



An overview of microplastics measurement

Jeff Wagner

Environmental Health Laboratory Branch

Center for Laboratory Sciences

California Department of Public Health

Biomonitoring CA SGP Meeting

Oakland, March 4, 2026

Outline

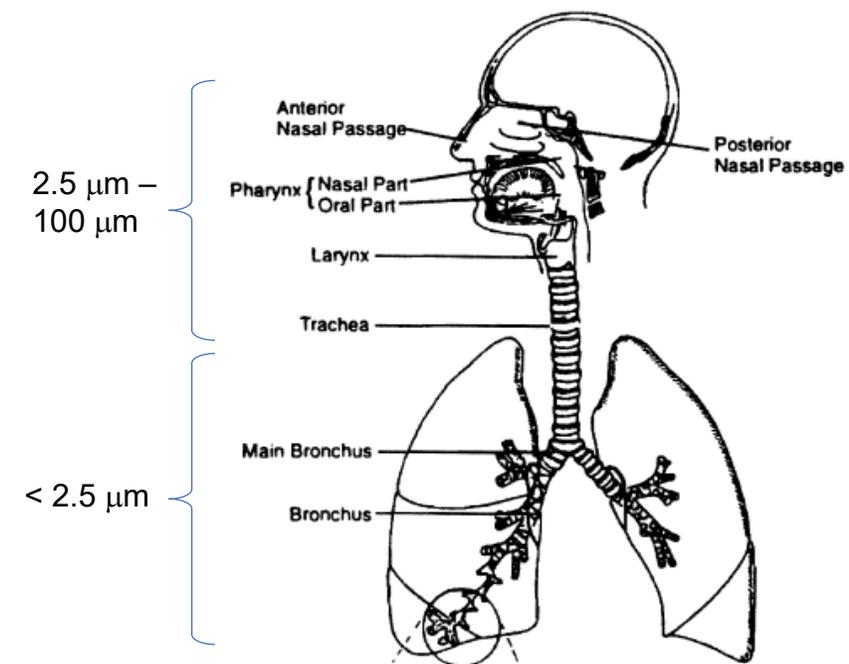
- Intro to microplastics (MP)
- MP definitions & pathways
- CDPH MP measurement methods
- Summary

Introduction to Microplastics (MP)

- MP detected in air, soil, wildlife, food, and water, and more recently, human blood, urine, and tissues
- Considerable uncertainties remain for
 - Health effects
 - Definition of MP
 - Measurement methods
 - MP migration of specific particle sizes to various organs
- CDPH, OEHHA, DTSC, and CA Water Boards working on MP
 - Biomonitoring CA currently gathering information on MP



Wagner et al, 2017



Evaluating the Health Effects of Microplastics in California Drinking and Bottled Water

- **SB 1147** requires OEHHA to study the health effects of microplastics in drinking and bottled water, provide biennial status update reports on findings, and develop a Public Health Goal (upon State Water Board request)
- Microplastics are a **unique contaminant suite** due to their multidimensionality, unique physical properties (\neq nanoparticles), associated chemicals, pathogens, etc.
- OEHHA's planned approach includes:
 - Conducting a **systematic literature review** of mammalian toxicity studies
 - Convening an **Expert Workshop**
 - Developing and implementing a **risk assessment framework**

MP definitions

- CA Water Boards defined MP in drinking water in 2020 as

- *solid, polymeric materials*
- *>1 nm and <5,000 μm*

**subject to change in response to new information, [...] advances in analytical techniques and/or the standardization of analytical methods*

- Typical polymers reported:
 - Polyethylene (PE), polypropylene (PP), polyethylene terephthalate (polyester/PET), nylon, polystyrene (PS), polyvinyl chloride (PVC), modified natural fibers (e.g., rayon)

THEREFORE BE IT RESOLVED THAT:

The State Water Board hereby adopts the definition of 'microplastics in drinking water' as appended to this resolution.

CERTIFICATION

The undersigned Clerk to the Board does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on June 16, 2020.

AYE: Chair E. Joaquin Esquivel
Vice Chair Dorene D'Adamo
Board Member Tam M. Doduc
Board Member Sean Maguire
Board Member Laurel Firestone

NAY: None
ABSENT: None
ABSTAIN: None

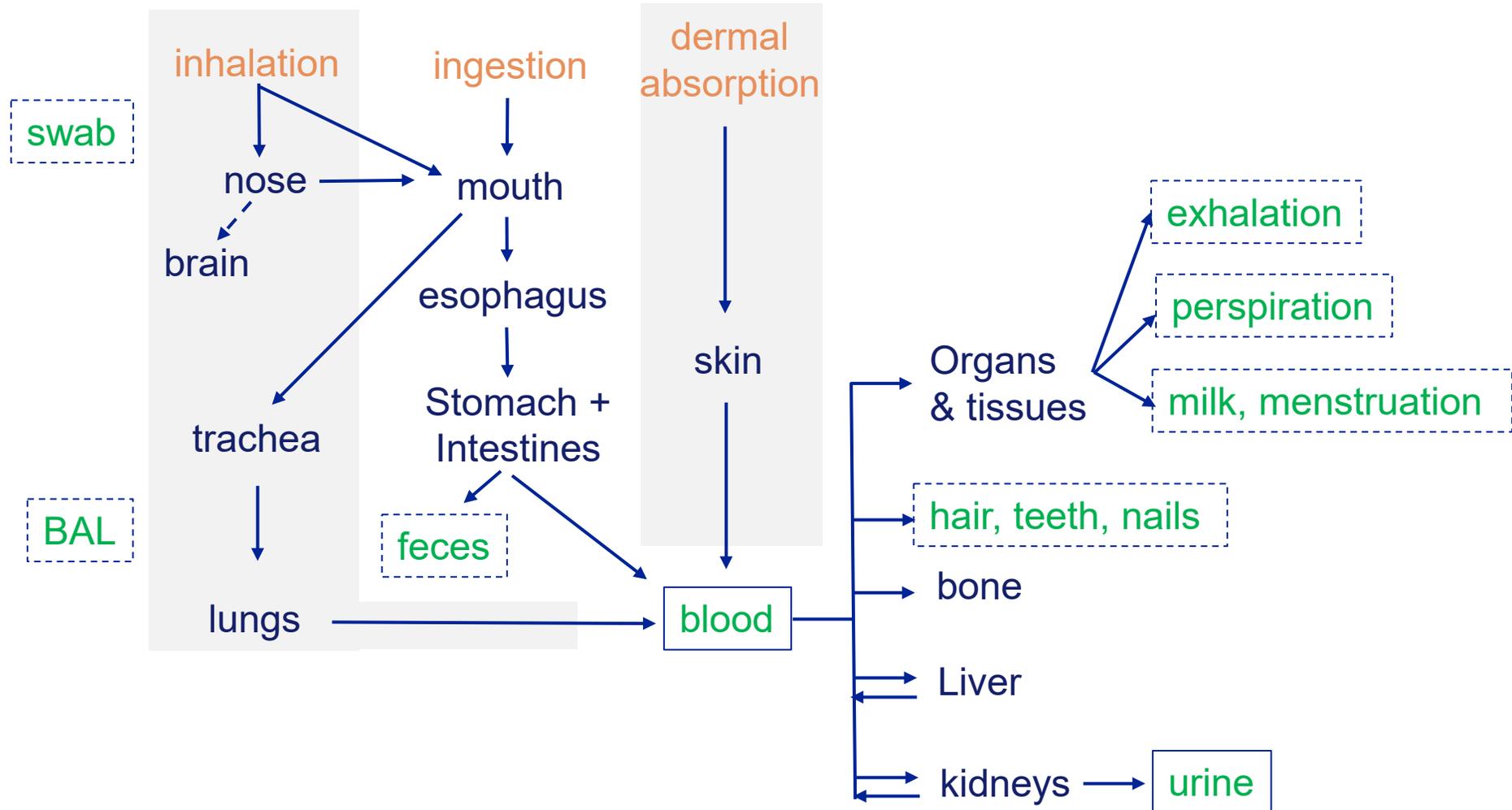

Jeanine Townsend
Clerk to the Board

Definition of 'Microplastics in Drinking Water'

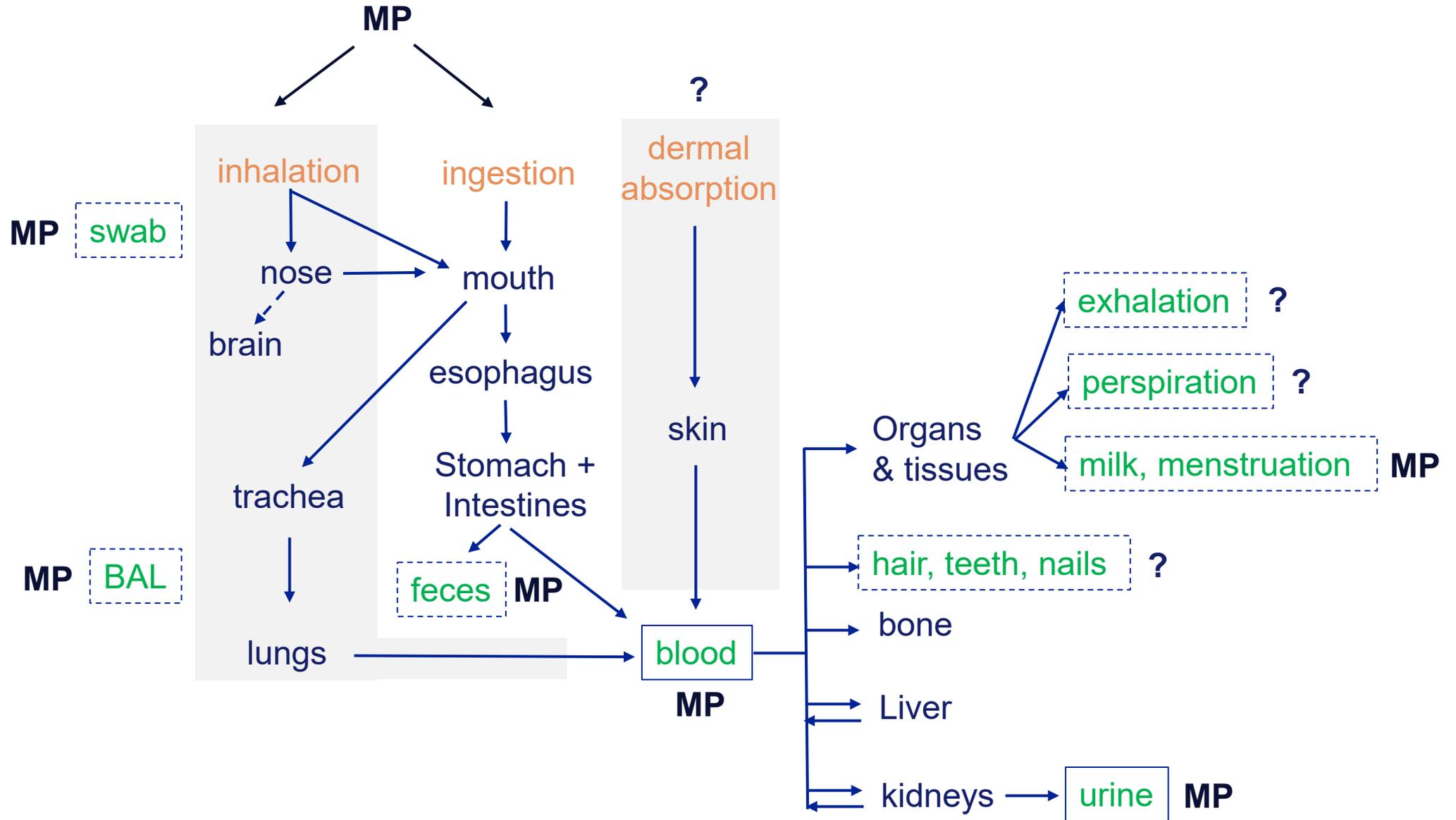
'Microplastics in Drinking Water' are defined as solid¹ polymeric materials² to which chemical additives or other substances may have been added, which are particles² which have at least three dimensions that are greater than 1 nm and less than 5,000 micrometers (μm)³. Polymers that are derived in nature that have not been chemically modified (other than by hydrolysis) are excluded.

**Evidence concerning the toxicity and exposure of humans to microplastics is nascent and rapidly evolving, and the proposed definition of 'Microplastics in Drinking Water' is subject to change in response to new information. The definition may also change in response to advances in analytical techniques and/or the standardization of analytical methods.*

MP exposure routes, pathways, and biomarker matrices



MP exposure routes, pathways, and biomarker matrices

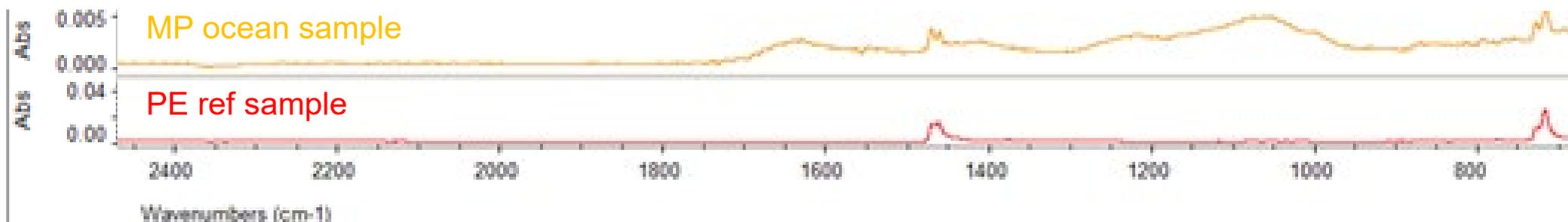


CDPH MP methods - Microspectroscopy

- Nine peer-reviewed CDPH MP method publications (2011-present)
 - Air, drinking water, wastewater, surface water, fish tissue, sediment, consumer products
- Semi-automated MP ID and size measurement of individual particles (MP counts/sample)
 - Raman (RMS) [$>1 \mu\text{m}$] & Fourier transform infrared (FTIR) [$>10 \mu\text{m}$]
 - Optical microscopy [$>1 \mu\text{m}$]
 - (Electron microscopy - SEM/EDS [$>0.1 \mu\text{m}$], TEM/EDS [$>0.01 \mu\text{m}$])

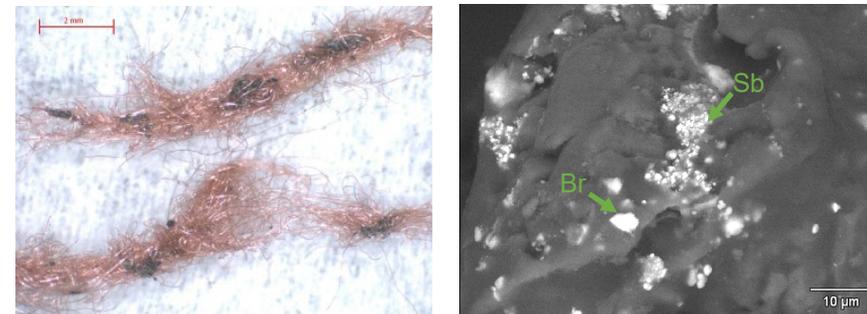


Wagner et al, 2017

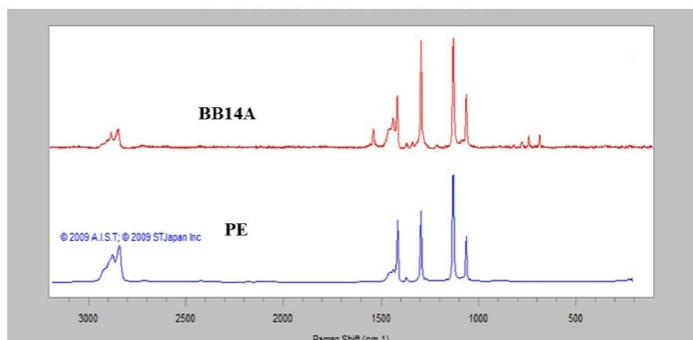


MP measurement methods - Microspectroscopy

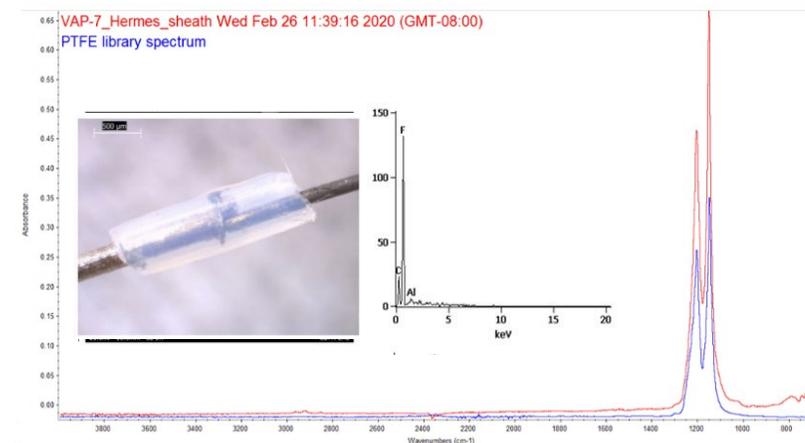
- CDPH experiences with microspectroscopy:
 - Very expensive and slow, but ideal for MP source ID and interpretation (particle size/shape/color)
 - Potential for contamination with MP in lab – QA, blanks, and detection plausibility are critical



Wagner et al, 2013



Wagner et al, 2017



Wagner et al, 2020

MP measurement methods – Pyrolysis (Py) GC/MS

- Gas chromatography/mass-spectrometry enables rapid sample throughput (MP mass /sample)
 - No special sample prep, no minimum particle size
 - Sample decomposes into polymer fragments used to ID MP
- All MP individual particle size, shape, and color information is lost
- Needs QA, ref MP, calibration, blanks, mass quantitation limit

Search Result: Quantification: Calibration:

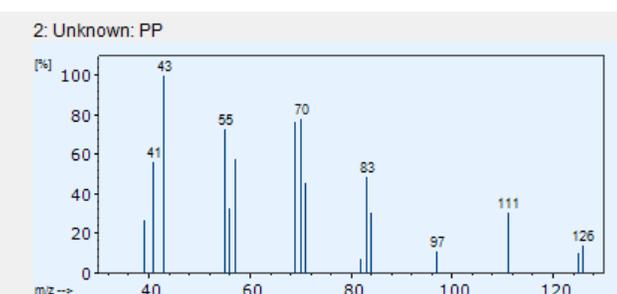
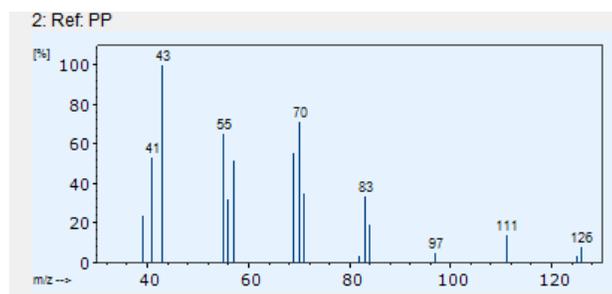
Spectrum EIC Area Height ESTC ISTD

Display Threshold: Result: Calibration Curve

Prob.: % Qty: ug CF Type: Zero:

Polymer	Prob. [%]	Qty [ug]	Ratio [%]	Area	RT [min]	LOQ [ug]
N66	97.7	161	49.6	7817871	5.19	
PET	90.6	122	37.6	7178330	13.02	
N6	87.8	20.0	6.15	3931759	10.51	
PP	96.6	17.0	5.24	607619	5.58	
SBR	67.4	4.83	1.49	340645	10.96	
PU	41.8	---	---	64873	16.84	
PC	53.4	---	---	209556	10.34	
PMMA	98.8	---	---	93027	3.91	
PS	92.6	---	---	1589392	19.09	
ABS	15.6	---	---	48921	16.57	
PVC	16.9	---	---	585483	9.55	
PE	93.8	---	---	70965	15.18	

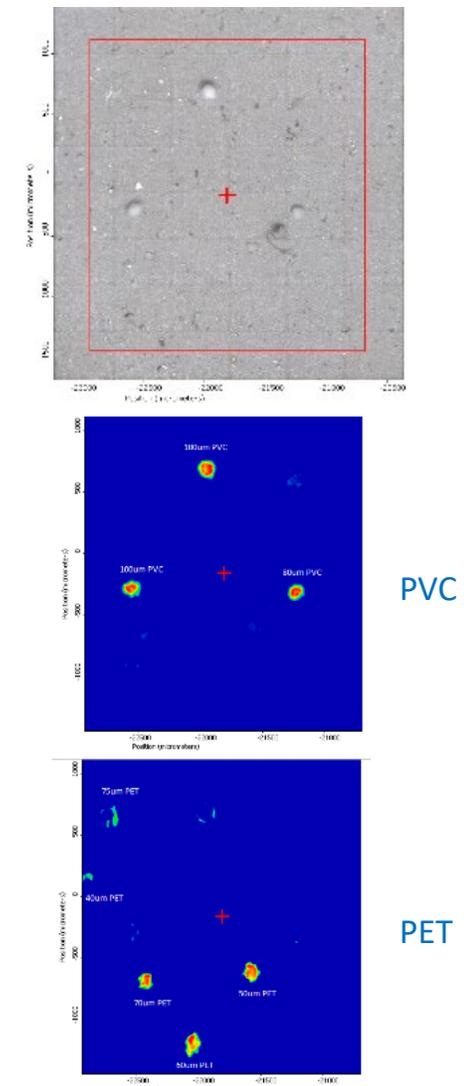
(100)



Summary

- Challenge: define specific health- and biomarker-relevant MP analytes (total vs. specific polymers, particle sizes)
 - Uncertainties remain for all of the above
 - Biomonitoring CA methods exist for MP-associated chemicals (fluorinated compounds, plasticizers, FRs, & metals)
- CDPH MP measurement methods
 - Count-based microspectroscopy costly, informative
 - Mass-based pyrolysis GC-MS is an emerging alternative
 - References, blanks & QC charts essential for both
 - Newer methods (e.g., flow cytometry) also promising

Wagner et al, 2019



CDPH MP publications

Ghosal S and Wagner J. (2013) Correlated Raman micro-spectroscopy and scanning electron microscopy analyses of flame retardants in environmental samples: a micro-analytical tool for probing chemical composition, origin and spatial distribution. *Analyst* 138:3836-3844.

Wagner J, Chen W, Vrdoljak G (2020) Vaping cartridge heating element compositions and evidence of high temperatures. *PLoS ONE* 15(10): e0240613. <https://doi.org/10.1371/journal.pone.0240613>.

Wagner J, Wang Z, Ghosal S, Cook A, Robberson W, Allen H (2019) Non-destructive Extraction and Identification of Microplastics from Freshwater Sport Fish Stomachs. *Environmental Science & Technology*, 53:14496–14506, <http://dx.doi.org/10.1021/acs.est.9b05072>.

Wagner J, Wang,Z, Ghosal S, Rochman C, Gassel M, and Wall S (2017) Novel method for the extraction and identification of microplastics in ocean trawl and fish gut matrices. *Analytical Methods*, DOI: 10.1039/C6AY02396G .

Wagner J, Ghosal S, Whitehead T, and Metayer C (2013) Morphology, spatial distribution, and concentration of flame retardants in consumer products and environmental dusts using scanning electron microscopy and Raman micro-spectroscopy. *Environment International* 59:16–26.

Wagner J, Robberson W, and Allen H (2022) Analytical Precision Assessment for Microplastic Analyses, *Environment International*, 304, <https://doi.org/10.1016/j.chemosphere.2022.135295>.

Wang Z, Wagner J, and Wall S (2011) Characterization of Laser Printer Nanoparticle and VOC Emissions, Formation Mechanisms, and Strategies to Reduce Airborne Exposures. *Aerosol Sci.Technol.* 45: 1060-1068.

Wang Z, Wagner J, Ghosal S, Bedi G, and Wall S (2017) SEM/EDS and optical microscopy analyses of microplastics in ocean trawl and fish guts. *Science of the Total Environment*, 603-4: 616-26. DOI: 10.1016/j.scitotenv.2017.06.047 .

Wang Z, Parashar M, Ghosal S, and Wagner J (2020) A new method for microplastic extraction from fish guts assisted by chemical dissolution. *Anal. Methods*,12, 5450-5457.