MJPHD

CONCENTRATION AND ANALYSIS OF AQUEOUS MICRO- AND NANOPARTICLE SUSPENSIONS

MARK JONES
CREATIVE DIRECTOR
MJPHD, LLC

DALE LECAPTAIN
PROFESSOR
CENTRAL MICHIGAN UNIVERSITY

23 March 2026

1

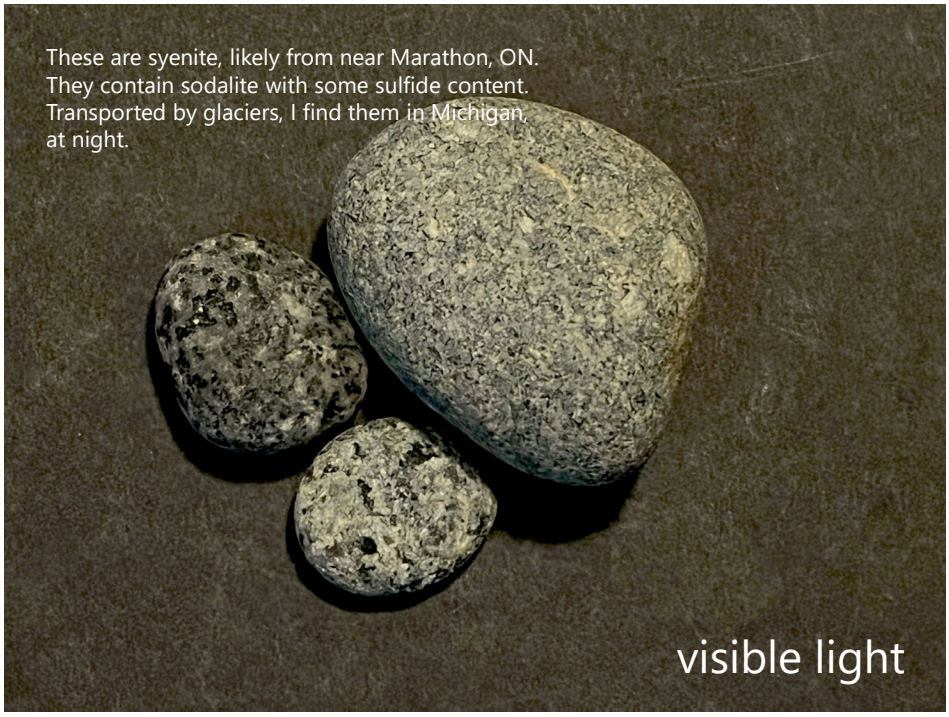
Microplastics are lipophilic, a property that can be used in their collection and concentration.

Plastic containers used for beverages shed plastic particles when physically stressed during shipment and use.

Development of options to include microplastics in testing of water quality with students.

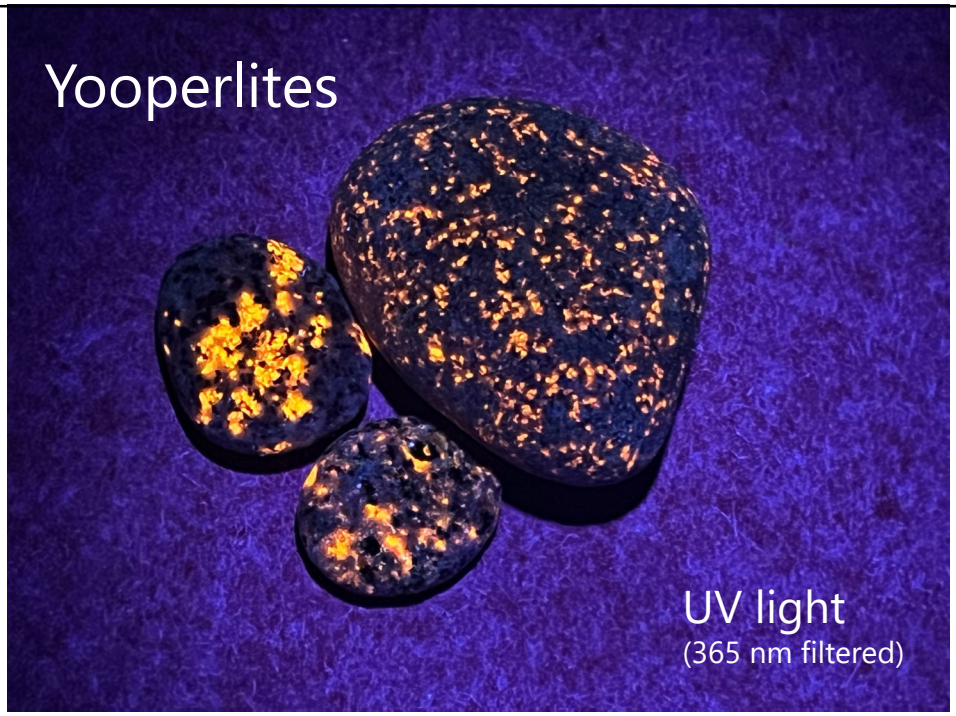
MJPHD

2



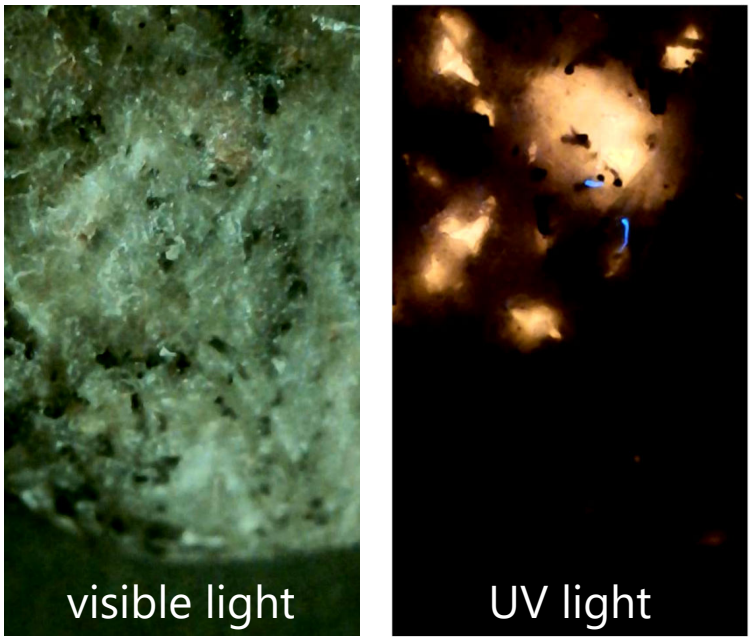
MJPhD

3



MJPhD

4



MJPhD

5

MJPhD

6

Cameras and Microscopes

requires hardware that does not automatically adjust exposure

cameras with Sony low-light sensors (2.1 and 4 megapixel [IMX 323 and IMX586 CMOS sensor])

MJPhD

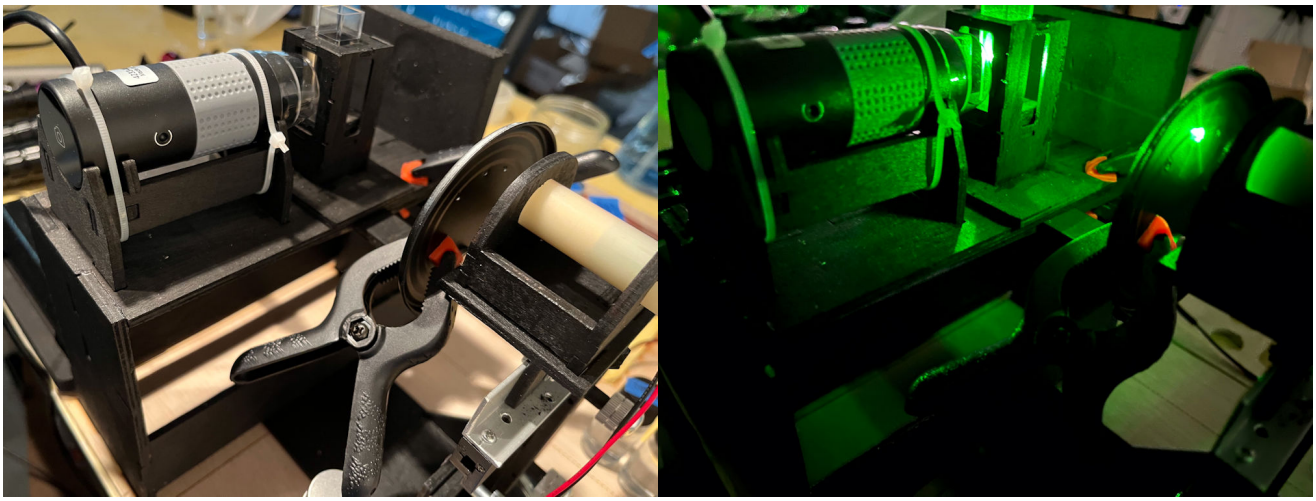
7

Portable/Rapid Setup

MJPhD

8

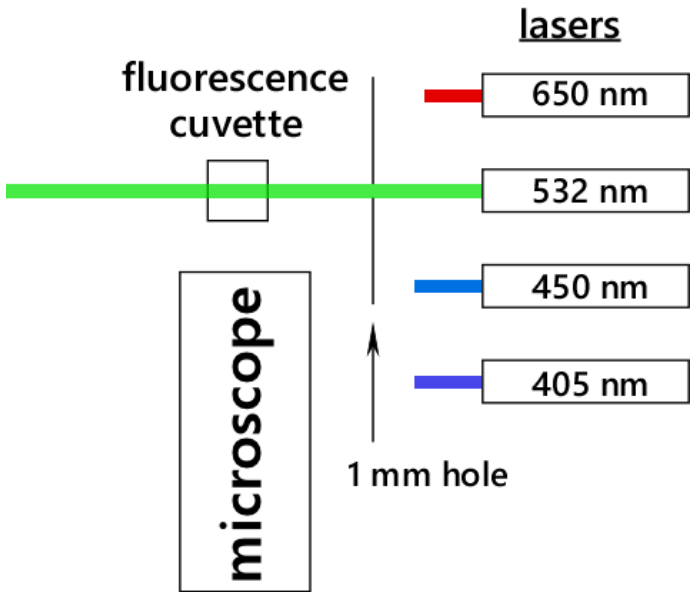
Rayleigh Scattering



MJPhD

9

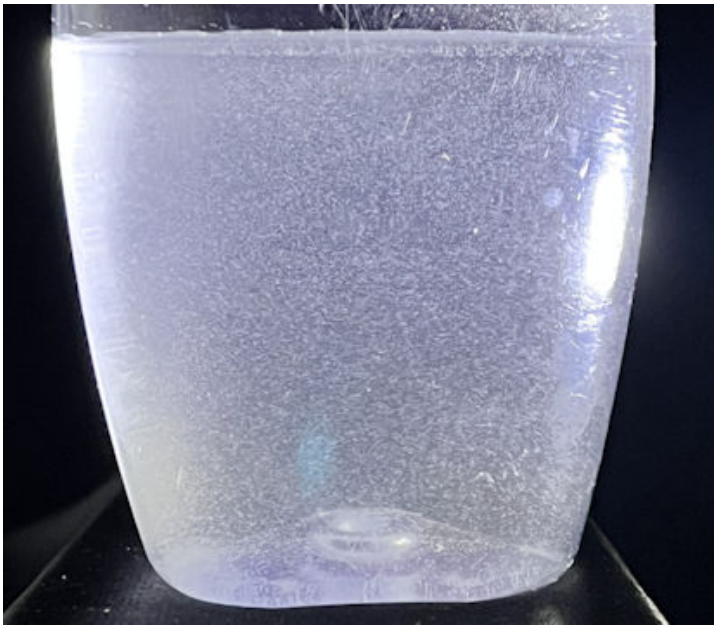
Rayleigh Scattering



Ye, Yan, and David YH Pui. "Detection of nanoparticles suspended in a light scattering medium." Scientific reports 11, no. 1 (2021): 20268.

MJPhD

10



MJPhD

12

https://mjphd.net/sc/sc.php?003

Yellow Fluorescent PET
365 nm UV Light

MJPhD

13

https://mjphd.net/sc/sc.php?005

PET Suspension

March 2026

MJPhD

15

Microplastics in the Environment –

Development of a Sample Preparation Method with Further Application and Evaluation in Fluvial and Marine Compartments

Von der Fakultät für Georessourcen und Materialtechnik der Rheinisch-Westfälischen Technischen Hochschule Aachen

zur Erlangung des akademischen Grades einer **Doktorin der Naturwissenschaften** genehmigte Dissertation

vorgelegt von
M. Sc. Simone Elisabeth Lechthaler
aus Düsseldorf

Berichter: PD Dr. rer. nat. Georg Stauch
Univ.-Prof. Dr.-Ing. Holger Schüttrumpf

Tag der mündlichen Prüfung: 10.05.2021

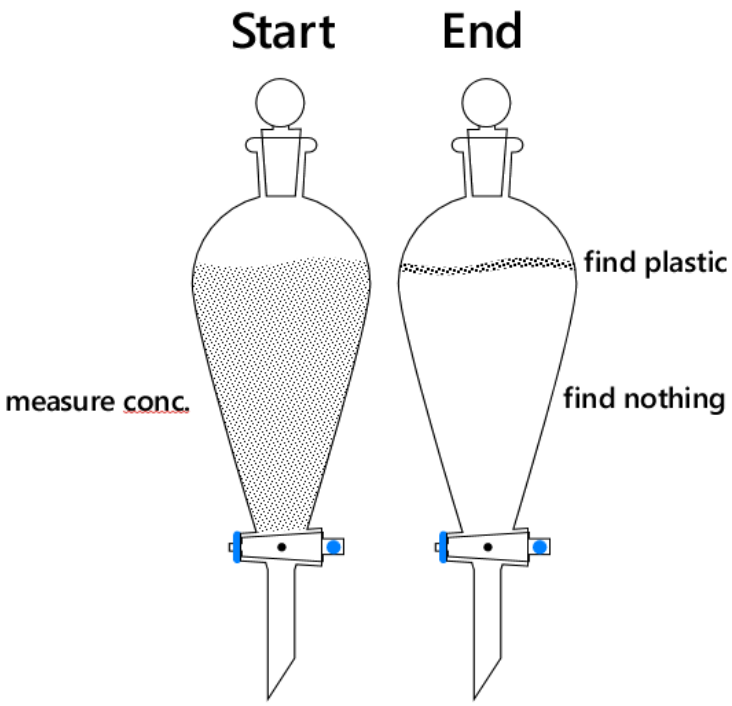
Diese Dissertation ist auf den Internetseiten der Universitätsbibliothek online verfügbar.

"extraction" into oil as a way of concentrating microplastic particles was described in 2021 by Simone Elisabeth Lechthaler

what about nano?

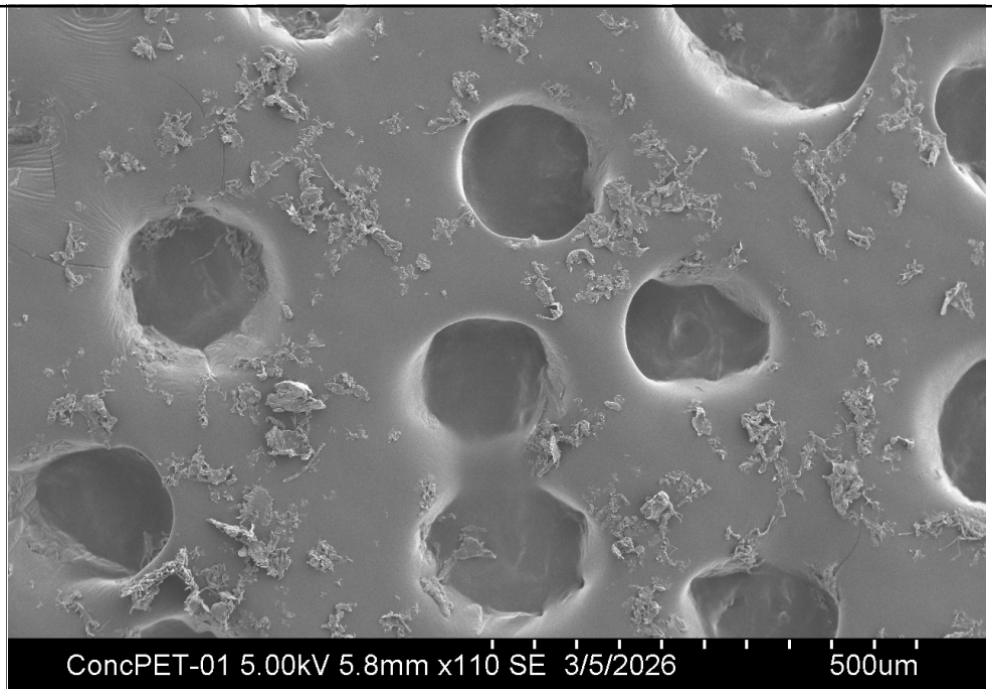
MJPhD

16



MJPhD

17



taken by Maraion Murrell

MJPhD

18

Observations and Hypothesis

- Observations:
  - it is impossible to find water free of particles
  - water with the same lot numbers and in the same cases/packages contain different amounts of plastic particles
  - bottles on the outside of cases/packages can, but don't always, contain more particles than those in the center of the case/package
  - there are particles produced from processing equipment present

- Hypothesis: impacts and flexing of polymer containers creates microplastic particles, some surprisingly big

MJPhD

20

Disagreement with the Literature

Chemosphere 343 (2023) 140106

Contents lists available at ScienceDirect

Chemosphere

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

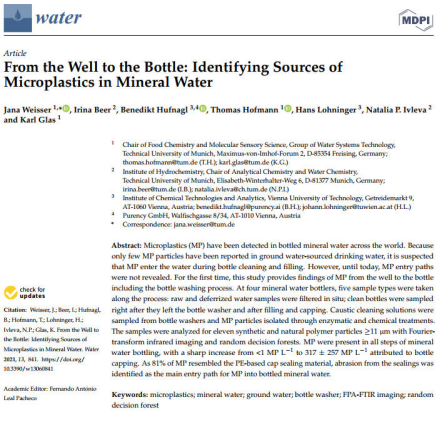
Exposure to micro(nano)plastics polymers in water stored in single-use plastic bottles

Albert Vega-Herrera [a], Maria Garcia-Torné [a], Xavier Borrell-Diaz [a], Esteban Abad [a], Marta Llorca [a], Cristina M. Villanueva [b,c,d,e], Marinella Farré [b,*]

HIGHLIGHTS

- Polyethylene terephthalate was the polymer found at highest concentrations.
- The most frequently detected polymer was polyethylene.
- The median value of the sum of polymer concentrations was 359 ng L^{-1}.
- 28 plastic additives were tentative detected in waters analysed from plastic bottles of 20 different commercial brands.
- Bis(2-ethylhexyl) adipate and bis(2-ethylhexyl) phthalate were the riskiest plastic additives for human health by the prioritisation study.

GRAPHICAL ABSTRACT



water

MDPI

Article

From the Well to the Bottle: Identifying Sources of Microplastics in Mineral Water

Jana Weisser [1,*], Irina Beer [2], Benedikt Hufnagl [3,4], Thomas Hofmann [1], Hans Lohninger [3], Natalia P. Ivleva [2] and Karl Glas [1]

[1] Chair of Food Chemistry and Molecular Sensory Science, Group of Water Systems Technology, Technical University of Munich, Maximus-von-Imhof-Forum 2, D-85354 Freising, Germany; thomas.hofmann@tum.de (T.H.); karl.glas@tum.de (K.G.)
[2] Institute of Hydrochemistry, Chair of Analytical Chemistry and Water Chemistry, Technical University of Munich, Elisabeth-Winterhalter-Weg 6, D-81377 Munich, Germany; irina.beer@tum.de (I.B.); natalia.ivleva@ch.tum.de (N.P.I.)
[3] Institute of Chemical Technologies and Analytics, Vienna University of Technology, Getreidemarkt 9, AT-1060 Vienna, Austria; benedikt.hufnagl@purencya.at (B.H.); johann.lohninger@tuwien.ac.at (H.L.)
[4] Purency GmbH, Wallischgasse 8/34, AT-1010 Vienna, Austria
* Correspondence: jana.weisser@tum.de

check for updates

Citation: Weisser, J.; Beer, I.; Hufnagl, B.; Hofmann, T.; Lohninger, H.; Ivleva, N.P.; Glas, K. From the Well to the Bottle: Identifying Sources of Microplastics in Mineral Water. *Water* **2021**, *13*, 841. https://doi.org/10.3390/w13060841

Academic Editor: Fernando António Leal Pacheco

Environ Monit Assess (2023) 195:62
https://doi.org/10.1007/s10661-022-10697-2

Investigating the pollution of bottled water by the microplastics (MPs): the effects of mechanical stress, sunlight exposure, and freezing on MPs release

Water Research 168 (2019) 115082

Contents lists available at ScienceDirect

Water Research

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

Does mechanical stress cause microplastic release from plastic water bottles?

Anna Winkler [a], Nadia Santo [b], Marco Aldo Ortenzi [c], Elisa Bolzoni [a], Renato Bacchetta [a,*], Paolo Tremolada [b]

[a] Department of Environmental Science and Policy, University of Milan, Via Celoria 26, 20133, Milan, Italy
[b] Unitech NOLIMITS, Imaging facility, University of Milan, Via Golgi 19, 20133, Milan, Italy
[c] CRC Materiali Polimerici (LaMPo), Department of Chemistry, University of Milan, Via Golgi 19, 20133, Milan, Italy

ARTICLE INFO

Article history:
Received 24 June 2019
Received in revised form
9 September 2019
Accepted 11 September 2019
Available online 13 September 2019

Keywords:
Microplastic sources
Drinking water
Scanning electron microscopy
Water bottles
Plastic degradation

ABSTRACT

Plastic particle ingestion has become of concern as a possible threat to human health. Previous works have already explored the presence of microplastic (MP) in bottled drinking water as a source of MP intake. Here, we consider the release of MP particles from single-use PET mineral water bottles upon exposure to mechanical stress utilizing SEM plus EDS, which allows the implementation of morphological and elemental analysis of the plastic material surface and quantification of particle concentrations in sample water. The aim of this study was to better evaluate the sources of MP intake from plastic bottles, especially considering the effect of daily use on these bottles such as the abrasion of the plastic material. For that, we analysed MP release of PET bottlenecks and HDPE caps on their surfaces after a series of bottle openings/closings (1 x, 10 x, 100 x). Furthermore, we investigated, if the inner surface of the PET bottles released MPs, counted particle increase of the water and identified MPs in the PET bottled water after exposing the bottles to mechanical stress (squeezing treatment; none, 1 min, 10 min). The results showed a considerable increase of MP particle occurrence on the surface of PET and HDPE material (bottlenecks and caps) after opening and closing the bottles. After 100 times the effect was impressive, especially on caps. Moreover, great differences exist in cap abrasion between brands which uncovers a discrepancy in plastic behavior of brands. Interestingly, particle concentrations in the bottled mineral water did not significantly increase after exposure to mechanical stress (squeezing treatment). The morphological analysis of the inner wall surface of the bottles supported this observation, as no stress cracks could be detected after the treatment, implying that the bottles itself are not a consistent source of MP particles after this extent of mechanical stress. However, chances of MP ingestion by humans increase with frequent use of the same single-use plastic bottle, though only from the bottleneck-cap system.

MJPhD

21

Water Bottle Abuse

- half-filled commercial water bottle
- drop from approx. 2 feet 1500, 3000 or 4500 times
- use 66 cm diameter, cylindrical, baffled tumbler operating at 50 revolutions per minute
- half-filled to allow more distortion, to overcome centripetal force and to limit equipment damage

MJPhD

22

Water Bottle Abuse

- set on air dry (no heat)
- operate for 30 minutes for one or two cycles

MJPhD

23

Abuse Options

MJPhD

24

Abuse Options

- moved to 50 ml per container
- either never completely empty bottle or minimum triple rinse
- 50 mL filled and saved as blank

MJPhD

25

Tested Lots of Containers

- washed ≥ 3 times with last wash retained for reference using the most particle free water on-hand
- abuse and record time
- take micrograph of visible particles
- look at before and after Rayleigh scattering to assess nanoparticles

MJPhD

26

https://mjphd.net/sc/sc.php?004

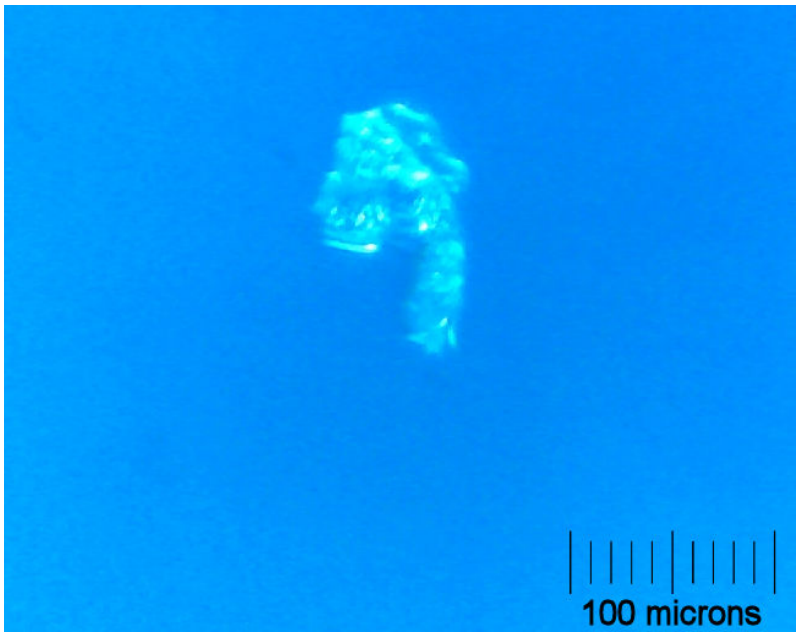
Beaten Water Bottle

March 2026

MJPhD

27

Example of Collected Particle



MJPhD

28

Removal Options

- Previous work (described at the 2025 ACS National Meeting in San Diego) showed that PET, PE, PP, tire and more particles are very lipophilic
- Capture was shown in oil and on lipophilic solids
- Reduction of particles by capture on oil-coated PET

MJPhD

29

MAKING PARTICLES

MJPhD

30

Water Chemistry in the Great Lakes Region

https://www.cmich.edu/academics/colleges/college-science-engineering/centers/cmu-biological-station/h2o-q-in-the-classroom

MJPhD

31

WATER COLLECTION

https://mjphd.net/sc/sc.php?007

water sampling

MJPhD

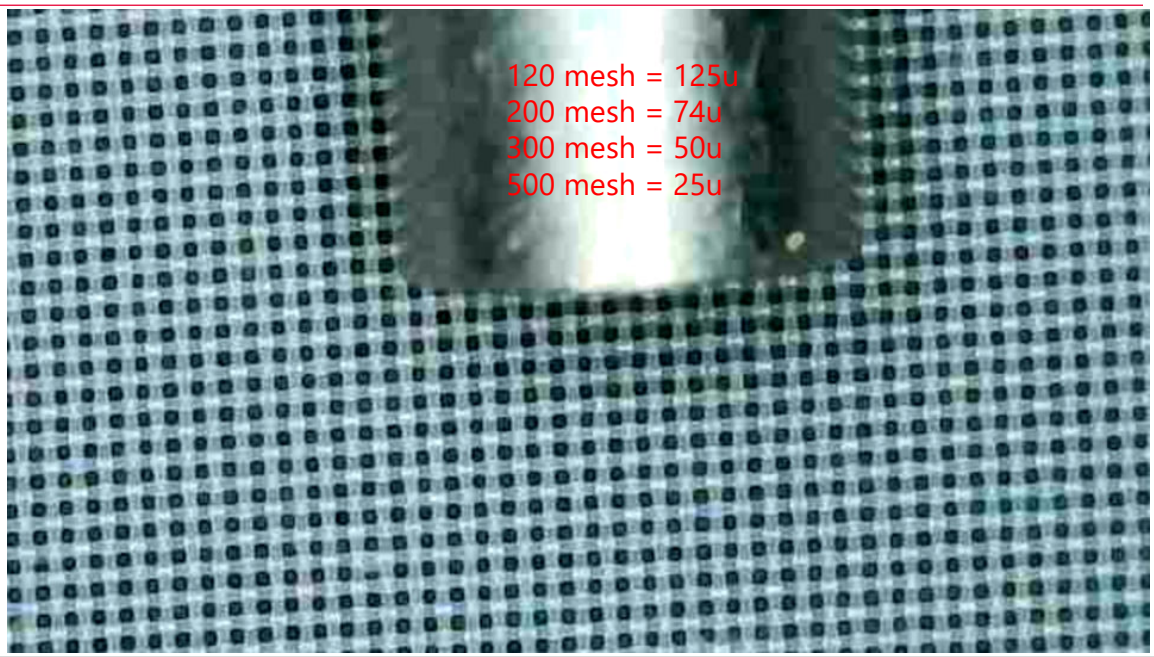
32

various options for filters explored

MJPhD

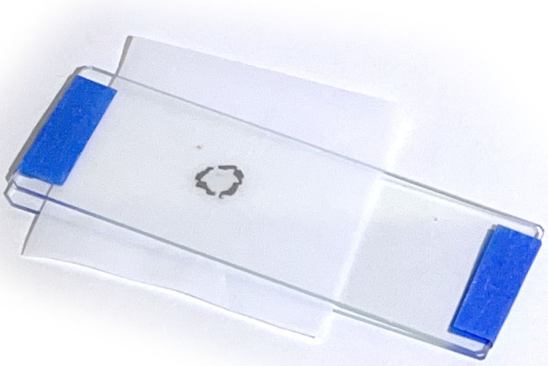
33

Silk Screen Fabric as Filters



MJPhD

34



slide sandwich showing traced outline of funnel on filter media

MJPhD

35

Portable/Rapid Setup

MJPhD

36

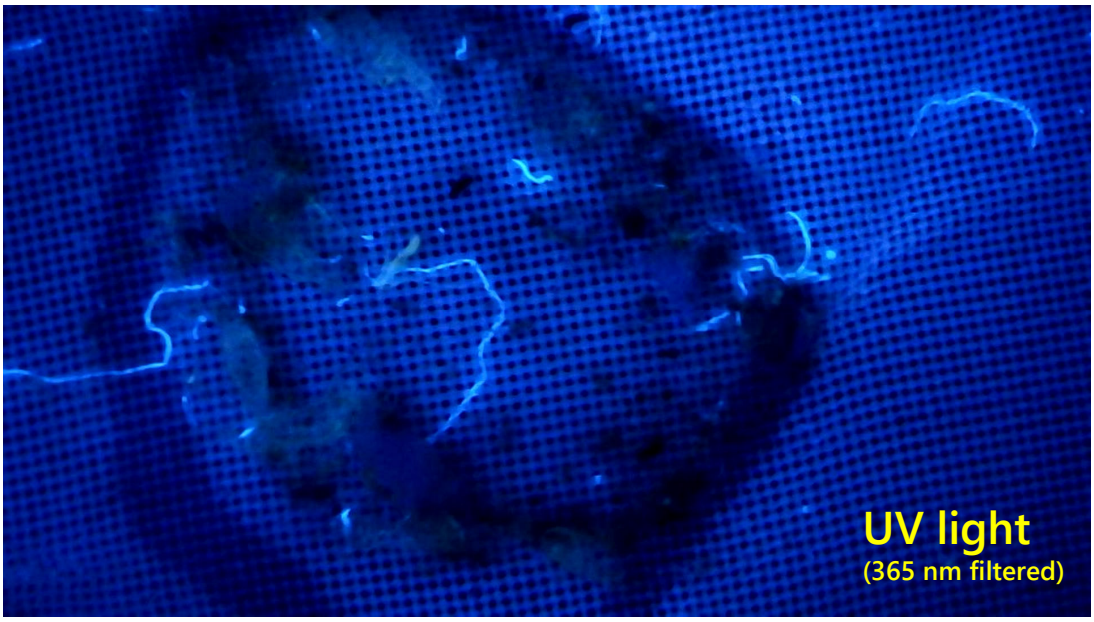
OBX Ocean Water

MJPhD

37

OBX Ocean Water

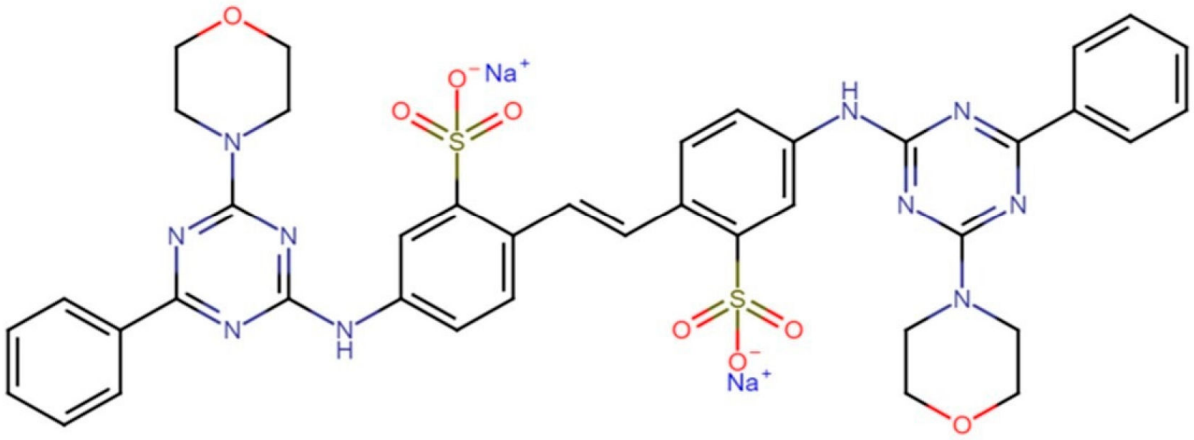
ble



MJPhD

38

Optical Brighteners



MJPhD

40

Environmental Science & Technology
pubs.acs.org/est

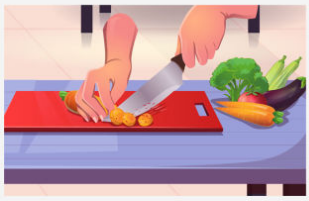
Cutting Boards: An Overlooked Source of Microplastics in Human Food?

Himani Yadav, Md Rakib Hasan Khan, Mohiuddin Quadir, Kelly A. Rusch, Partho Pritom Mondal, Megan Orr, Elvis Genbo Xu, and Syeed Md Iskander*

Cite This: *Environ. Sci. Technol.* 2023, 57, 8225−8235 Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: Plastic cutting boards are a potentially significant source of microplastics in human food. Thus, we investigated the impact of chopping styles and board materials on microplastics released during chopping. As chopping progressed, the effects of chopping styles on microplastic release became evident. The mass and number of microplastics released from polypropylene chopping boards were greater than polyethylene by 5−60% and 14−71%, respectively. Chopping on polyethylene boards was associated with a greater release of microplastics with a vegetable (i.e., carrots) than chopping without carrots. Microplastics showed a broad, bottom-skewed normal distribution, dominated by <100 μm spherical-shaped microplastics. Based on our assumptions, we estimated a per-person annual exposure of 7.4−50.7 g of microplastics from a polyethylene chopping board and 49.5 g of microplastics from a polypropylene chopping board. We further estimated that a person could be exposed to 14.5 to 71.9 million polyethylene microplastics annually, compared to 79.4 million polypropylene microplastics from chopping boards. The preliminary toxicity study of the polyethylene microplastics did not show adverse effects on the viability of mouse fibroblast cells for 72 h. This study identifies plastic chopping boards as a substantial source of microplastics in human food, which requires careful attention.



KEYWORDS: *polyethylene, polypropylene, human exposure, FTIR, toxicity*

DOI: 10.1021/acs.est.3c00924

> "cumulative annual release of 7.4–50.7 g of polyethylene. . . . from a polypropylene chopping board was 49.5 g"

MJPhD

42

ewg

Who We Are ⌄ Areas of Focus ⌄ Consumer Guides Research News & Insights ⌄

NEWS & INSIGHTS / NEWS / 2023 / 10

Making meals without microplastics: Tips for safer cutting boards

assuming 1 use per day, that's 0.14 g per use

> 50 grams per year – roughly equivalent to the weight of ten plastic credit cards

https://www.ewg.org/news-insights/news/2023/10/making-meals-without-microplastics-tips-safer-cutting-boards

MJPhD

43

MJPhD

44

Microplastics are lipophilic, a property that can be used in their collection and concentration.

Plastic containers used for beverages shed plastic particles when physically stressed during shipment and use.

Development of options to include microplastics in testing of water quality with students.

MJPhD

45

46