

Supplement

Significance of morphology in characterizing human health risk from di(2-ethylhexyl) phthalate in polyvinyl chloride microplastics in groundwater

Ki-Han Song¹, Sang-Gyu Yoon², Jin-Yong Lee³ and Jinsung An^{2,4,*}

¹Department of Civil Engineering, Seoul National University of Science and Technology, Seoul 01811, South Korea

²Department of Smart City Engineering, Hanyang University ERICA, Ansan 15588, South Korea

³Department of Geology, Kangwon National University, Chuncheon 24341, South Korea

⁴Department of Civil & Environmental Engineering, Hanyang University ERICA, Ansan 15588, South Korea

* Correspondence: jsan86@hanyang.ac.kr; Tel: +82-31-400-5146.

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Table S1. Major solute concentration in the ‘artificial groundwater’ solution used in the di(2-ethylhexyl) phthalate (DEHP) leaching experiments

Reagent	Amount of reagent
KH ₂ PO ₄	0.30 mg/L
KNO ₃	0.05 mg/L
MgCl ₂ 6H ₂ O	53.81 mg/L
MgSO ₄	5.94 mg/L
K ₂ CO ₃	2.04 mg/L
MgCO ₃	34.58 mg/L
CaCl ₂	87.12 mg/L
NaHCO ₃	299.59 mg/L
Characteristics	Value
pH	7.7
Ionic strength	7.3 mM

Table S2. Gas chromatography-mass spectrometry conditions for di(2-ethylhexyl) phthalate (DEHP) analysis

Gas chromatograph	
Column	DB-5MS (length: 30 m, diameter: 0.25 mm, film: μm)
carrier gas	He (1.0 mL/min)
Inlet temperature	280°C
Detector temperature	300°C
Oven temperature program	Step 1. 120°C Step 2. Increase at 20°C/min Step 3. 280°C (hold for 2 min) Step 4. Increase at 20°C/min Step 5. 300°C (hold for 5min)
Mass spectrometry	
DEHP	molecular weight: 390.55 mg/mol
Mass to charge ratio	149 m/z
Electron impact	35 eV – 70 eV

Table S3. Polyvinyl chloride (PVC) MP concentration surveyed at each sampling site [7-9]

Location	Groundwater sampling point (n)	MPs concentration (particles/L)
Donghae and Samcheok (May)	9	9.71 ± 26.14
Donghae and Samcheok (Aug.)	10	3.71 ± 11.12
Yanggu	14	3.09 ± 5.52
East Jeju	13	0.34 ± 1.23
West Jeju	8	0 ± 0

* Microplastic concentrations in the southwestern region of Jeju Island were generally lower than those in the northeastern region, and PVC was not detected at certain sampling points. This is likely due to the predominant use of PE and PP in agricultural activities in the southwestern region, with minimal use of PVC. Additionally, lower rainfall and reduced soil permeability in this region may have limited the infiltration of microplastics into the groundwater.

Table S4. Length:width:height (L:W:H) ratio for each microplastic shape used for MPs volume calculation. After Length of MPs of 20-5000 μm was applied, the volume of MP was calculated according to the upper and lower limits of L:W:H [10].

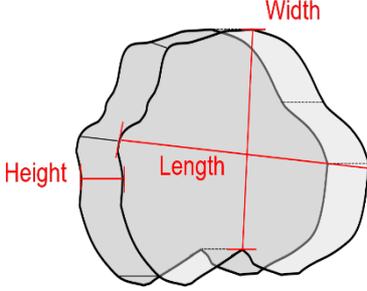
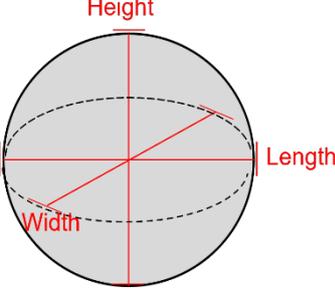
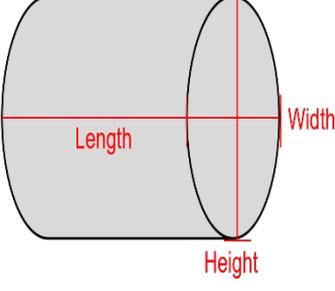
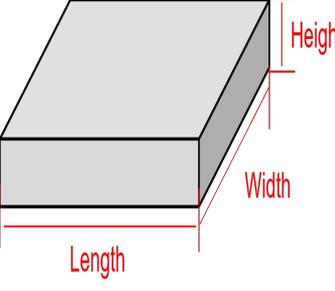
Shape	Ratio (L:W:H)		
	Upper limit	Lower limit	
	Fragment	1:1:1	1:0.1:0.01
	Sphere	1:1:1	1:0.6:0.36
	Fiber	1:0.5:0.5	1:0.001:0.001
	Film	1:1:0.1	1:0.1:0.01

Table S5. Di(2-ethylhexyl) phthalate (DEHP) content in diverse PVC products

Product	Content (%)	Reference
Plastic film ^a	34.1	In this study
CRM 113-03-006	0.0999	[1]
plastic film	22.4	[2]
	29.1	[3]
	24.1	[3]
mulching film	38	[4]
	33	[4]
	35	[5]
Tubing for transfusion	27.5	
Tubing for infusion	27	
Quadrupole bag	24	
Transfer bag	23	[6]
Dialysis tubing	22	
Dialysis bag	18	
Sag-M transfer bag	5	

a: PVC plastic film was provided by the Environmental Chemistry Laboratory of Korea University (South Korea).

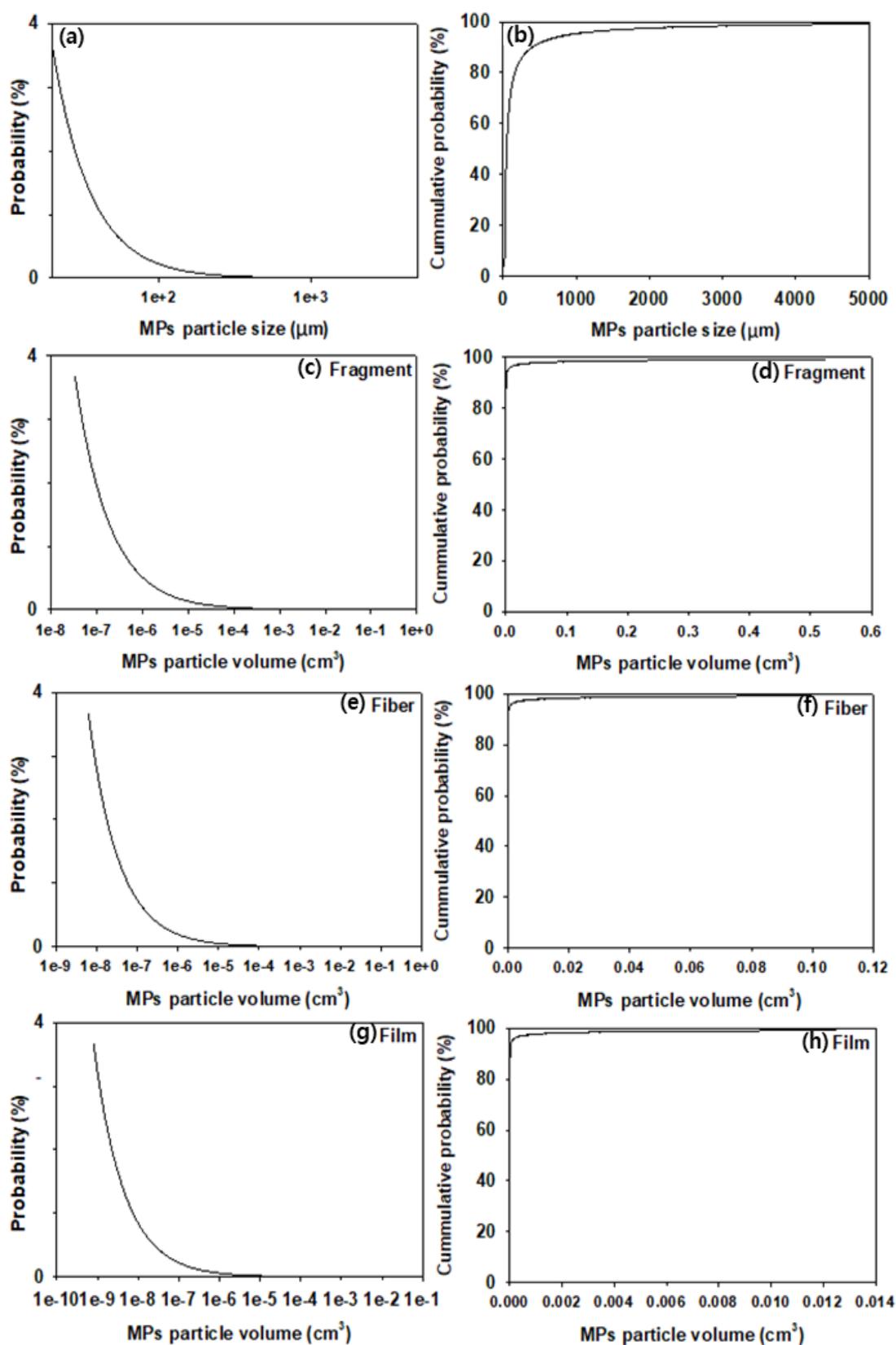


Figure S1. Continuous and cumulative probability distribution by MPs particle size (a, b), and continuous and cumulative probability distributions of volumes according to MPs particle size and shape (fragment (c, d), fiber (e, f), and film (g, h) determined using power functions.

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