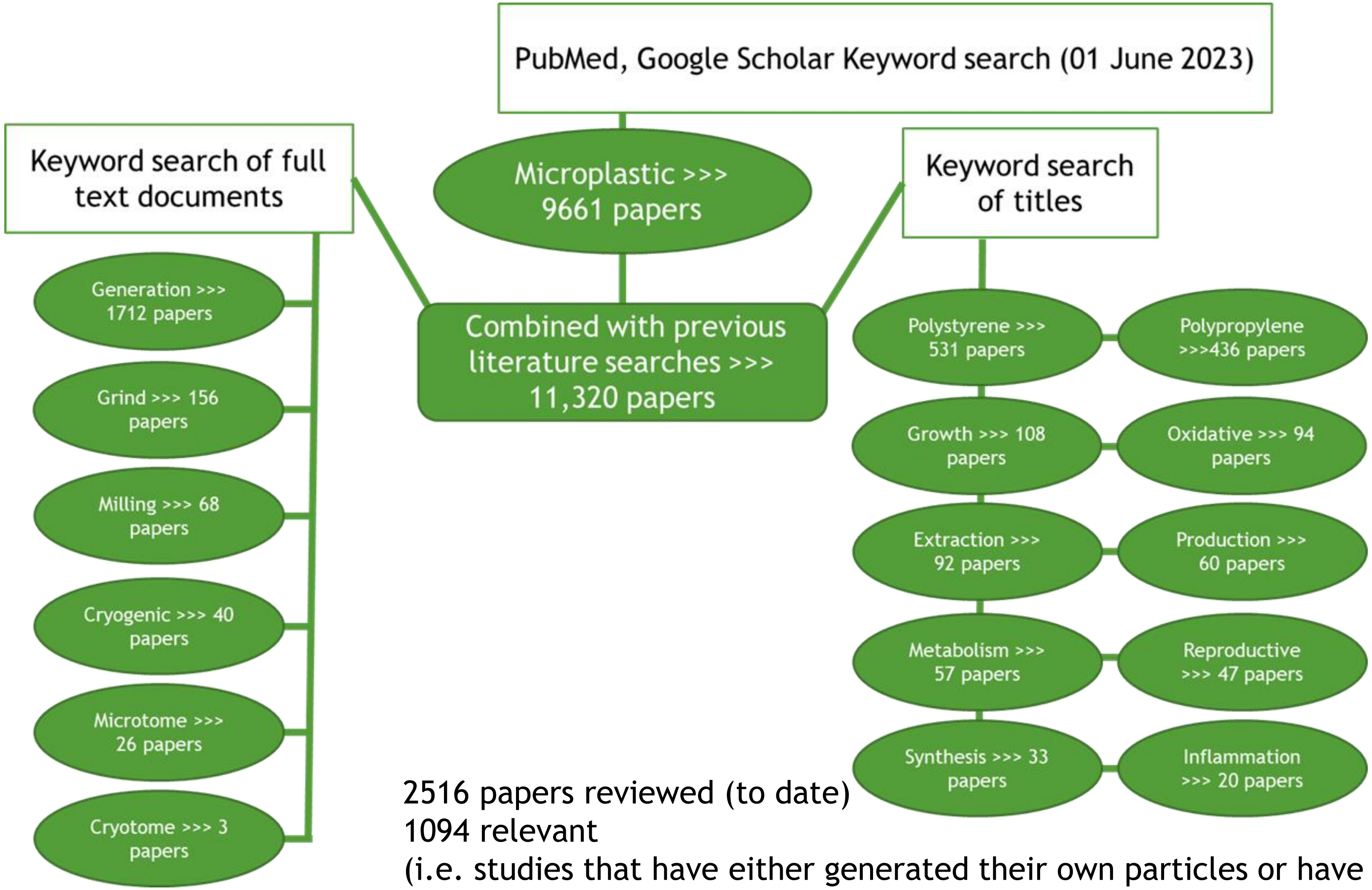
- Need to generate particles representative of both discrete sizes, shapes and polymer composition as well as a standard heterogenous mixture
  - Problem formulation
- Need to review the methods used for generating particles, with an emphasis on identifying strengths and weaknesses
- Identify long-hanging fruit opportunities – start simple
- Fibers!!
  - Research need.
- Benefits for reference materials:
  - Strengthen interlab comparisons (tox)
  - Strengthen analytical development
  - Reliable source of well-characterized particles



# Exponential growth in the scientific literature



# Literature review

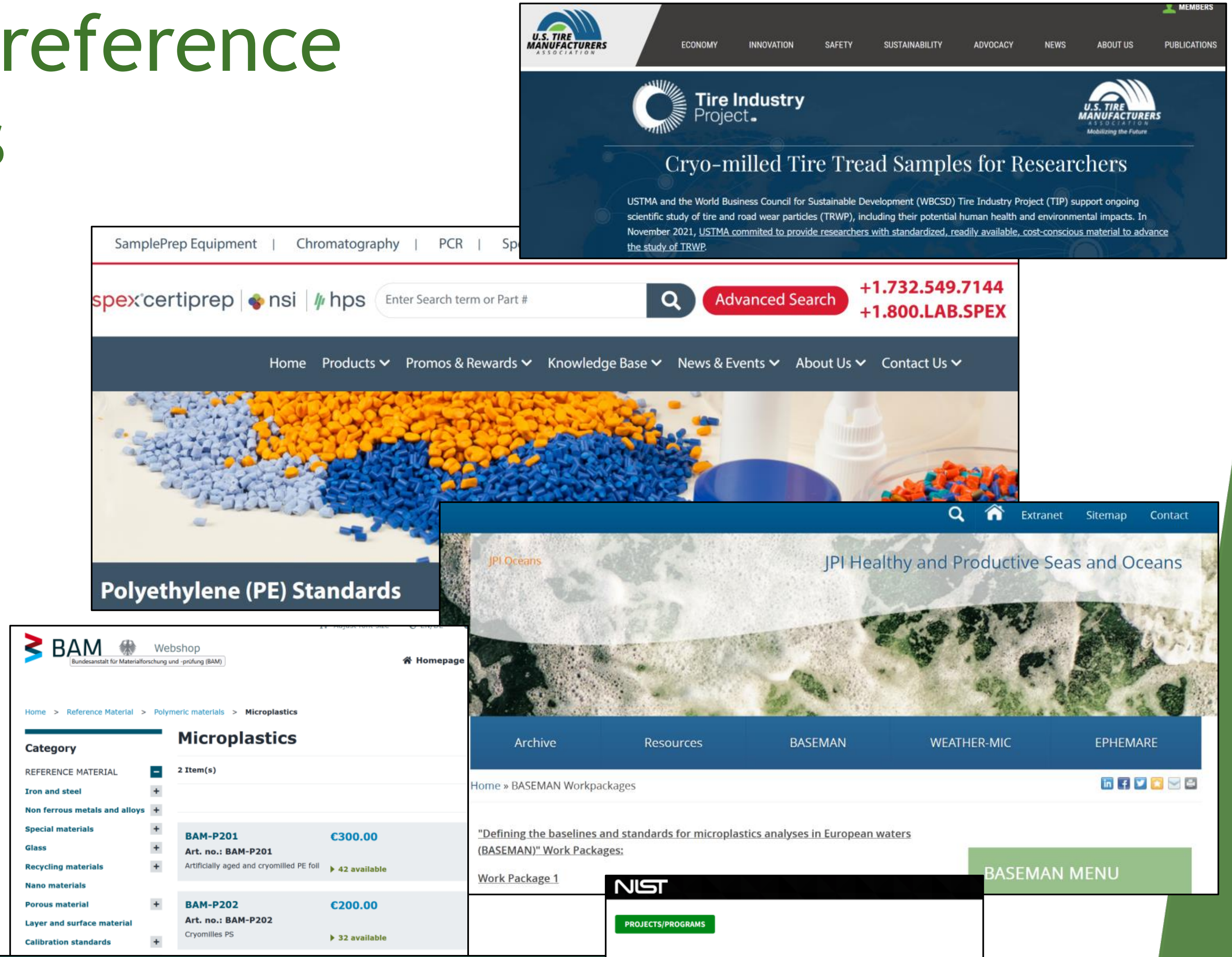


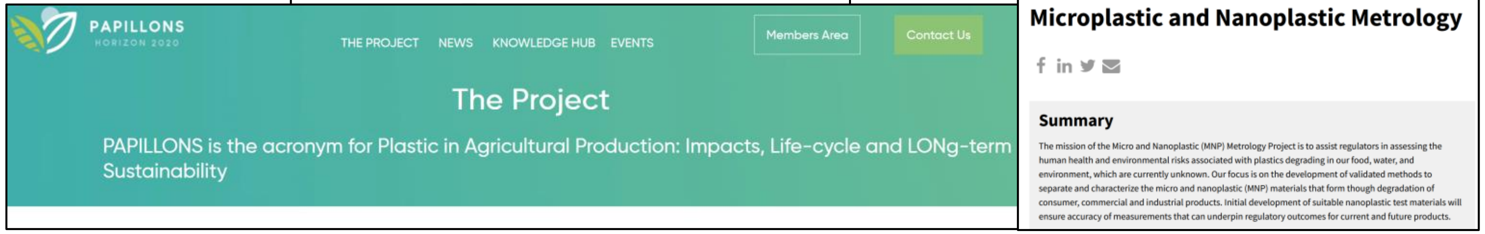

2516 papers reviewed (to date)
1094 relevant
(i.e. studies that have either generated their own particles or have purchased from a supplier for purposes of studying:

- Ecotoxicological effects
- Toxicological effects (mammalian in vivo or in vitro)
- Environmental fate
- Chemical sorption/leaching

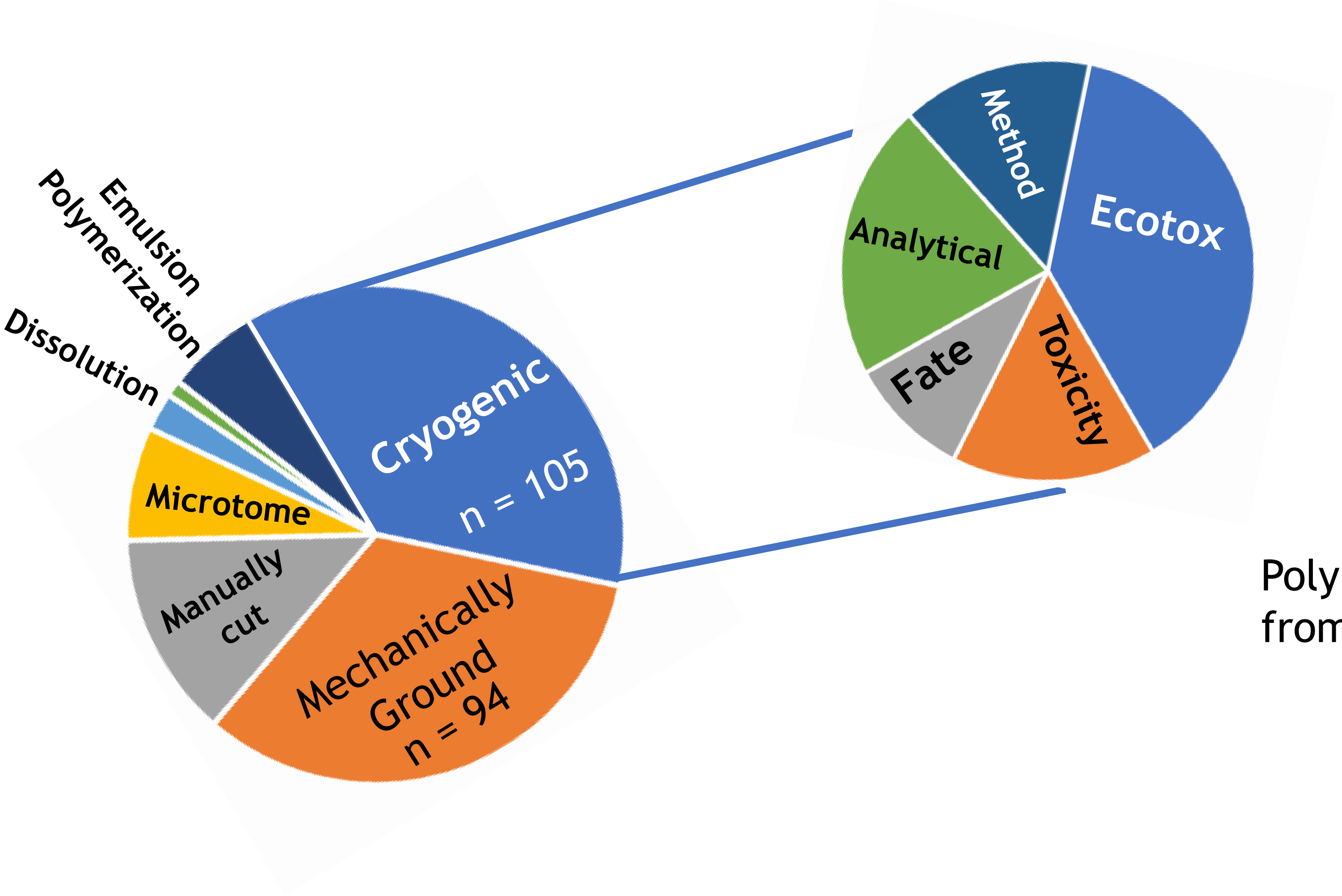
# Evidence of existing reference material repositories

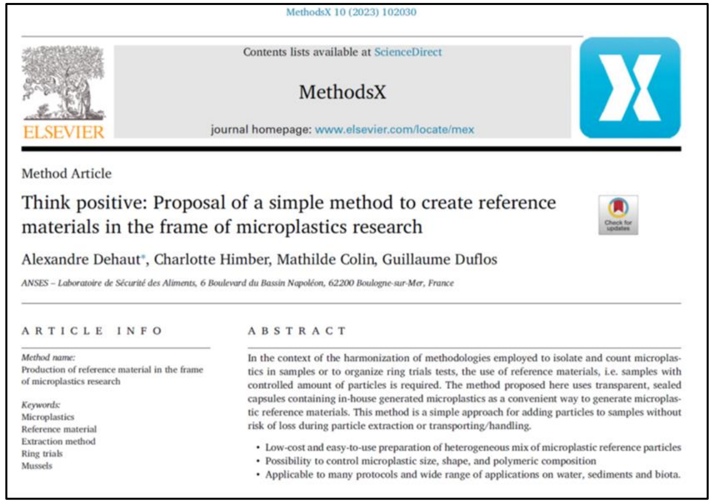
- Silos of activities
  - Spex ceriprep CRMs
    - PE, PVC, Plastic additives
  - Baseman (JPI Oceans project)
    - BASF, LyondellBasel, Borealis
  - H2020 CUSP
    - BAM
  - PlasticsEurope
    - TNO
  - IMPASSE and PAPILLON
  - U.S. Tire Manufacturers
    - Cryo-milled Tread samples
  - NIST
    - Particle characterization
  - Interlab comparisons
    - JRC, others



# Generated particles (285 studies)



MethodsX 10 (2023) 102030

Contents lists available at ScienceDirect

MethodsX

journal homepage: www.elsevier.com/locate/mex

ELSEVIER

Method Article

Think positive: Proposal of a simple method to create reference materials in the frame of microplastics research

Alexandre Dehaut*, Charlotte Himber, Mathilde Colin, Guillaume Duflos

ANSES – Laboratoire de Sécurité des Aliments, 6 Boulevard du Bassin Napoléon, 62200 Boulogne-sur-Mer, France

ARTICLE INFO

Method name:
Production of reference material in the frame of microplastics research

Keywords:
Microplastics
Reference material
Extraction method
Ring trials
Mussels

ABSTRACT

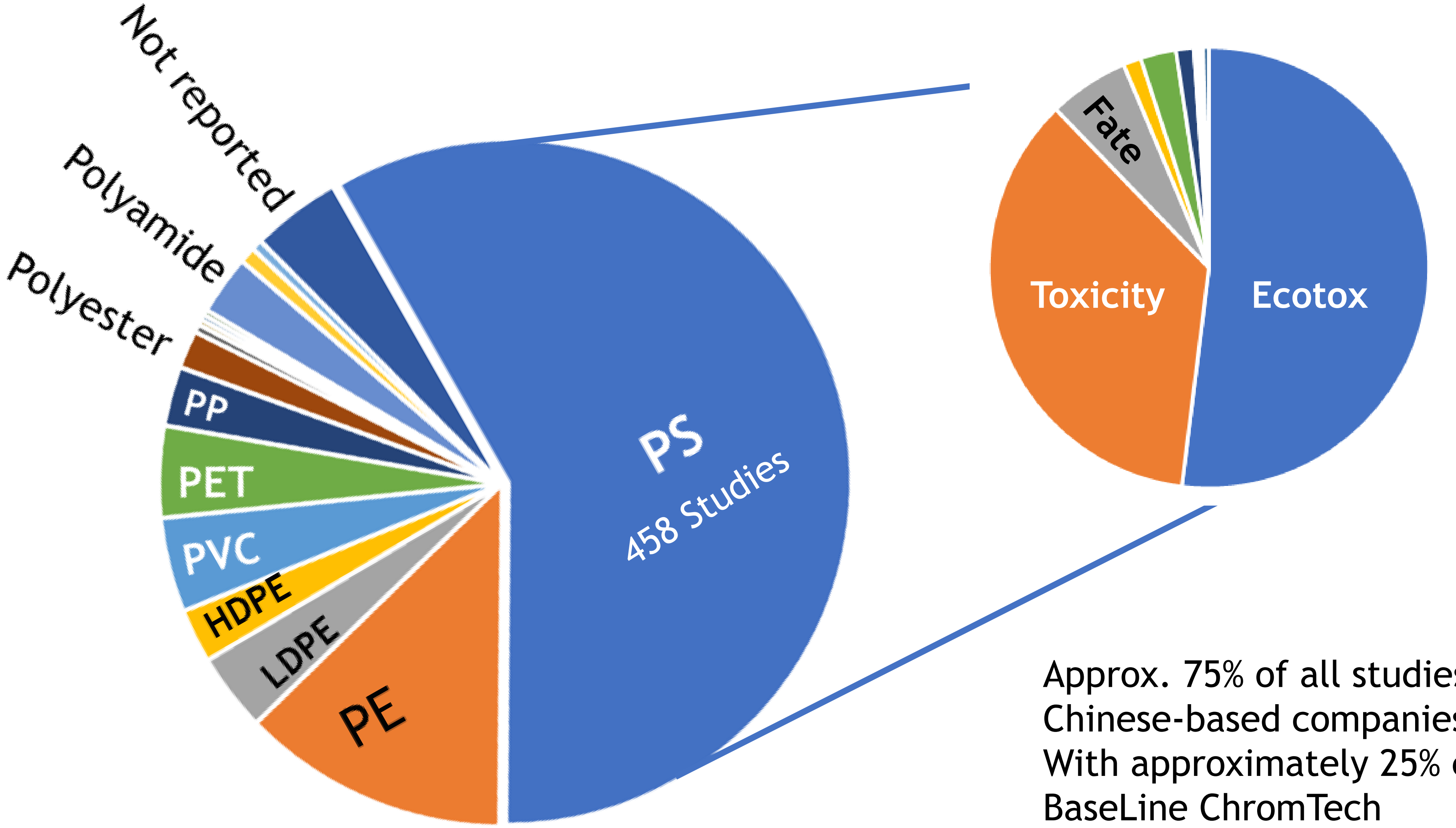
In the context of the harmonization of methodologies employed to isolate and count microplastics in samples or to organize ring trials tests, the use of reference materials, i.e. samples with controlled amount of particles is required. The method proposed here uses transparent, sealed capsules containing in-house generated microplastics as a convenient way to generate microplastic reference materials. This method is a simple approach for adding particles to samples without risk of loss during particle extraction or transporting/handling.

- Low-cost and easy-to-use preparation of heterogeneous mix of microplastic reference particles
- Possibility to control microplastic size, shape, and polymeric composition
- Applicable to many protocols and wide range of applications on water, sediments and biota.

Polymers with origin dominated from various consumer products:

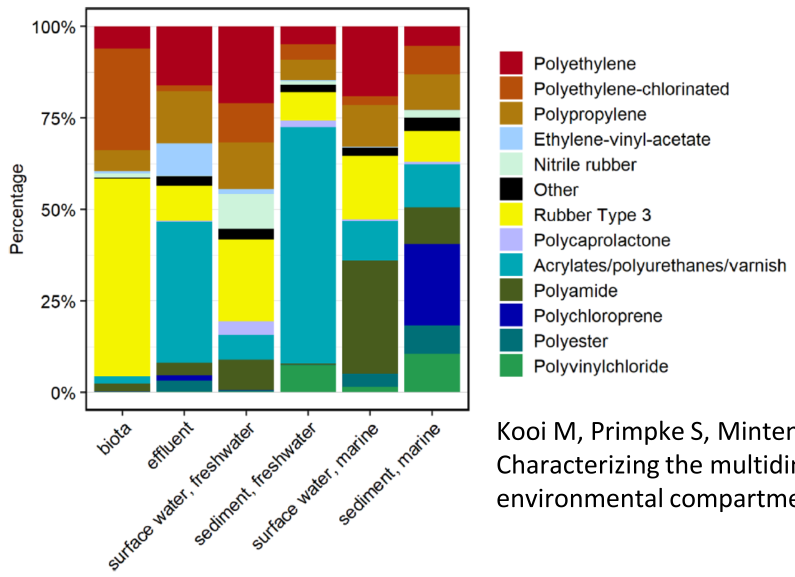
- PS
- PE
- PP
- PET
- PVC

# Purchased particles (single polymer; 785 studies)

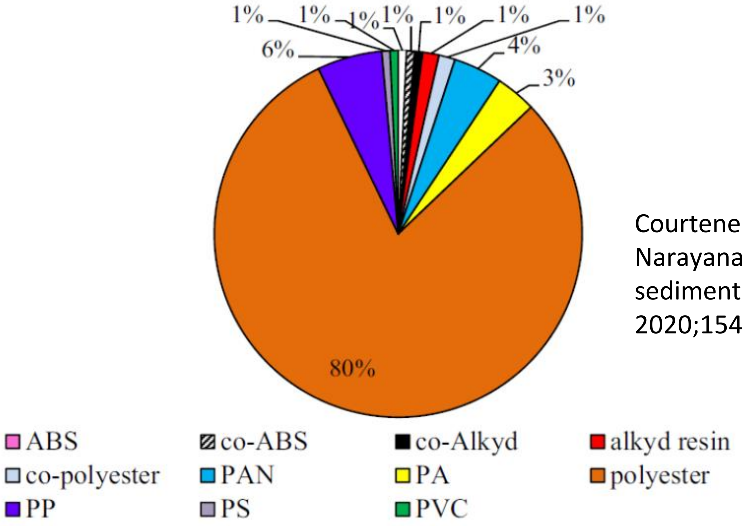



Approx. 75% of all studies sourced PS from Chinese-based companies
With approximately 25% coming from BaseLine ChromTech

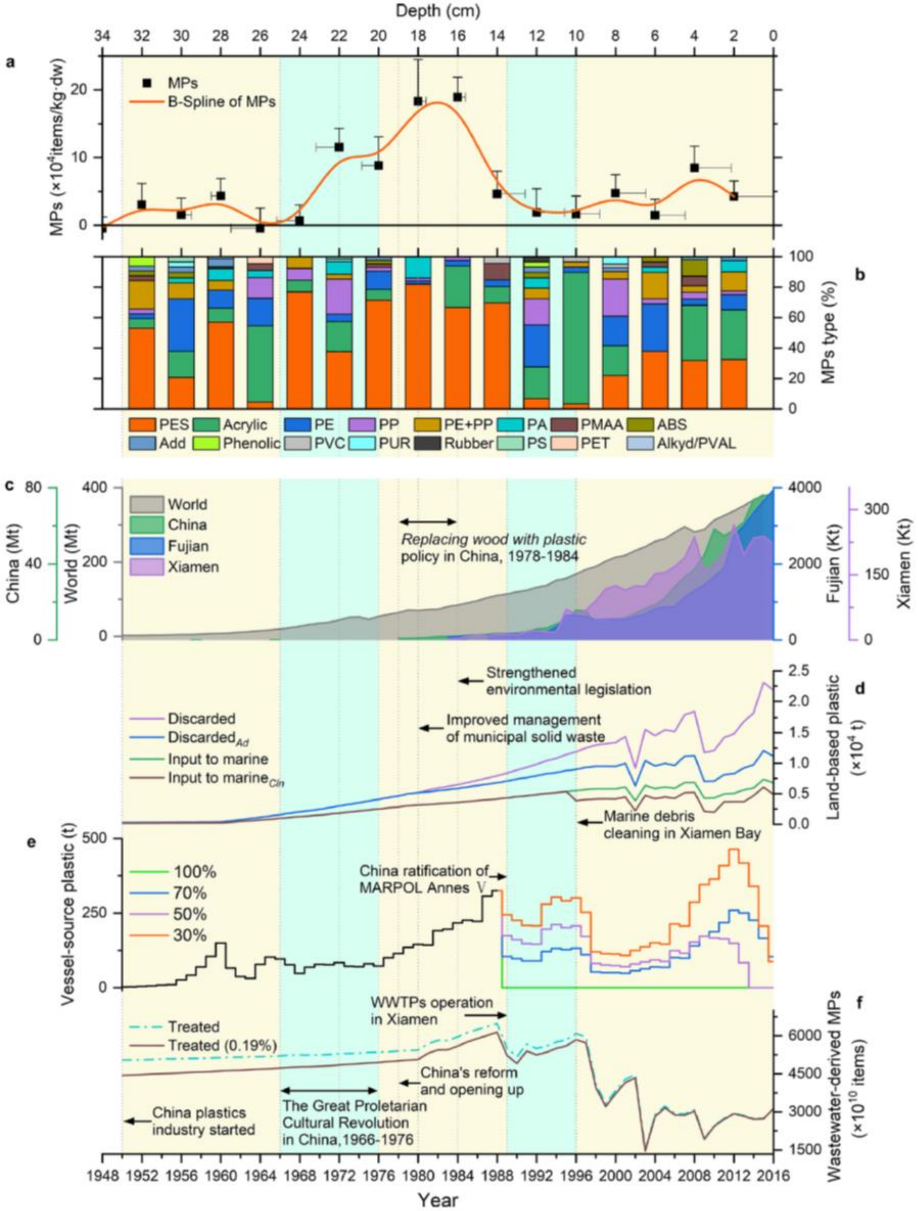
# Environmental data




Kooi M, Primpke S, Mintenig SM, Lorenz C, Gerdts G, Koelmans AA. Characterizing the multidimensionality of microplastics across environmental compartments. Water Res. 2021;202:117429.




Courtene-Jones W, Quinn B, Ewins C, Gary SF, Narayanaswamy BE. Microplastic accumulation in deep-sea sediments from the Rockall Trough. Mar Pollut Bull. 2020;154:111092




Long Z, Pan Z, Jin X, Zou Q, He J, Li W, et al. Anthropocene microplastic stratigraphy of Xiamen Bay, China: A history of plastic production and waste management. Water Res. 2022;226:119215

# What to prioritize?

- Heavy reliance on purchasing particles:
  - Chinese companies versus rest of the world
    - Dominated by polystyrene as a model particle used largely to support ecotox and toxicity testing
  - Particle characterization continues to be lacking
    - Research need?
- Large number of research groups are generating particles independently
  - Bespoke methods
  - Different types of starting materials
    - New consumer products
    - Environmentally collected debris
  - No standard methods being applied
- Feasibility of establishing a single group that might be responsible for creating and maintaining a repository of reference materials?
  - Resource co-ordination (logistical and scientific) would be significant!!
  - Community of practice
    - Facilitate activities aimed at pooling knowledge:
      - Particle characterization
      - Standard methods: Generation / Weathering / Aging

# Key considerations

Chemosphere 331 (2023) 138691

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

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Characterisation of microplastics is key for reliable data interpretation

Diana S. Moura[a,*], Carlos J. Pestana[a], Colin F. Moffat[a], Jianing Hui[b], John T.S. Irvine[b], Linda A. Lawton[a]

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Particle characterization

The size and polymer composition of some of the material provided by a supplier was inconsistent with the analytical data obtained.

- Commercially available particles
- Support for a particle repository
- Prioritize quantification of chemical contaminants
    - Plastic additives
    - Monomeric residuals
- Surface charge
- Surface area
- Particle size distribution
- Eco-corona

Environmental Science Processes & Impacts

ROYAL SOCIETY OF CHEMISTRY

CRITICAL REVIEW

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Cite this: *Environ. Sci.: Processes Impacts*, 2022, 24, 8

**Review of ecotoxicological studies of widely used polystyrene nanoparticles†**

Egle Kelpsiene,*[ac] Mikael T. Ekvall,[bc] Martin Lundqvist,[ac] Oscar Torstensson,[a] Jing Hua[a] and Tommy Cedervall[ac]

# Key considerations

Parker et al. Microplastics and Nanoplastics (2023) 3:10
https://doi.org/10.1186/s43591-023-00058-2
Microplastics and Nanoplastics

METHODOLOGY Open Access

**Protocol for the production of micro- and nanoplastic test materials**

Luke A. Parker[1*], Elena M. Höppener[1], Edward F. van Amelrooij[1], Sieger Henke[1], Ingeborg M. Kooter[1], Kalouda Grigoriadi[2], Merel G. A. Nooijens[2], Andrea M. Brunner[1] and Arjen Boersma[2]

Environmental Pollution 315 (2022) 120383
Contents lists available at ScienceDirect
Environmental Pollution
journal homepage: www.elsevier.com/locate/envpol

**Cryogrinding and sieving techniques as challenges towards producing controlled size range microplastics for relevant ecotoxicological tests☆**

Tony Gardon[a,*,1], Ika Paul-Pont[b], Gilles Le Moullac[a], Claude Soyez[a], Fabienne Lagarde[c], Arnaud Huvet[b]

[a] Ifremer, ILM, IRD, Univ Polynésie Française, UMR EIO, F-98719, Taravao, Tahiti, Polynésie Française, France
[b] Univ Brest, Ifremer, CNRS, IRD, LEMAR, F-29280, Plouzané, France
[c] Institut des Molécules et Matériaux du Mans, IMMM - UMR CNRS 6283, Le Mans Université, Avenue Olivier Messiaen, 72085, Le Mans, France

Powder Technology 412 (2022) 117960
Contents lists available at ScienceDirect
Powder Technology
journal homepage: www.journals.elsevier.com/powder-technology

**Characterisation of different manufactured plastic microparticles and their comparison to environmental microplastics**

S. Kefer[a,*], T. Friedenauer[b], H.-C. Langowski[c]

[a] Chair of Brewing and Beverage Technology TUM, Weihenstephaner Steig 20, 85354 Freising, Germany
[b] Technical Chemistry I, University of Duisburg-Essen, Universitätsstr. 7, 45141 Essen, Germany
[c] TUM School of Life Sciences, Weihenstephaner Steig 22, 85354 Freising, Germany

## Particle generation: Best practices

- Performance related to different types of polymers
  - Cryogenic milling
  - Mechanical grinding
- Manually cut (Fibres)
  - Cryotome
- Dissolution/precipitation
  - Appropriateness of different solvents relative to polymer of interest
- Emulsion polymerization
  - Polystyrene main polymer generated to date

# Key considerations

Community of practice

Problem formulation
Why are particles being used/generated?

Are they fit-for-purpose?

## Particle characterization

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- Support for a particle repository
- Prioritize quantification of chemical contaminants
  - Plastic additives
  - Monomeric residuals
- Surface charge
- Surface area
- Particle size distribution
- Eco-corona

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**Problem formulation**
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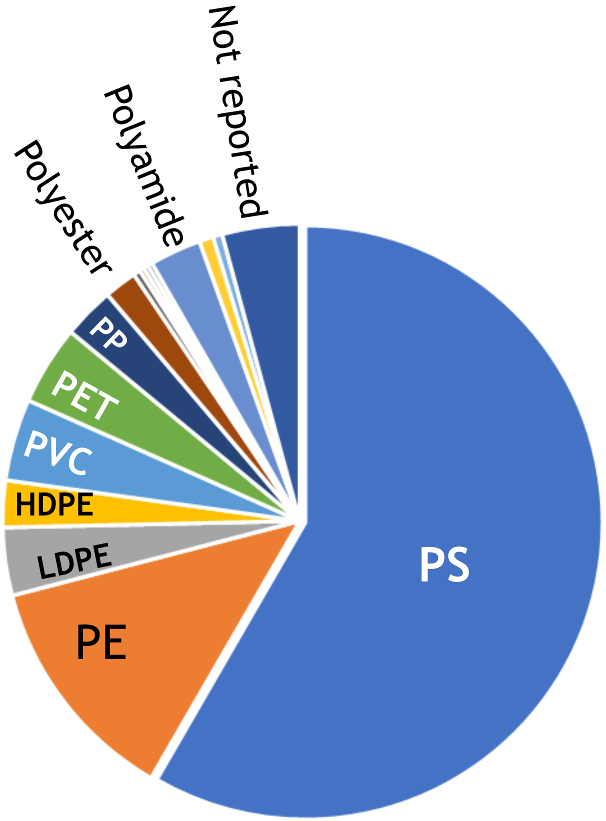
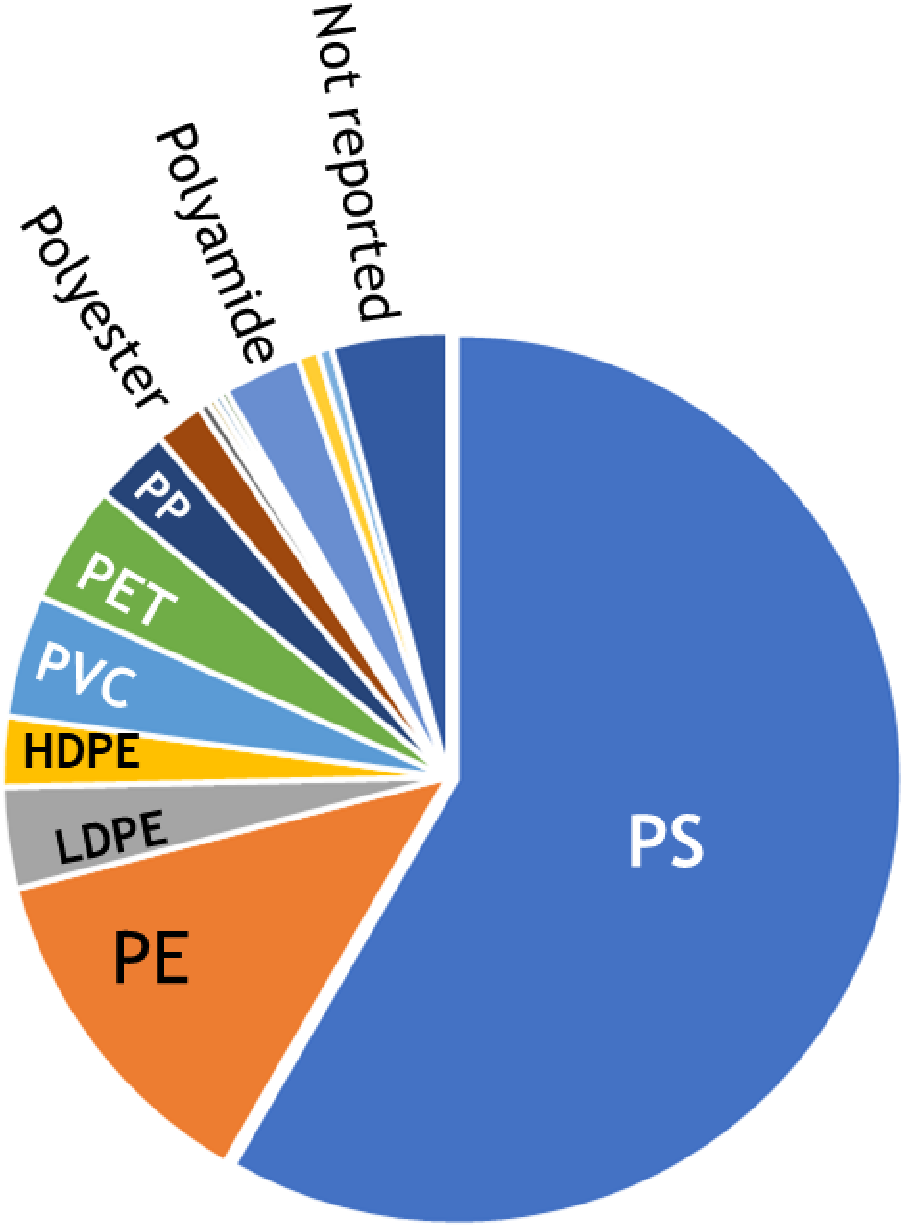
# Acknowledgements

American Chemistry Council®


Not reported
Polyamide
Polyester
PP
PET
PVC
HDPE
LDPE
PE
PS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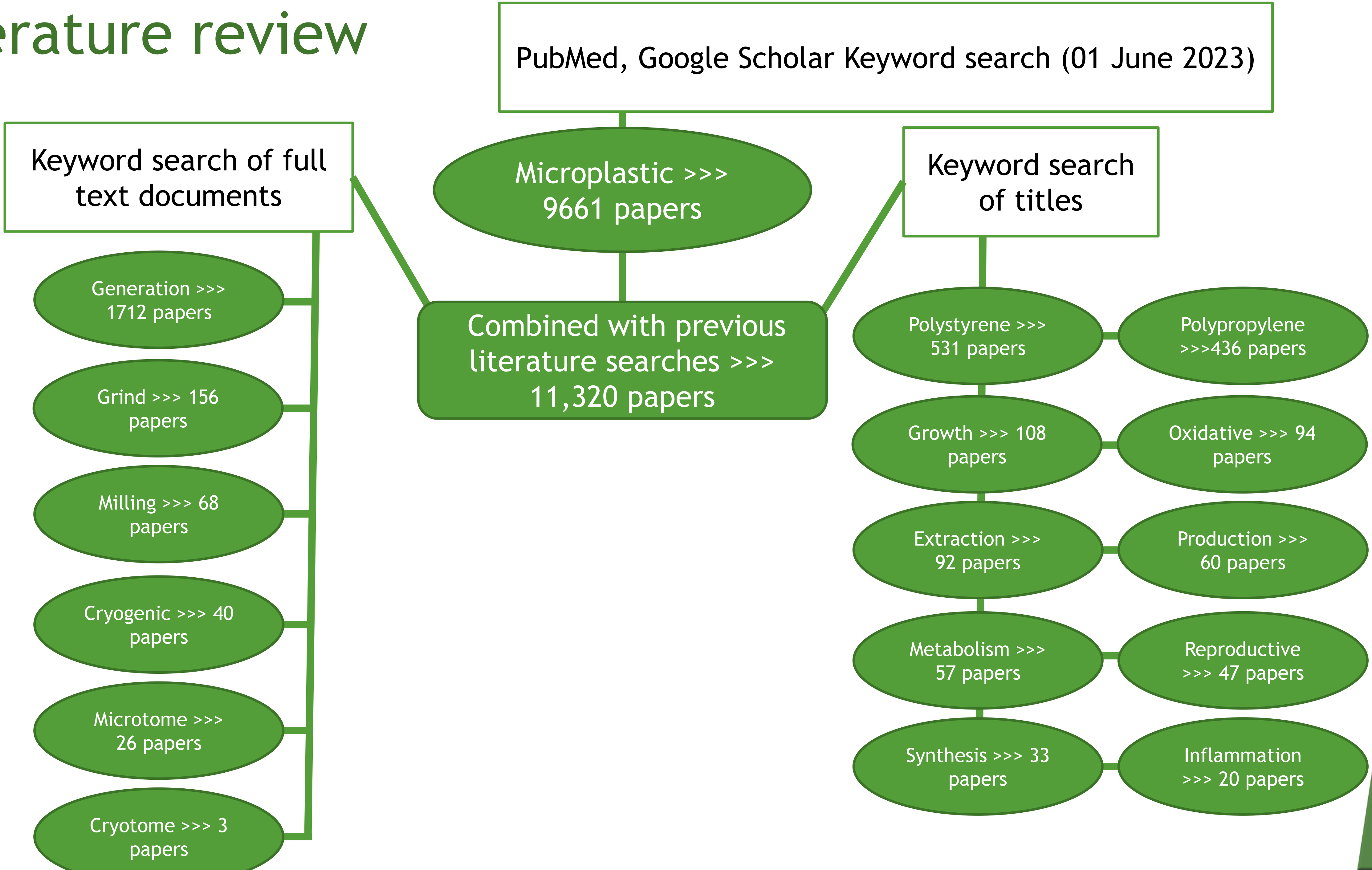

# Way forward

- Co-ordination between all groups generating NMPs
  - Prioritize
    - Polymer types
    - Shapes
    - Sizes
  - Best practices needed for generating, weathering and aging
    - Experts
      - Community of practice
      - Data-sharing resources
- Logistical challenges
  - Key groups (NIST, JRC, industry trades, etc.)