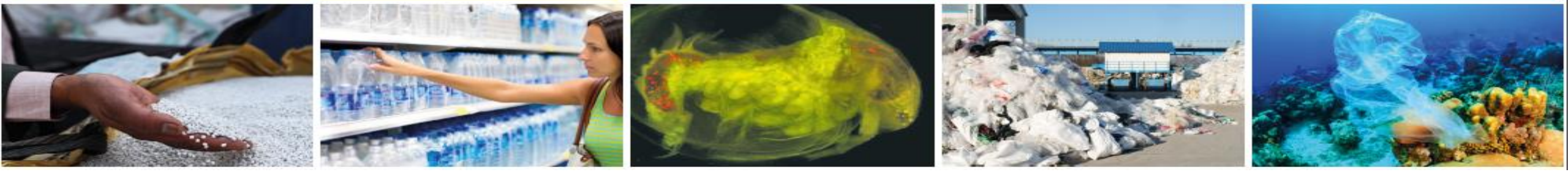


Release of synthetic fibres during washing of typical household textiles: Findings from washing machine tests and resulting policy recommendations

Korinna Altmann, Claus-G. Bannick, Alexander Kerndorff, Claudia Heller,
Monika Fuchs and Ulrike Braun

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Eine Initiative des Bundesministeriums für Bildung und Forschung
Plastik in der Umwelt
Quellen • Senken • Lösungsansätze

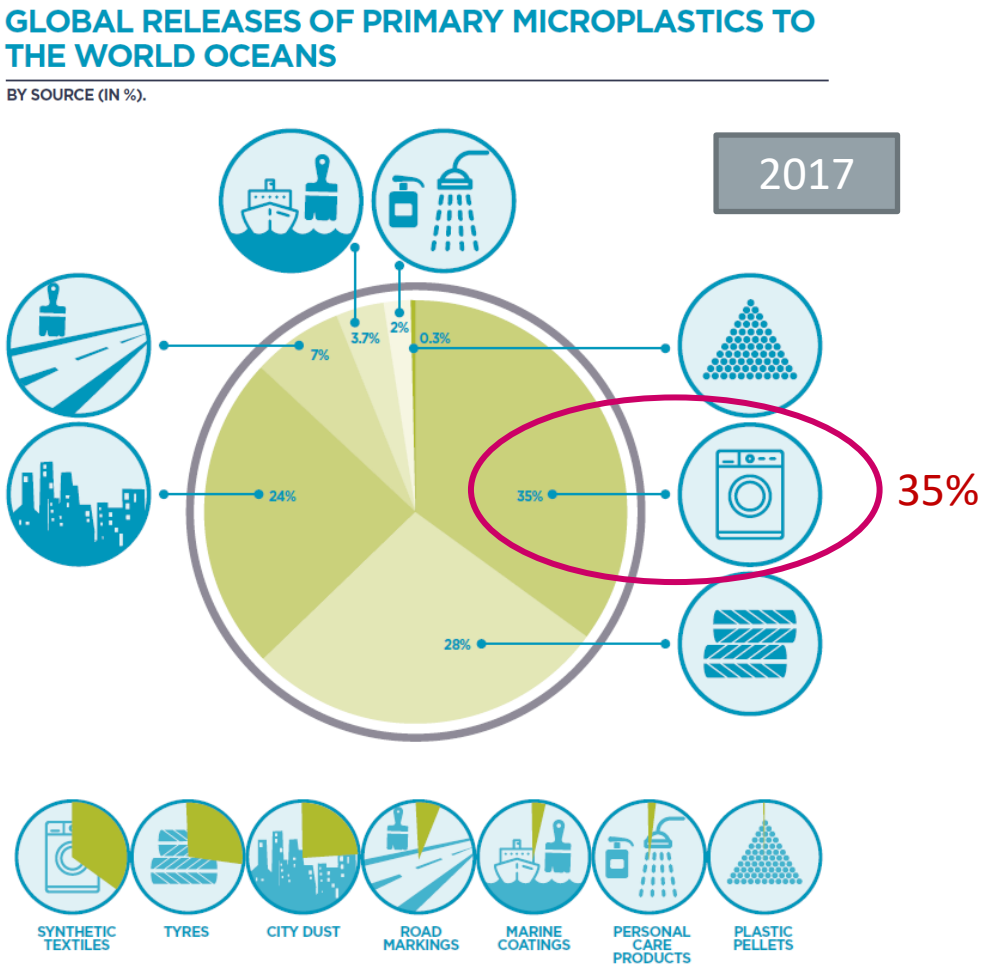
FONA
Forschung für Nachhaltigkeit

Motivation

2018

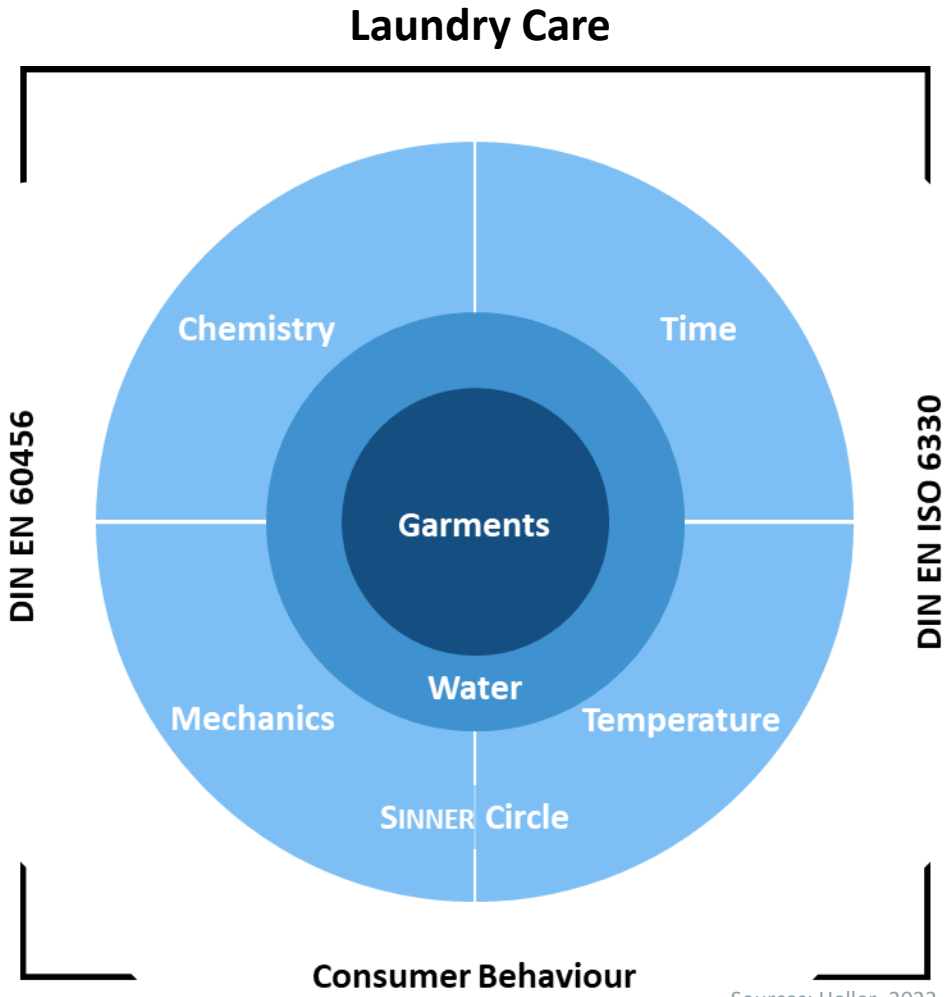
Source@https://www.dailymail.co.uk/sciencetech/fb-5408973/HOW-PLASTIC-POLLUTION-BREATHE-DAY.html

- High media attention
- Is high synthetic polymer fibre release true for a close-to home laundry?



Source: IUCN, 2017, p. 21.

Experimental idea



Sources: Heller, 2022

» Close-to-home washing of a defined laundry load under reproducible conditions

Textile products = clothing

» PET – Polyester
» PA – Polyamid 6
» CO - Cotton

Experimental design

	Men‘s shirt	T-shirt
Fibres	65% CO, 35% PET	55% CO, 45% PA
Fabric construction	Woven	Knitwear
Colour	Dark grey	Dark blue
Sizes	39,5/41/42/ 43/44,5	M, L, XL, XXL

» laundry load comparable to households

+ Dirt
+ Washing powder

Easy care
Temperature: 40°C
Max. speed: 1200 U/min
Load quantity: 4 kg

2 Machines

30x

Sampling and sample preparation

Air dried

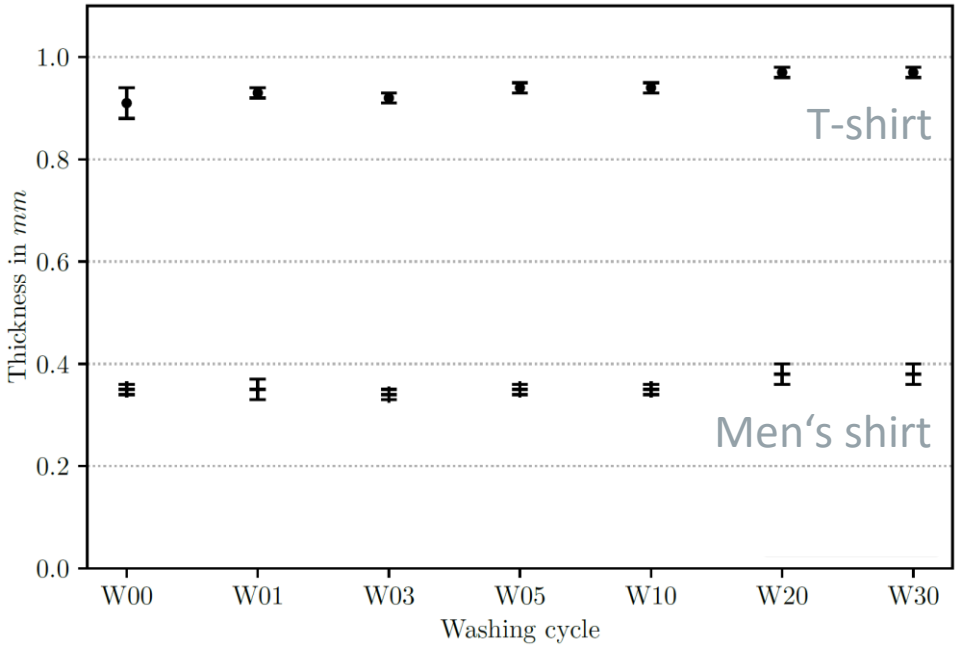
500 µm → < 10 µm

- Fractionated filtration of grey water of the washing machine (approx. 54 L)
- Mesh sizes of the filters: 500 µm, 100 µm, 50 µm, 10 µm
- Preparing the sieve residues for analysis

TEXTILE-PHYSICAL RESULTS (ANALYSIS ON TEXTILES)

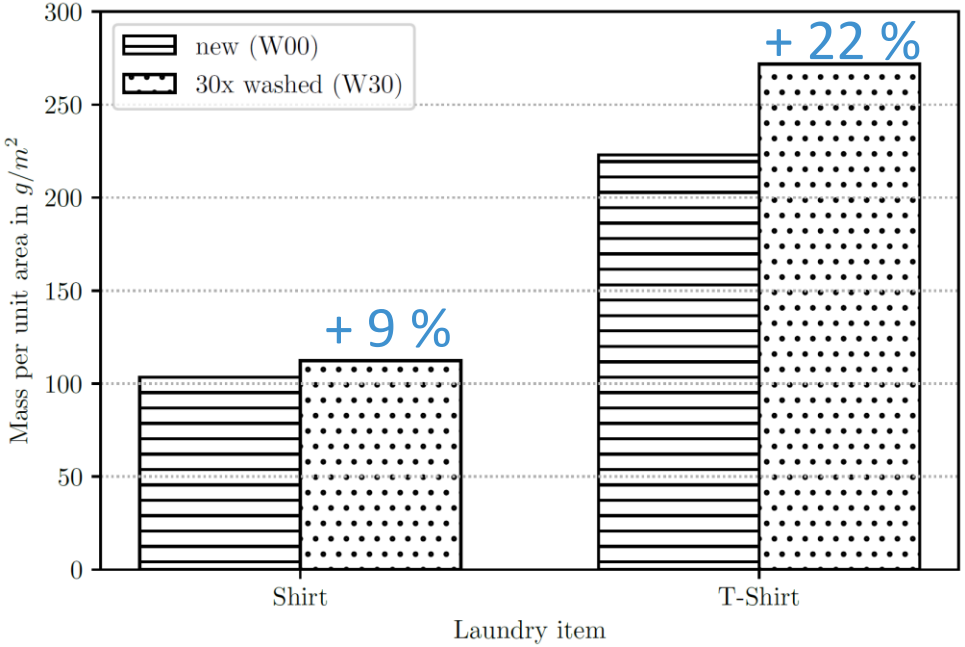
Thickness and mass per unit area

Thickness (DIN EN ISO 5084)



- T-Shirts are thicker than the shirts
- Thickness of shirts and T-Shirts increases from W00 to W30

Mass per unit area (DIN EN 12127)

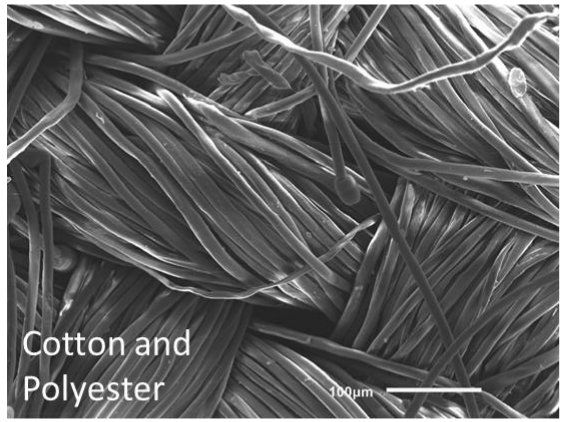


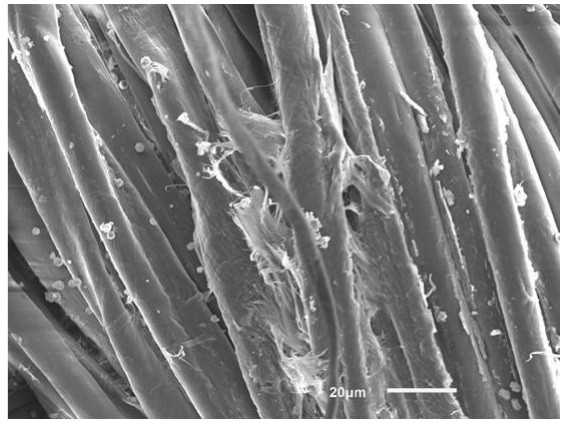
- Mass per unit area of shirts and T-Shirts increases from W00 to W30
- Size of garments shrunks, more fibres on the same area

Sources: Heller, 2022

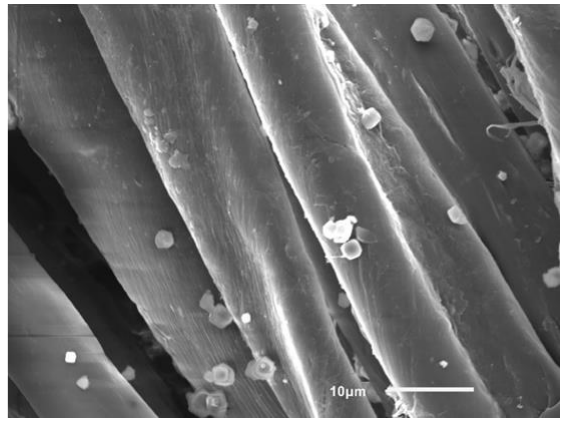
Scanning electron microscopy (PET)

new, right fabric side, 220x magnification





30x washed, right fabric side, 800x magnification



30x washed, right fabric side, 2000x magnification

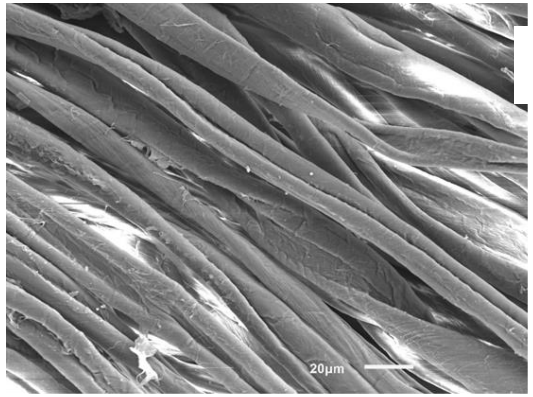
- Textile is damaged
- Washing powder as deposits

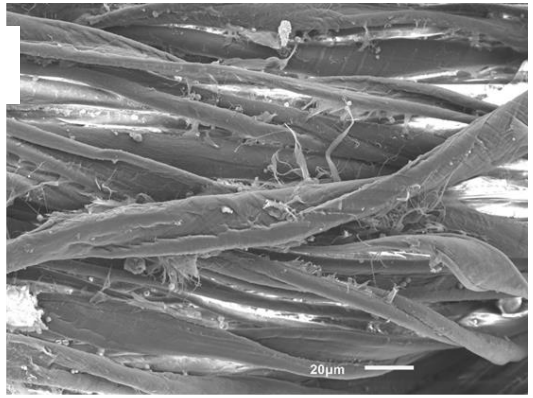
Sources: Heller, 2022

Scanning electron microscopy (PA)

Cotton

New, right fabric side, 600x magnification

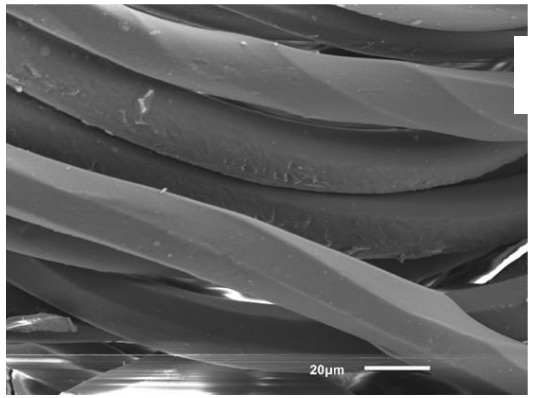


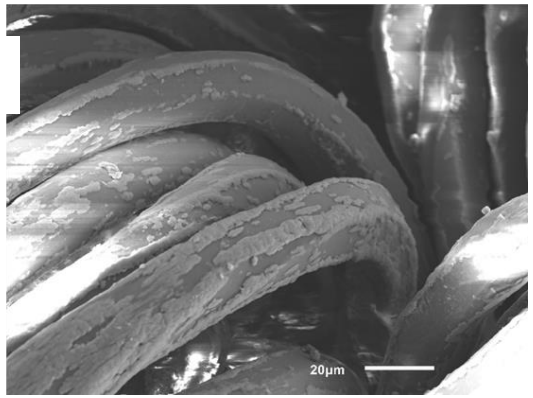


30x washed, right fabric side, 600x magnification

PA

New, left fabric side, 800x magnification



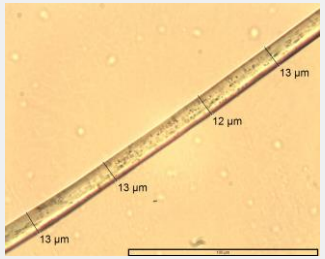
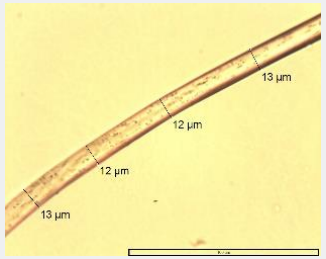
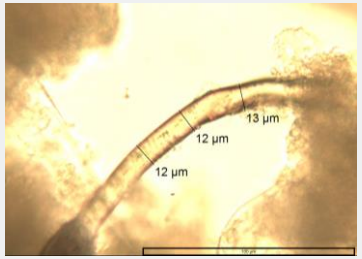


30x washed, left fabric side, 850x magnification

- Textile is damaged according to cotton, not to PA
- Washing powder as deposits

Sources: Heller, 2022

Fibre thickness (PET)

Men‘s shirt (new)	> 500 µm (WZ_10)	> 50 µm (WZ_10)
		
		

- Thickness of the fibres is around 12 µm
- No change over 10 washing cycles (WZ)
- Fibres in the washing water have the same size like in textile

MICROPLASTIC FIBRE RELEASE (ANALYSIS OF THE WASHING WATER)

Screening Methode – TED-GC/MS

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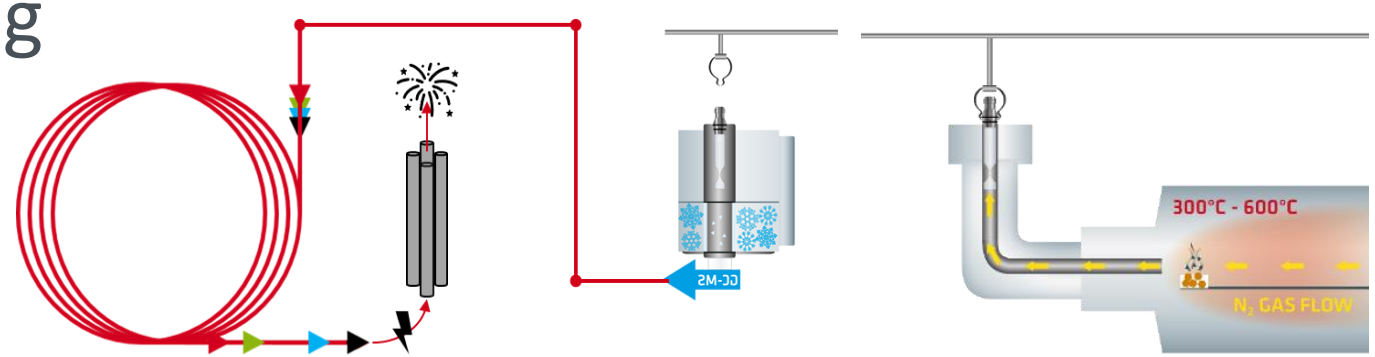
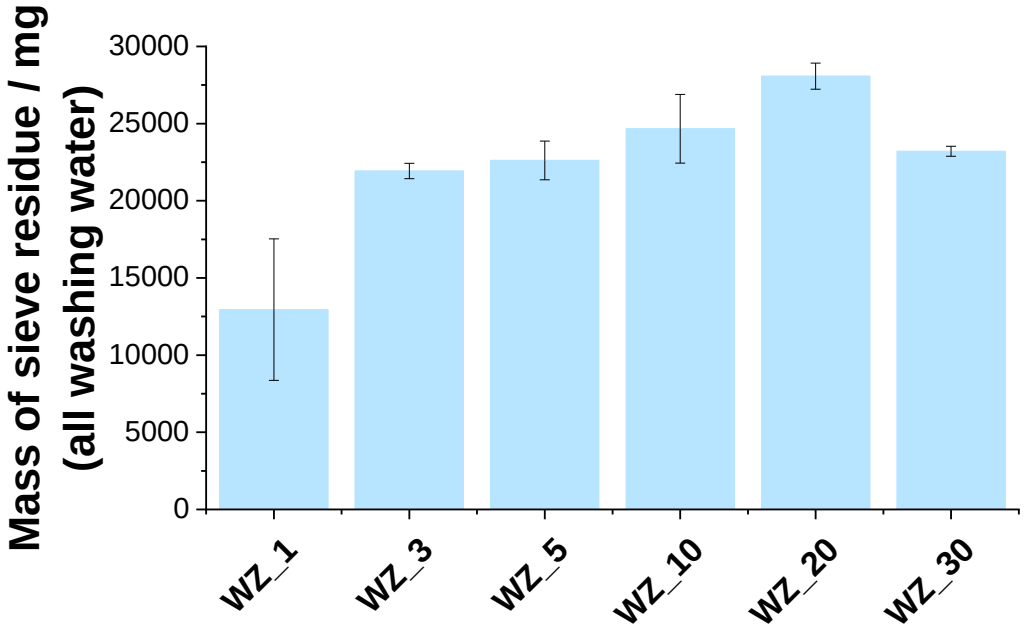
BAM Bundesanstalt für Materialforschung und -prüfung

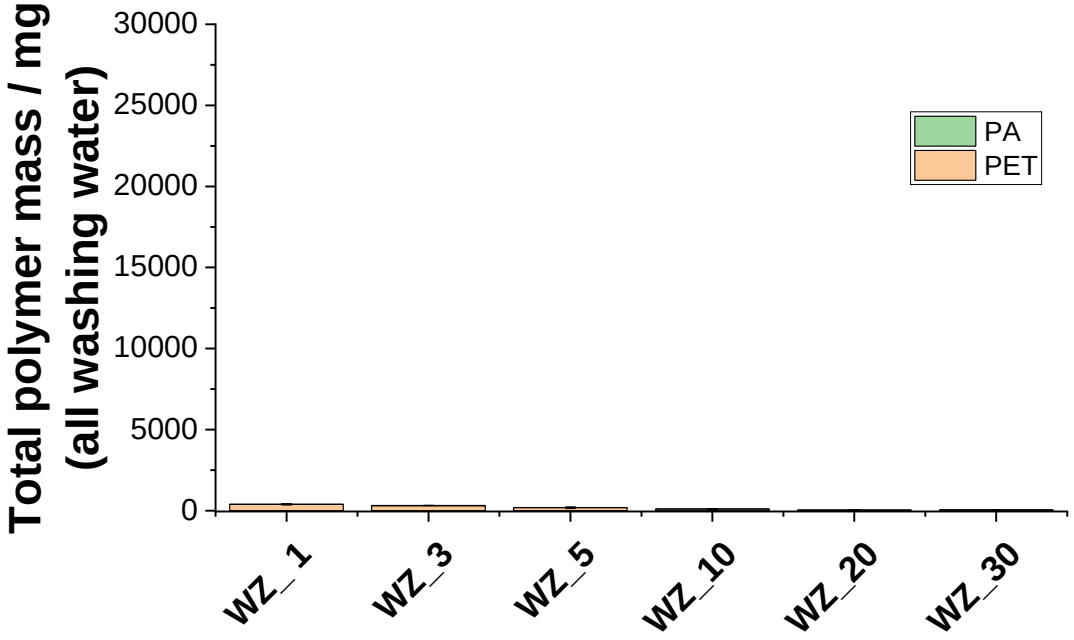
Thermo Extraktion Desorption-Gas Chromatographie-Massen Spektrometrie

- Fast and robust, multistage
- 73 min / measurement
- Fully automated
- High intake up to 700 mg
- No sample preparation (water, air)



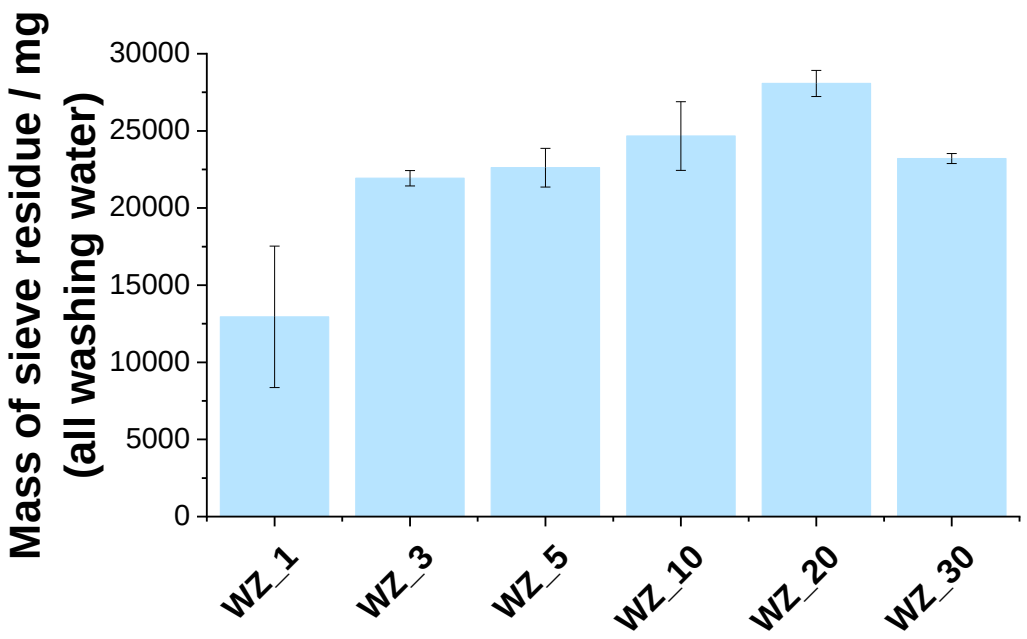
Sieve resiude vs. fibre release

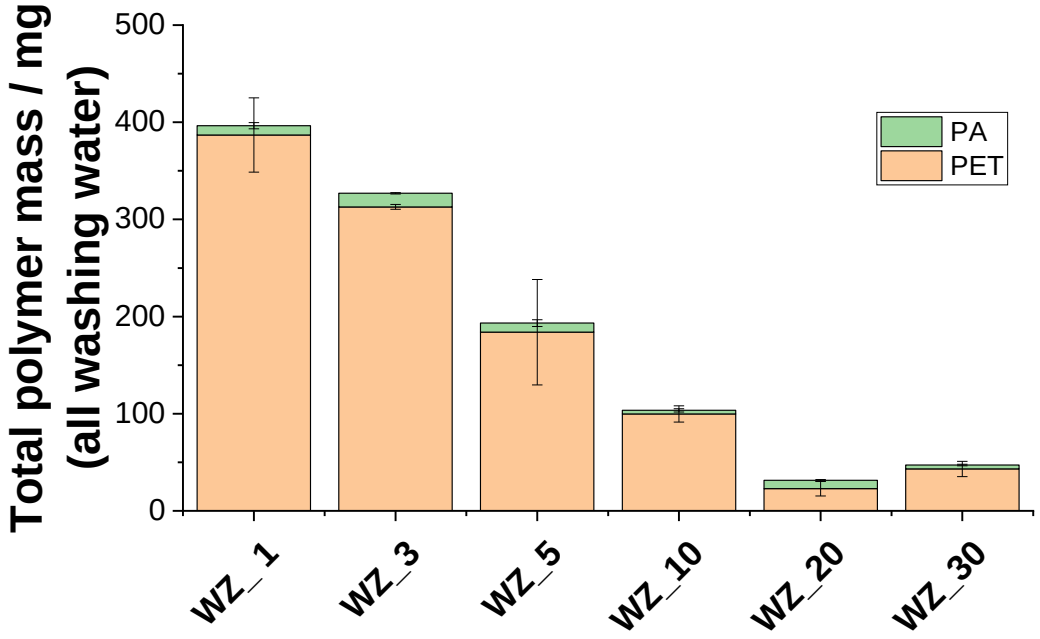




WZ = washing cycle

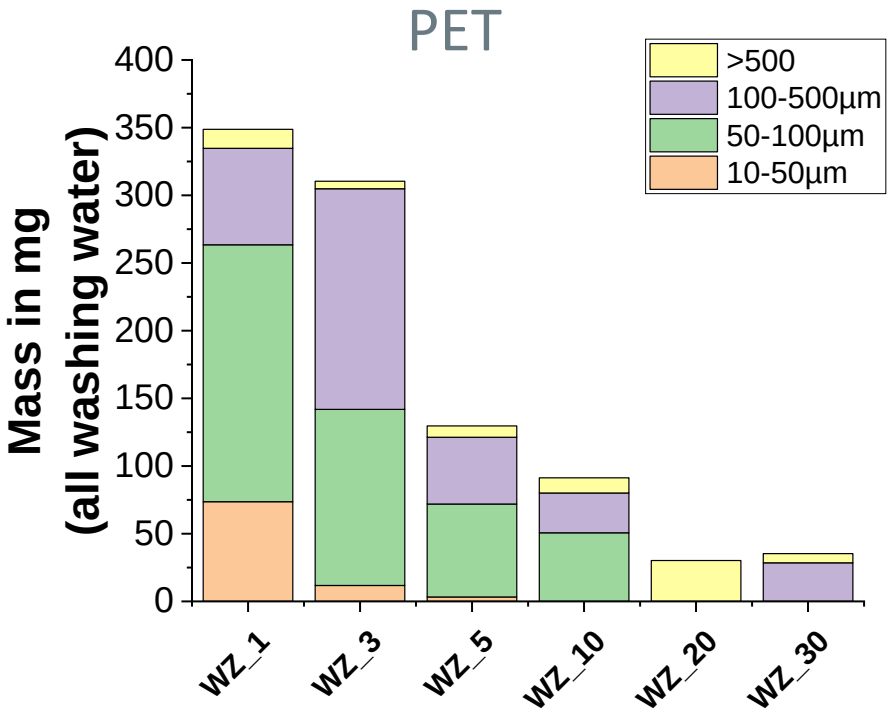
Sieve resiude vs. fibre release

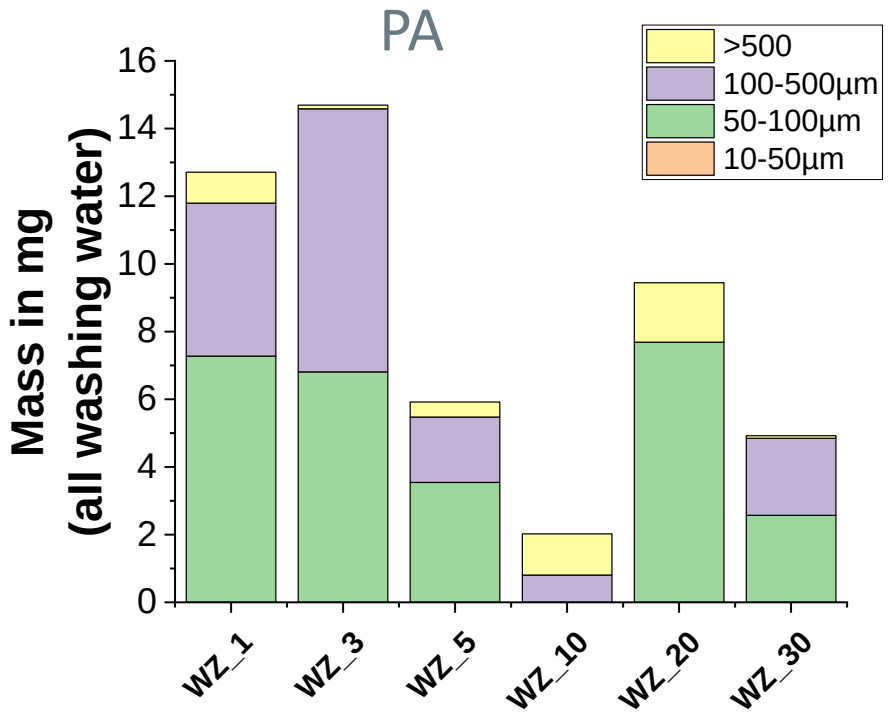




- Proportion of polymer fibre discharge in sieve residue = 0.7%
- Fibre release PET (staple fibre, fabric) > Fibre release PA (continuous fibre, knitted fabric)

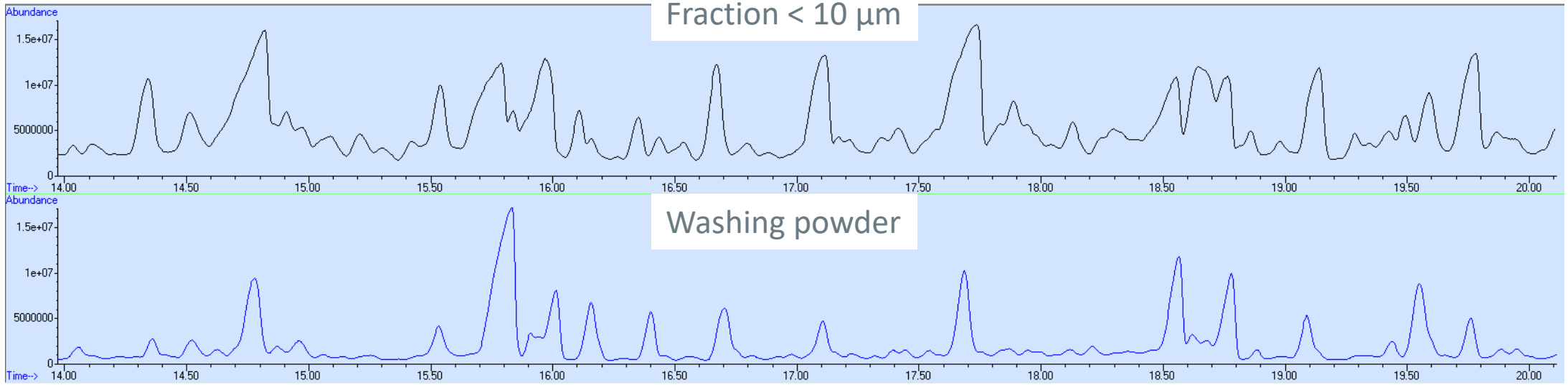
Mass per fraction (washing mashine No. 2)





- Most synth. fibres in 50-500 µm fraction (PA and PET)
- Less synth. fibres in fraction 10-50 µm + only in first WZ
- No synth. fibres in fraction < 10 µm (under limit of detection)

Fraction < 10 µm (WZ_30)



- Mainly washing powder
- No synth. polymers found

Summary

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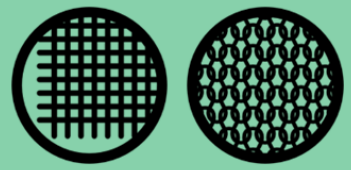
Most of the sieve residue are cotton fibres



Heterogeneity of garments must be taken into account in test series (design, implementation and evaluation), the shown test series offers exemplary insight

Household-related test series lead to new results (e.g. detergent, lime and dirt residues)

Purely gravimetric measurements do not lead to correct results

Heller, C., et al., *Garment ageing in a laundry care process under household-like conditions.* Applied Research. **n/a**(n/a): p. e202200086 https://doi.org/10.1002/appl.202200086.

Altmann, K., Braun, U., et al., *Repräsentative Untersuchungsstrategien für ein integratives Systemverständnis von spezifischen Einträgen von Kunststoffen in die Umwelt.* Abschlussbericht. 2022

Achnowledgment

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Contact:
Dr. Korinna Altmann
Bundesanstalt für Materialforschung und –prüfung, Unter den Eichen 87, 12205 Berlin, Germany
korinna.altmann@bam.de