



Sorption by aged polystyrene microplastics

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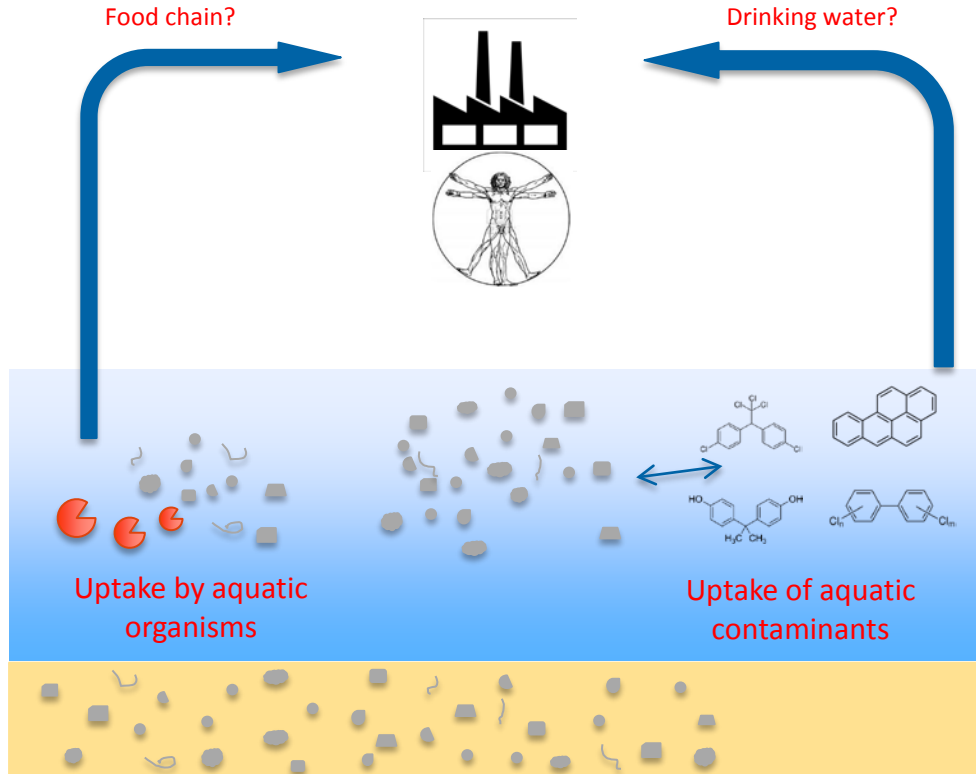
Anne-Katrin Weniger

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Relevance of microplastic



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Microplastic as vector?



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„microplastic will transfer hazardous hydrophobic organic chemicals (HOC) to marine animals.”

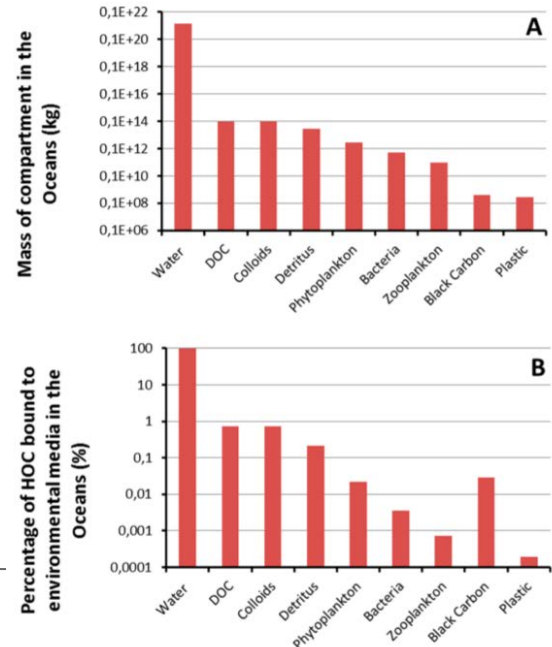
ENVIRONMENTAL
Science & Technology

Critical Review
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Microplastic as a Vector for Chemicals in the Aquatic Environment: Critical Review and Model-Supported Reinterpretation of Empirical Studies

Albert A. Koelmans,^{a,*} Adil Bakir,^b G. Allen Burton,^b and Colin R. Janssen^a

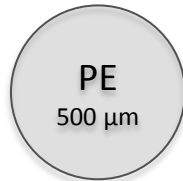
- Microplastic is in equilibrium with most organic contaminants
- Mass flows of contaminants show uptake by natural prey exceeds that uptake via microplastic



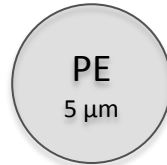
Why still sorption?

- Particle number concentration

100 $\mu\text{g/L}$:



1 Particle

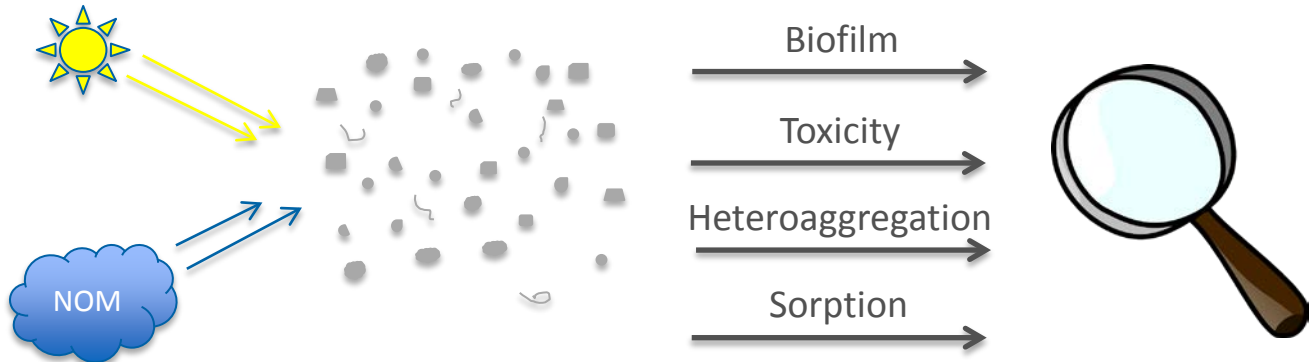


10^6 Particles



10^9 Particles

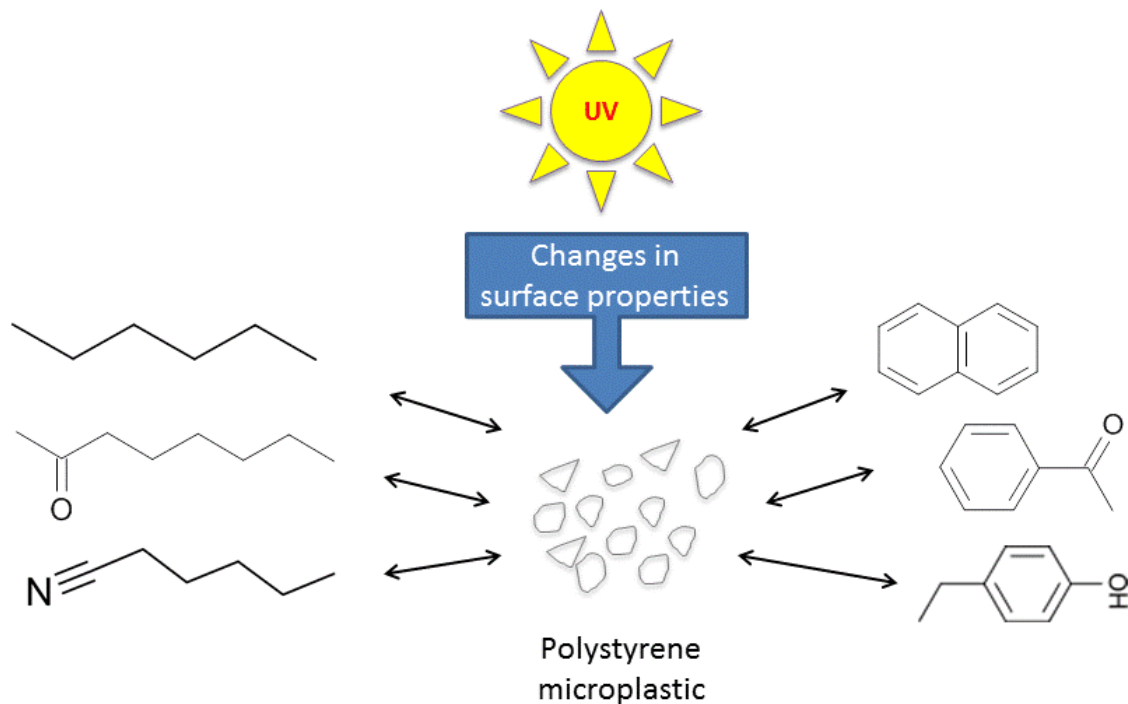
- Aging of particles



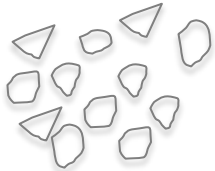
Motivation



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Aging methods



ISO 4892-2
 $\lambda = 300\ldots 400 \text{ nm}$
24 days
 65°C
 60 W/m^2



$\lambda = 254 \text{ nm}$
10 days
4 x 15 W
1 g MP + 10 % H_2O_2

Chemical & physical particle characterization:

Functionalization, crystallinity, surface area, particle size

Methods:

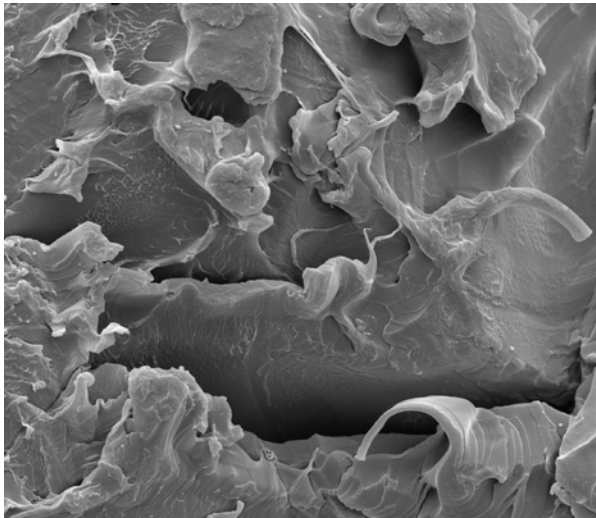
ATR-FT-IR, SEM, DSC, TOT, BET

Particle characterization

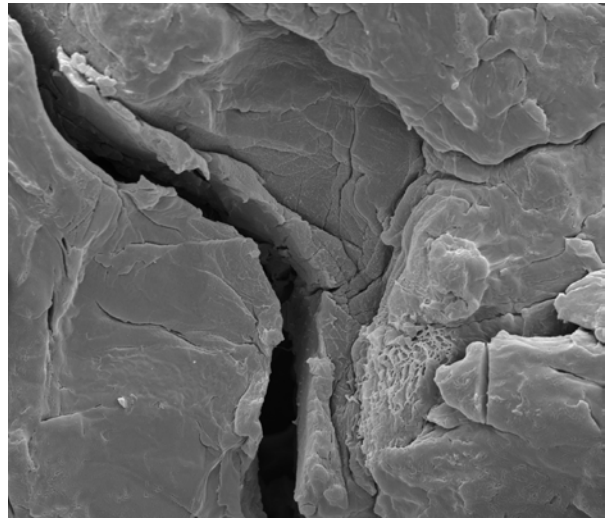


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Polystyrene (PS) pristine



Polystyrene (PS) aged



Isolated small crack formation on surface of aged PS

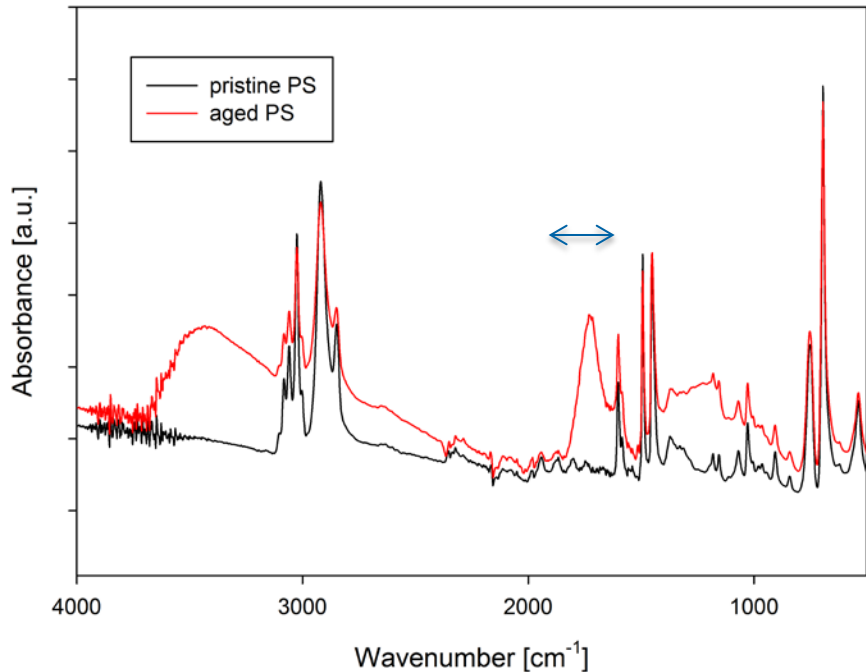
Particle characterization



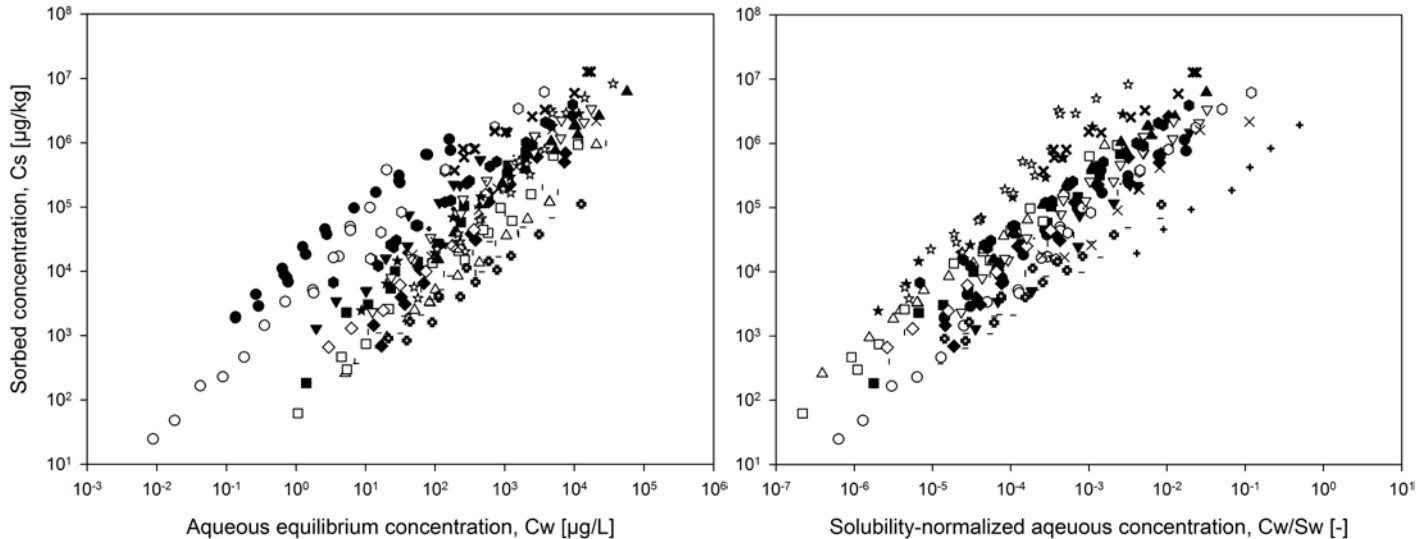
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ATR-FTIR:

- Significant bands for C-O & C=O stretching
- Increase of carbonyl index from 0.44 to 1.61



Sorption isotherms

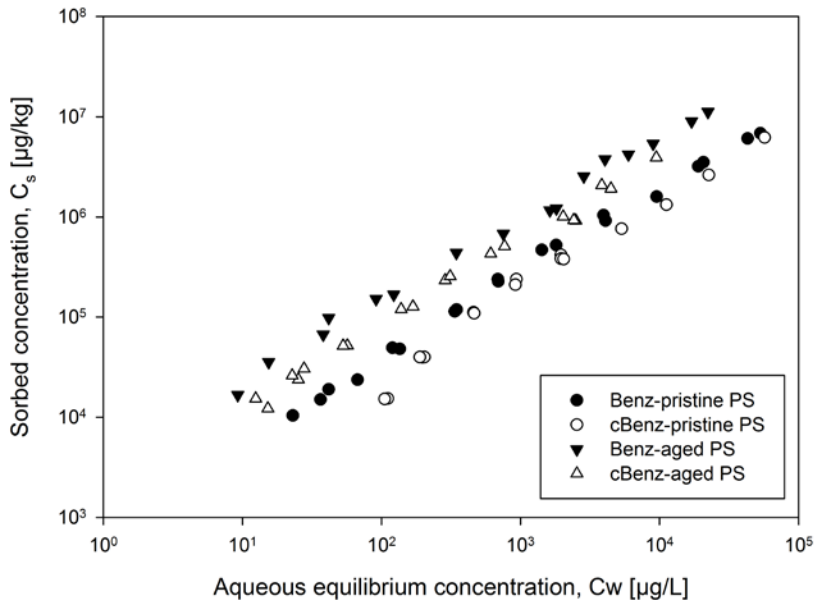


- For polar sorbates relatively high concentration range
- Experimental data set of so far broadest molecular probes for aged polystyrene microplastic

Comparison of isotherms



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System	Log K_F	n
Benz-PS	2.90	0.844
Benz-aged PS	2.42	0.931
cBenz-PS	3.53	0.801
cBenz-aged PS	2.89	0.927

- Reduction in sorption affinity (smaller size fraction)
- Sorption linearity increases

Ad- or Absorption??

Adsorption versus Absorption



Polymer	K_n/K_c (C6)	C_a [$\mu\text{g/L}$]
PS	1.09	10
aged PS	2.78	10

Soft, rubbery

Glass transition temperatur

hard, glass-like

Linearity of sorption isotherms

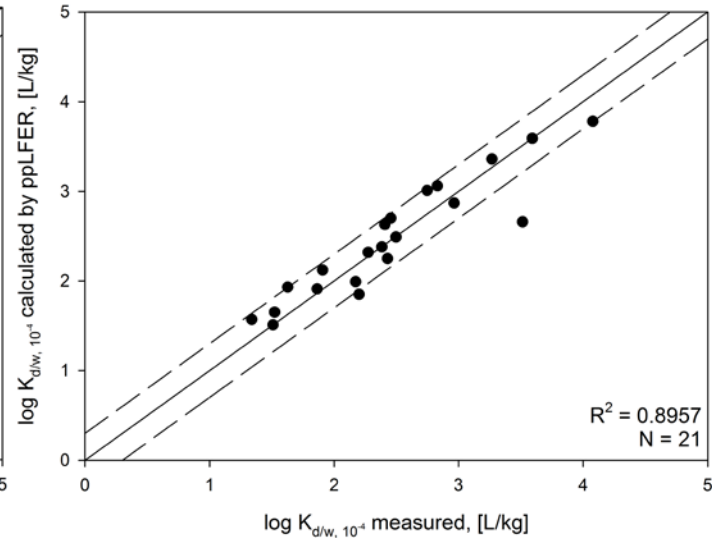
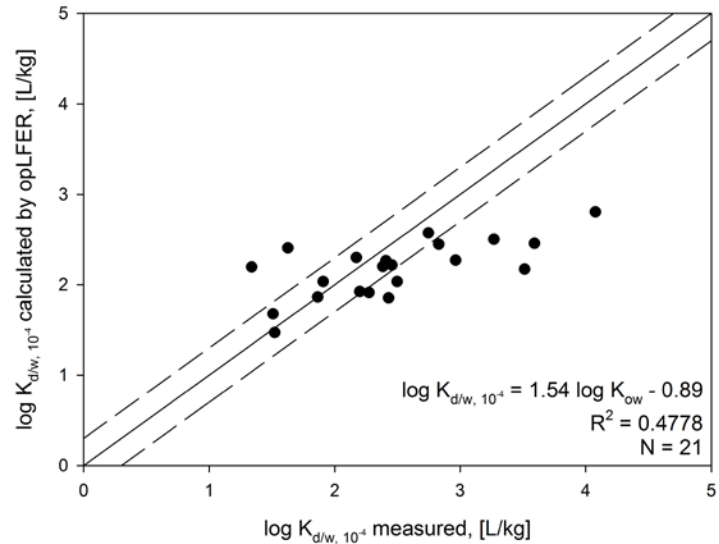
Absorption

Sorptions mode

Adsorption

LFER for aged PS

$$\log K_{PS,aged} = 0.69E - 0.70S + 1.64A - 3.27B + 2.75V - 0.75$$



Conclusion

- UV-induced aging changed particle properties depending on polymer type
 - Artificial/accelerated aging lead to a reduction of sorption by polystyrene
 - „Precise modelling of sorption by aged polystyrene using ppLFER“
-



Thank you for your attention

Just because you can't see it, doesn't mean it isn't there

