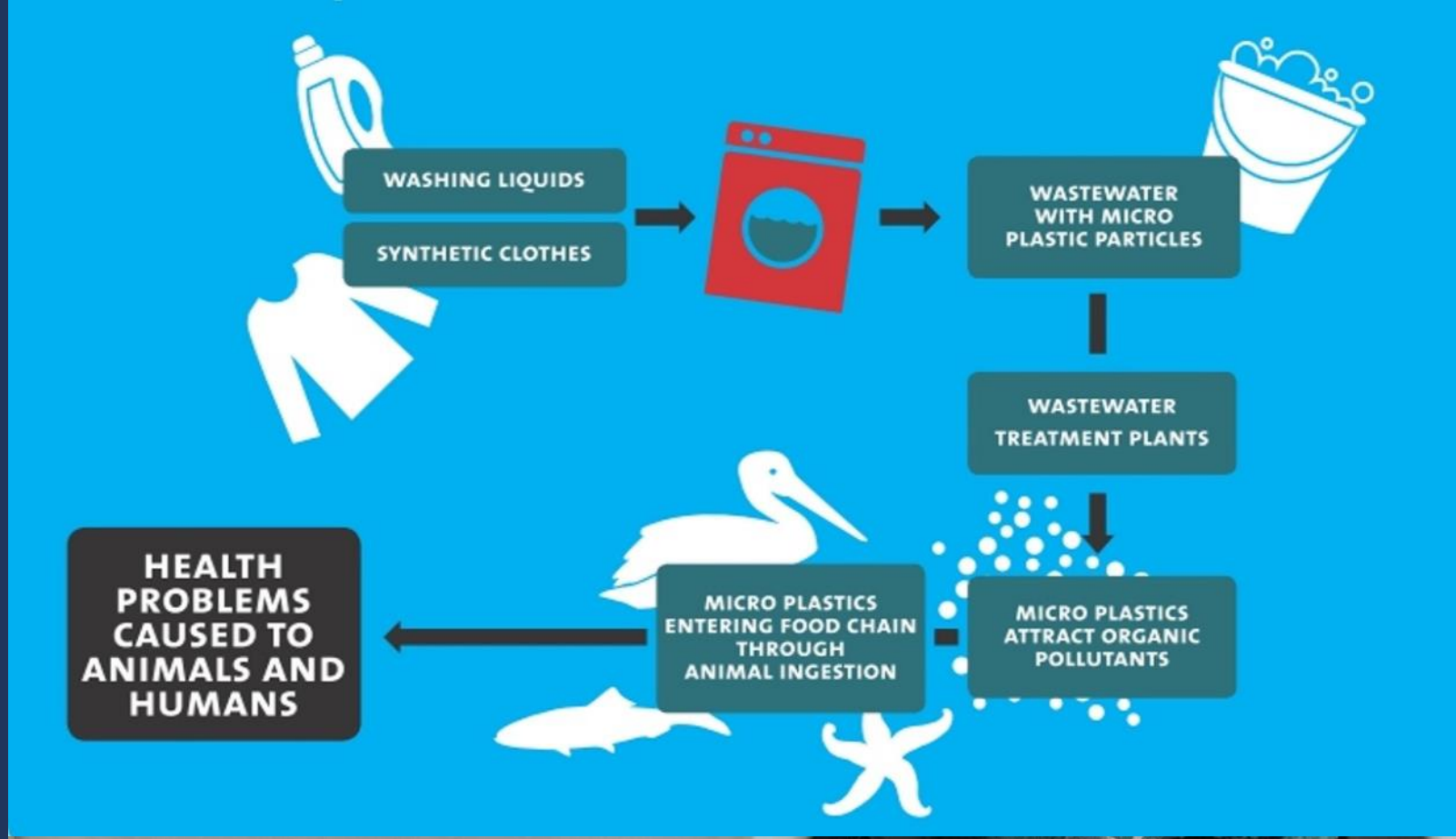
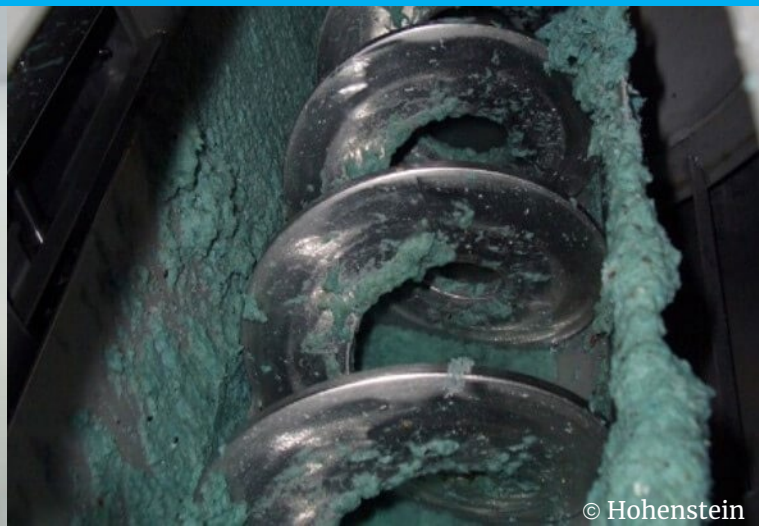
HOHENSTEIN

Microfiber Analysis for More Sustainable Product Development

The Problem




© Hohenstein

State of Research – back in 2016

Home Laundry

Browne et al. (2011)
> 1900 fleece fibers from a fleece sweater
Napper et al. (2016)
~ 700 000 acrylic fibers per 6 kg laundry
Pirc et al. (2016)
0.01 wt% microfibers from a fleece-textile

… Are these approaches systematic?

Industrial Laundry

No investigations/data so far

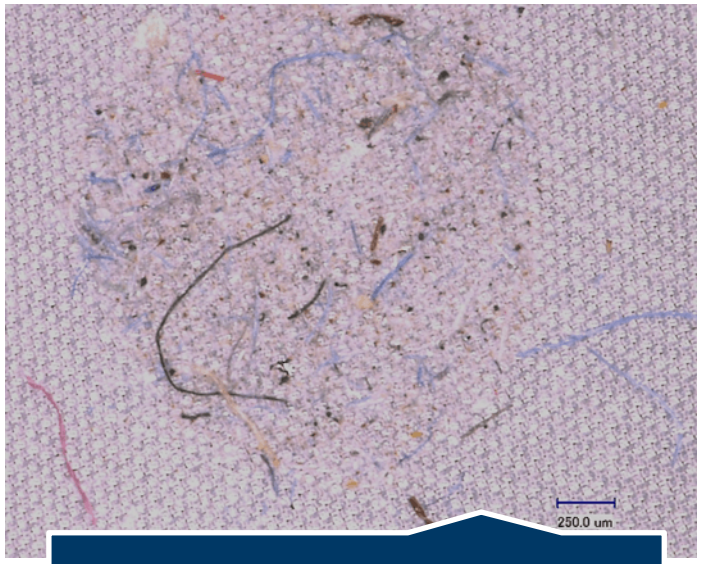
© Hohenstein

Aim of the Hohenstein AiF R&D Project

Characterization & quantification of textile fibers discharged in industrial laundry processes

© Hohenstein

Hohenstein Workflow

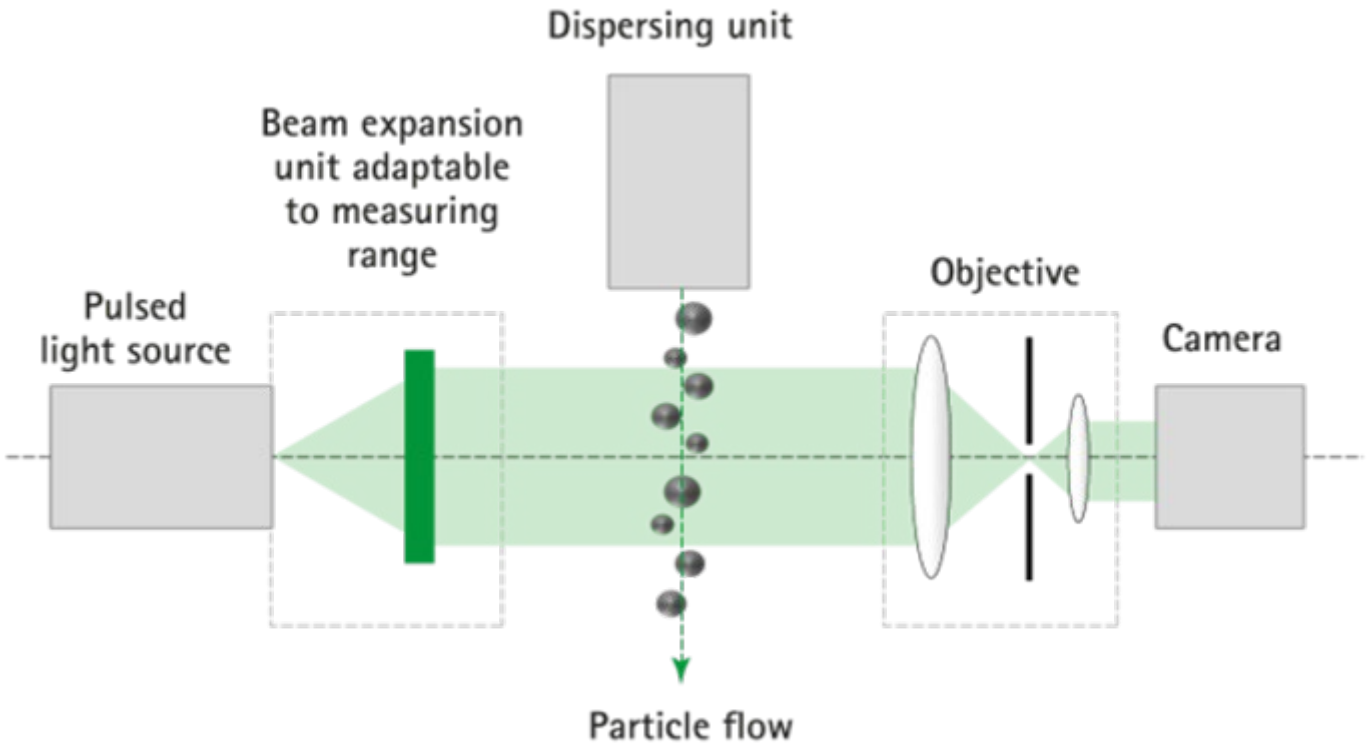


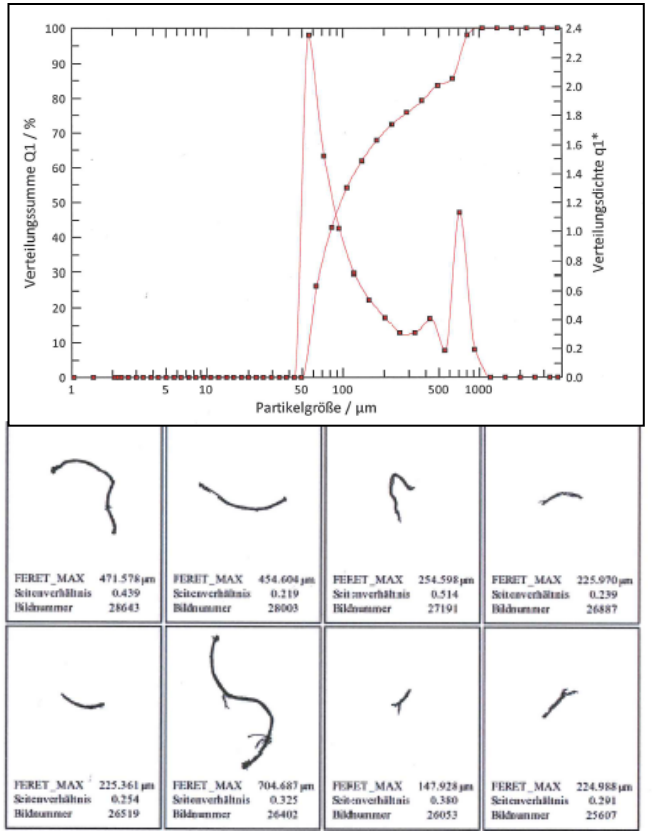
Analytics

Origin / Cause of Fiber Discharge

Reduction

© Hohenstein





No special sample preparation, but under “clean” conditions

Possible future filtration required when analyzing “regular” wastewater

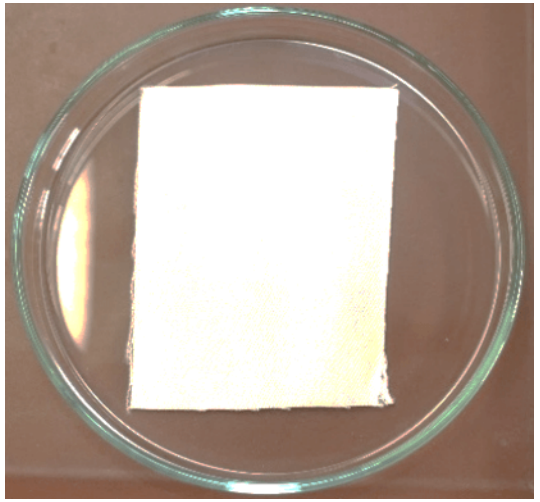
~ 10,000 images per measurement

Dynamic Image Analysis - Shape, Number & Size Distribution in Turbid & Colored Liquid, 10-3500 µm

© Hohenstein

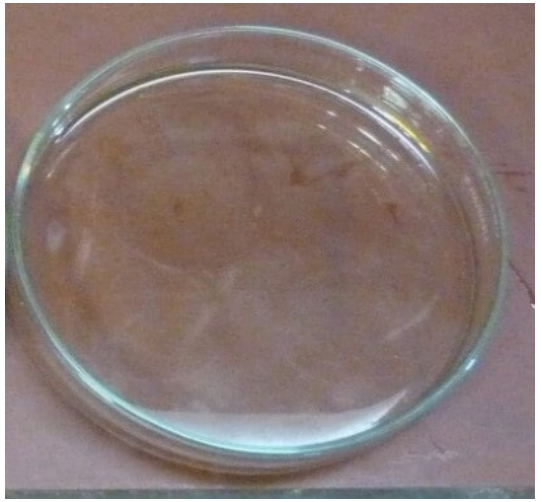
Chemical Fiber Identification
from Blended Fabrics

Sulphuric acid method (ISO 1833-11) in combination with dynamic image analysis



100 % Cotton

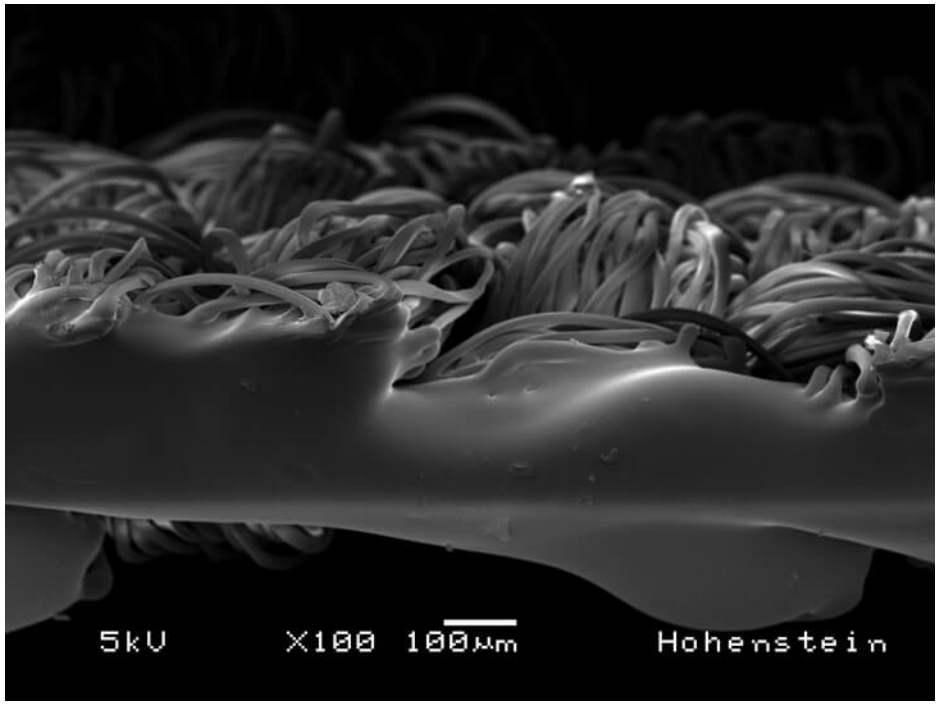
75% H_2SO_4
50°C, 1 h



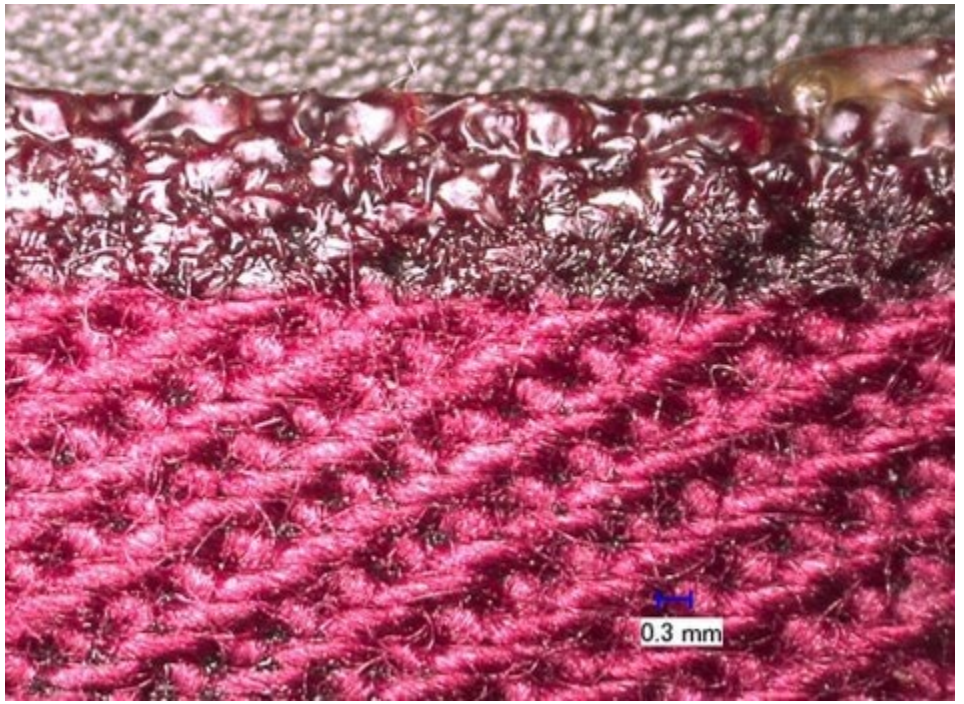
© Hohenstein

Sample Preparation

Heat/Melt Cutting Polyester



Gluing Edges Cotton/Blended Fabrics

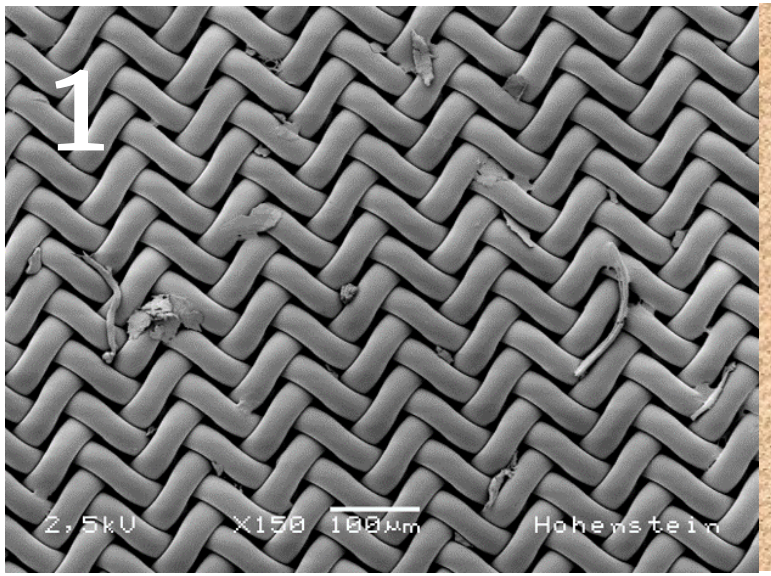


© Hohenstein

Pre-Investigations: Washing Process without Textiles

1. Scanning electron microscopy (SEM)
2. Microscopy
3. Dynamic image analysis

1



2

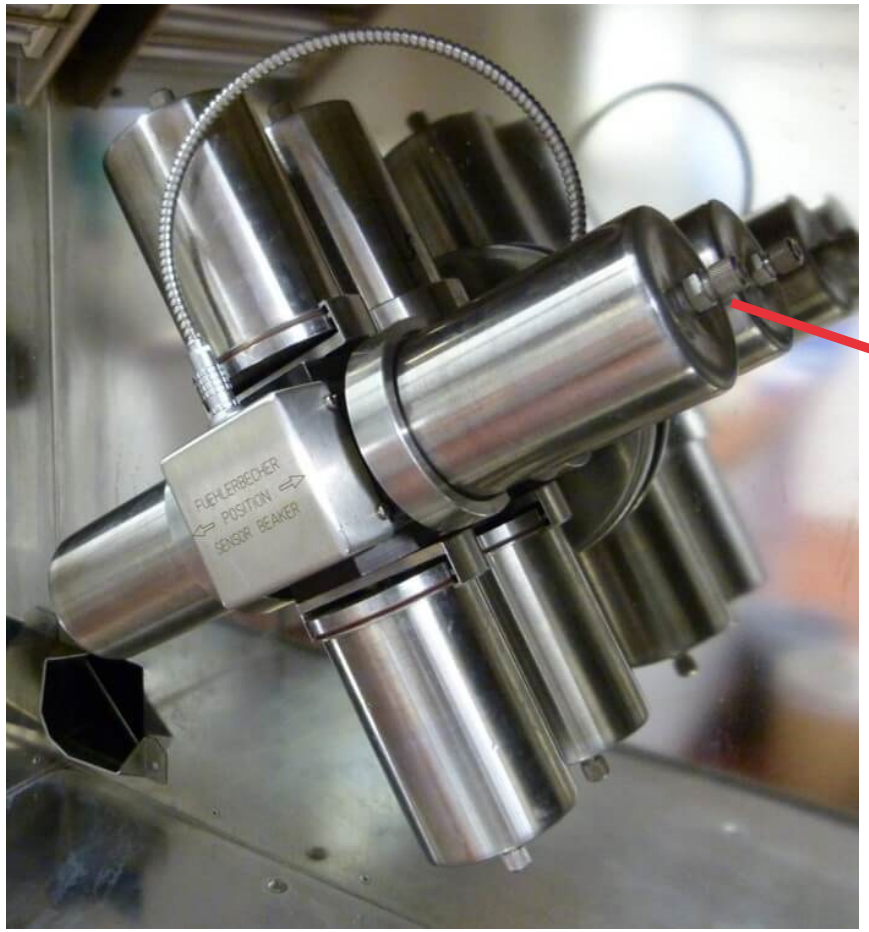
3

LEFI	554.539 µm	LEFI	141.280 µm	LEFI	120.121 µm	LEFI	132.250 µm
DIFI	15.030 µm	DIFI	16.800 µm	DIFI	19.754 µm	DIFI	10.201 µm
Sphärizität	0.270	Sphärizität	0.495	Sphärizität	0.655	Sphärizität	0.633
Geradheit	0.924	Geradheit	1.000	Geradheit	0.889	Geradheit	0.711
Elongation	0.027	Elongation	0.119	Elongation	0.164	Elongation	0.077
Bildnummer	1029	Bildnummer	641	Bildnummer	287	Bildnummer	2896

© Hohenstein

Pre-Investigations: Washing Process without Textiles

Contamination of the septum



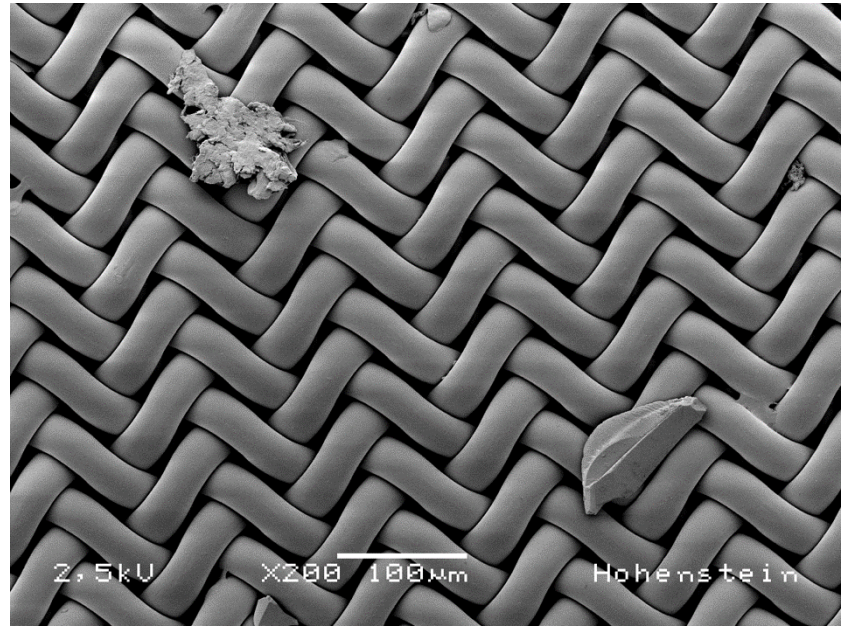
© Hohenstein

Pre-Investigations: Washing Process without Textiles

LEFI	196.562 µm
DIFI	9.057 µm
Sphärizität	0.376
Geradheit	0.826
Elongation	0.046
Bildnummer	855

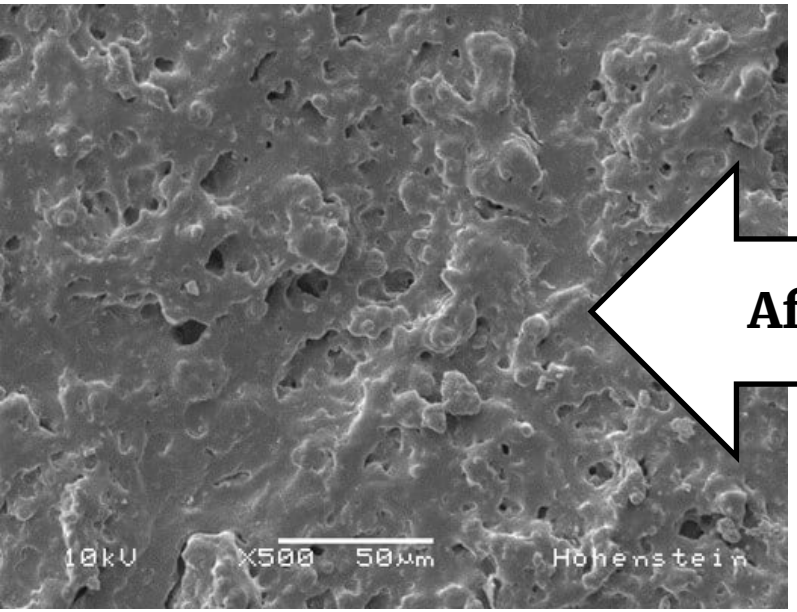
LEFI	147.248 µm
DIFI	28.570 µm
Sphärizität	0.681
Geradheit	0.913
Elongation	0.194
Bildnummer	671

REM-EDX: $SiO_2(CH_3)_2$

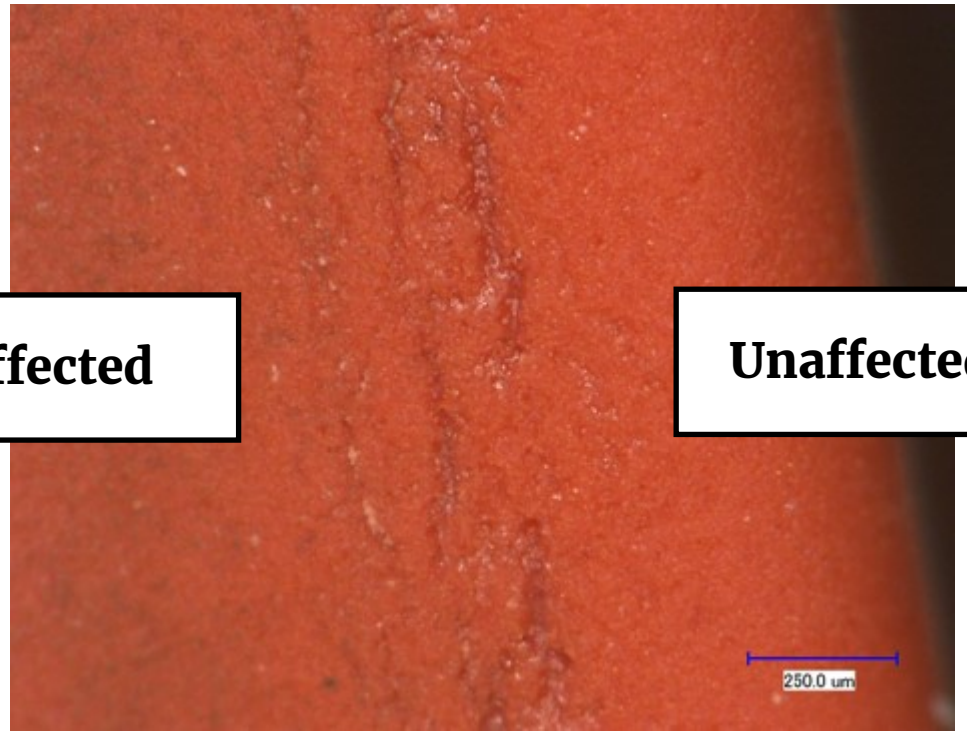


© Hohenstein

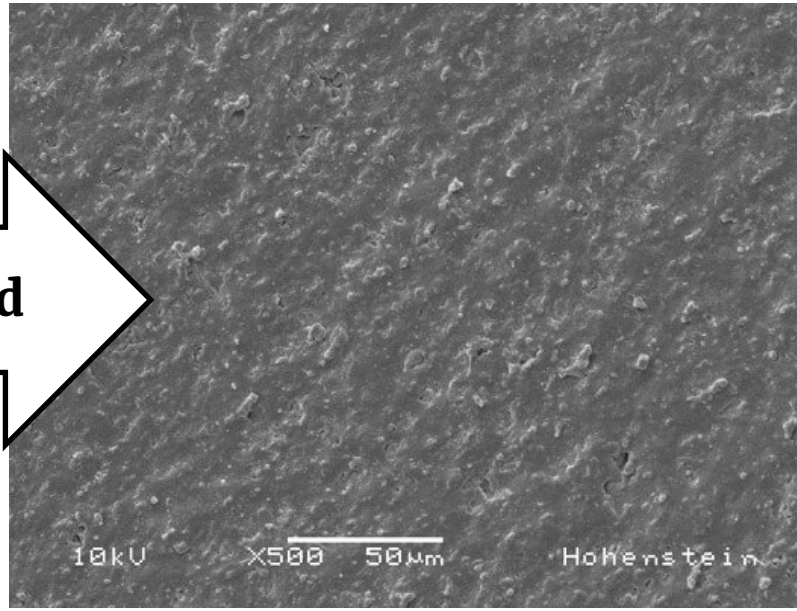
Washing Beaker - Sealing Ring



Affected



Unaffected



© Hohenstein

Pre-Investigations: Washing Liquid (No Textile)

- No powder detergent!
- Liquid detergent
- Water quality: ultrapure water

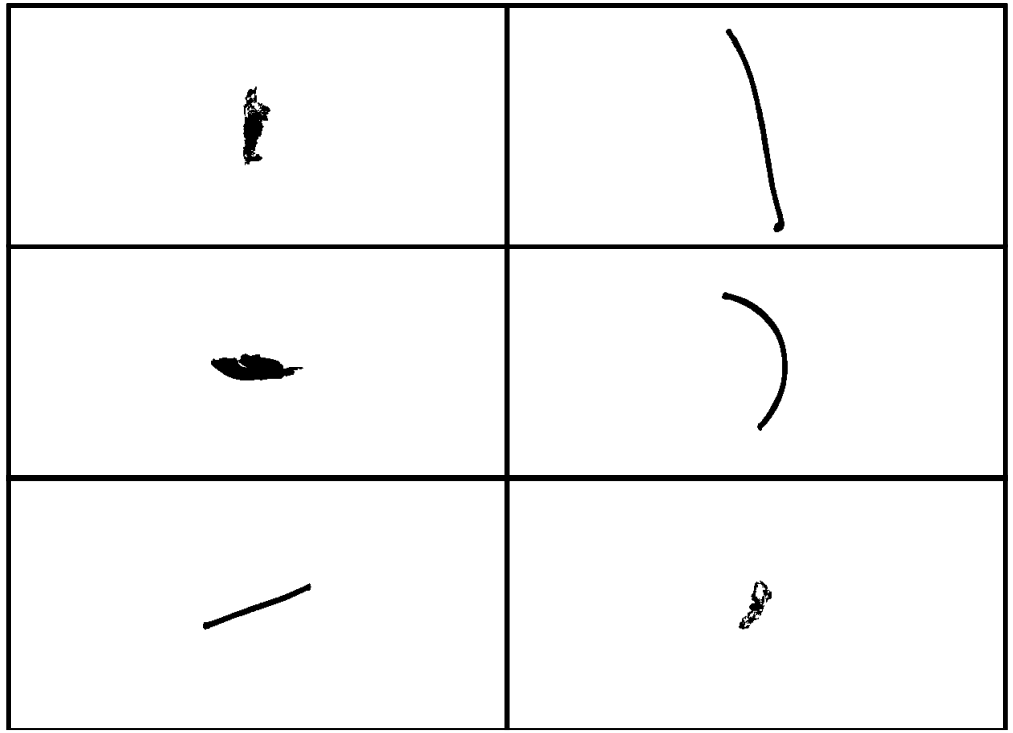
Powder Detergent

LEFI	80.025 µm	LEFI	79.872 µm	LEFI	73.713 µm
DIFI	10.785 µm	DIFI	10.030 µm	DIFI	8.545 µm
Sphärizität	0.458	Sphärizität	0.468	Sphärizität	0.437
Geradheit	0.914	Geradheit	0.984	Geradheit	0.916
Elongation	0.135	Elongation	0.126	Elongation	0.116
Bildnummer	648	Bildnummer	436	Bildnummer	768

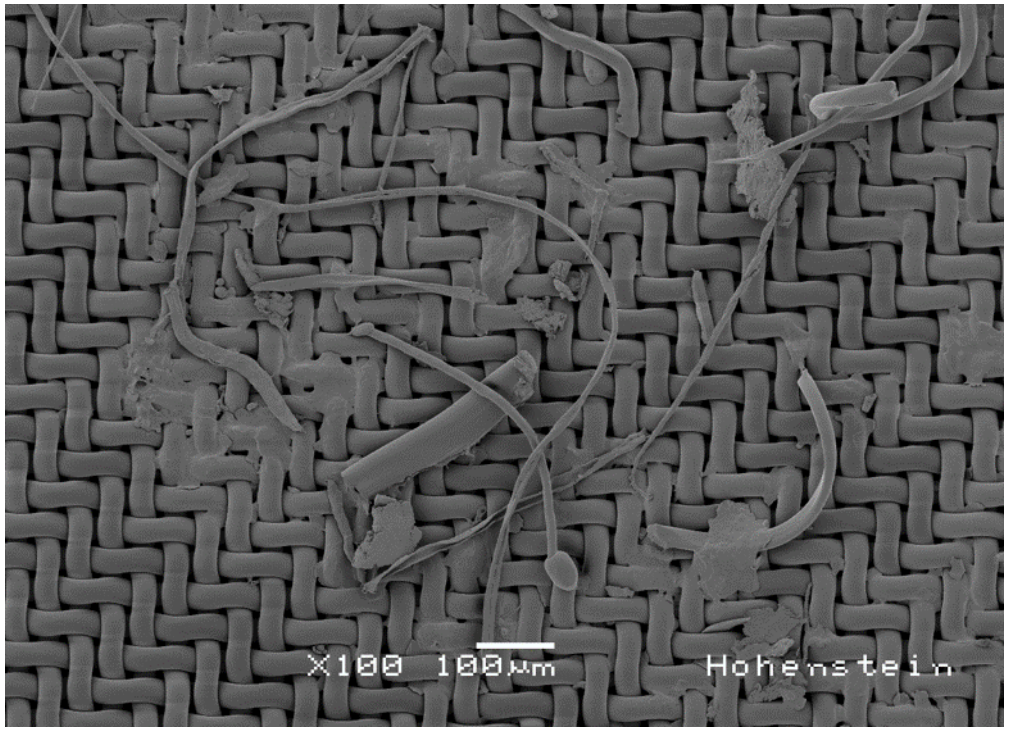
© Hohenstein

Analysis of Wastewater (PES)

Dynamic Image Analysis

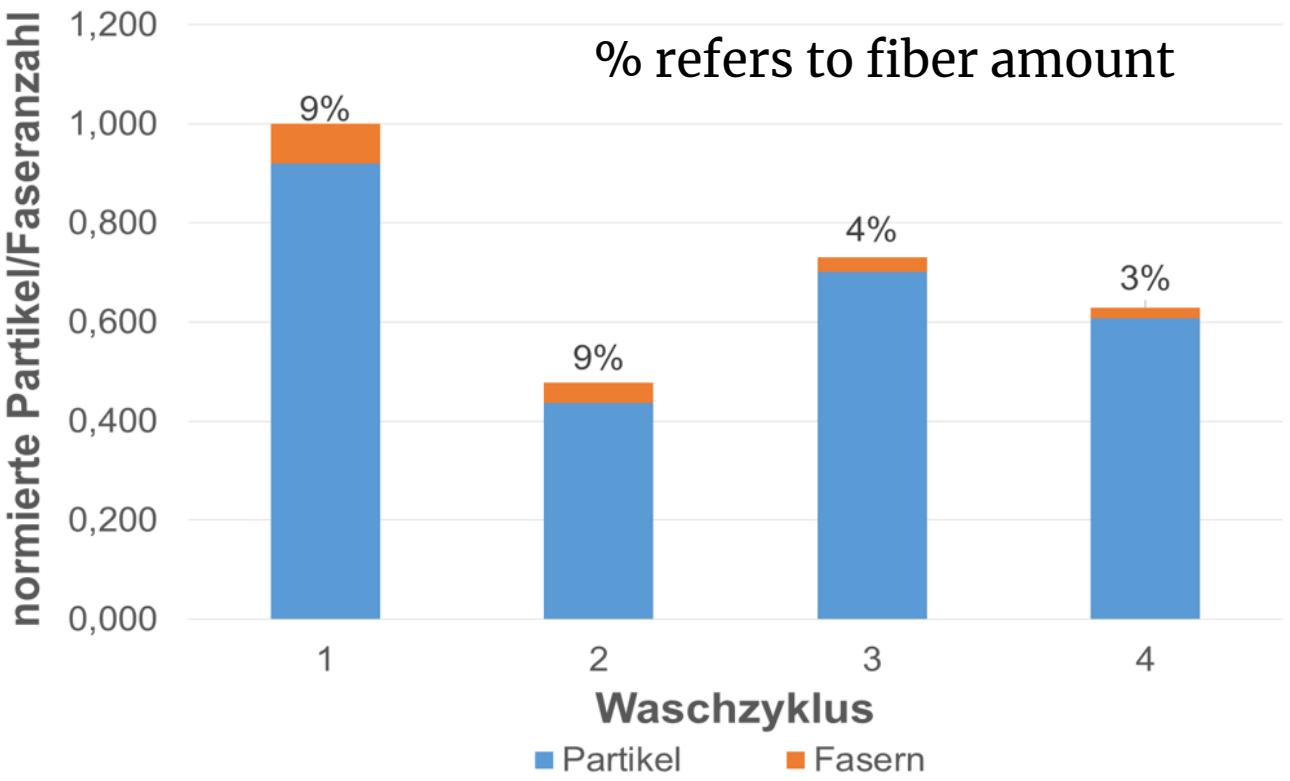


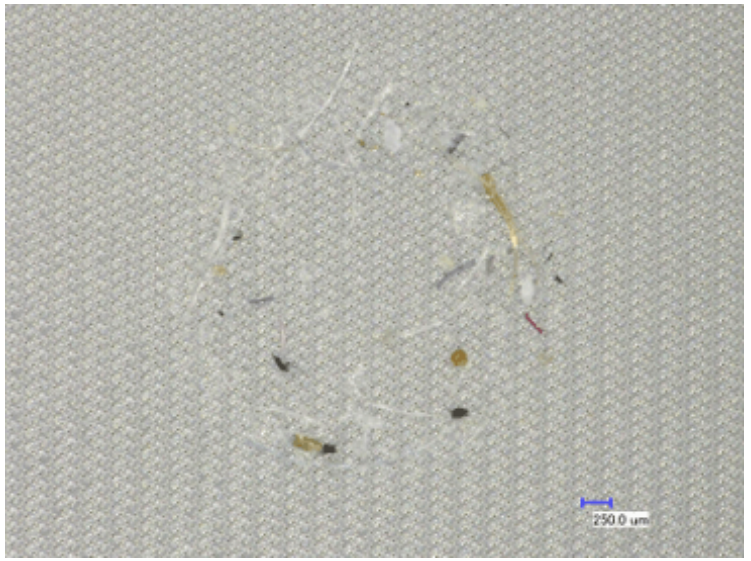
SEM

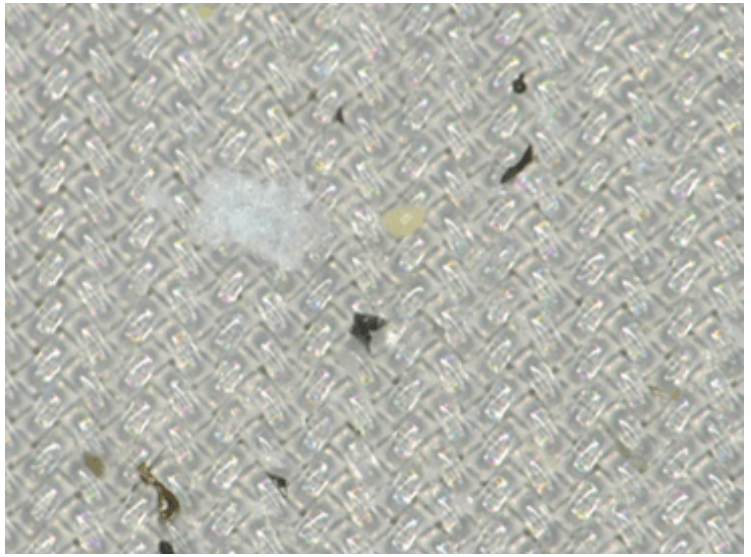


© Hohenstein

Particle vs. Fiber Amount in a Wastewater Sample (PES)

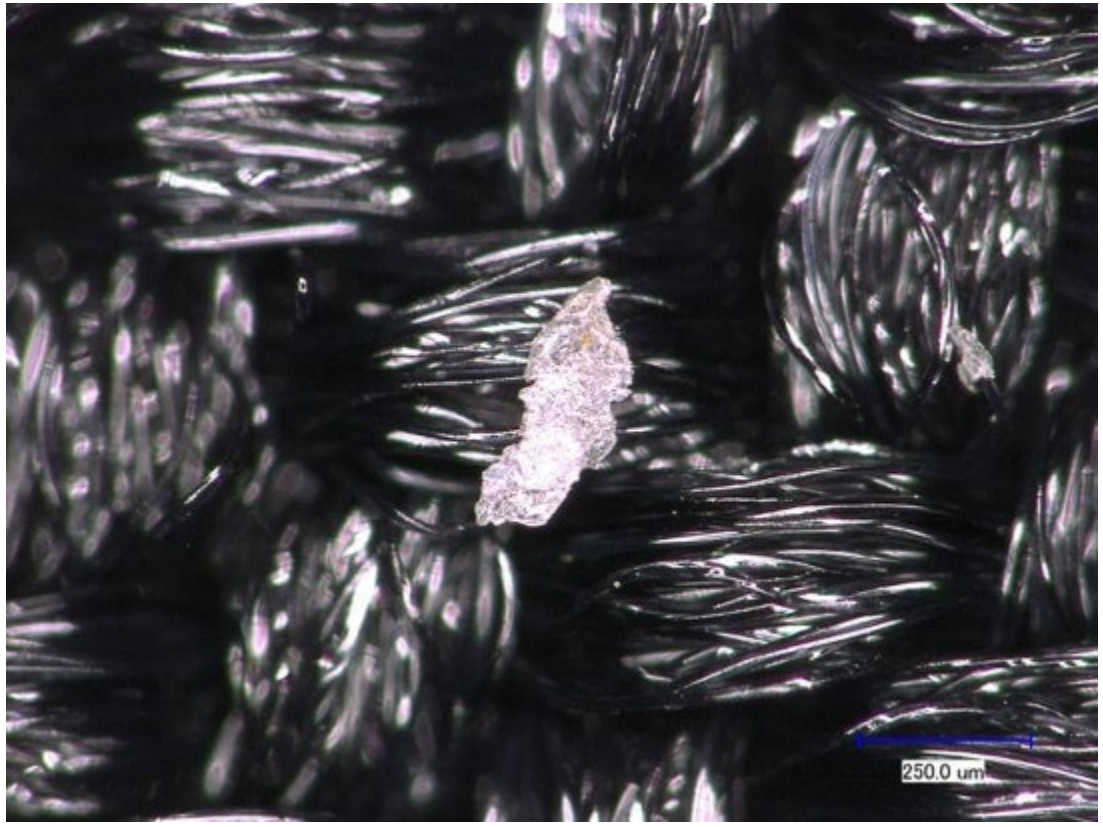


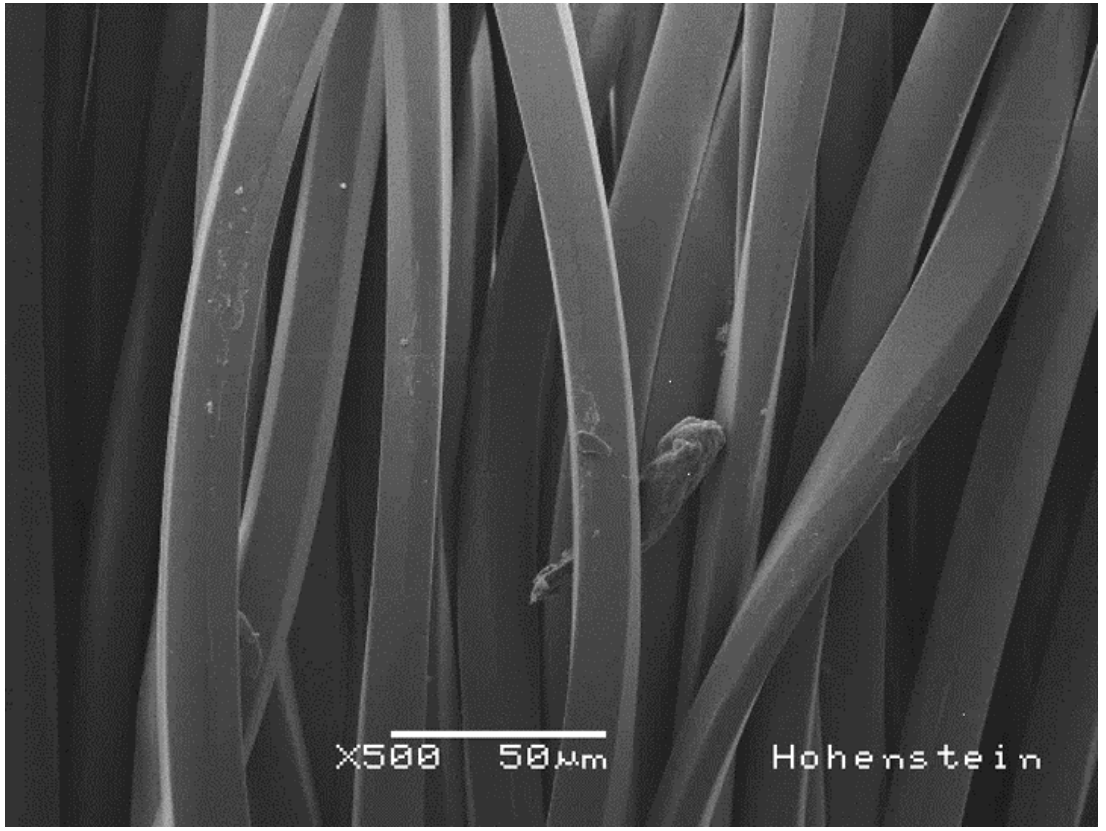




© Hohenstein

Particles from Textiles (PES)

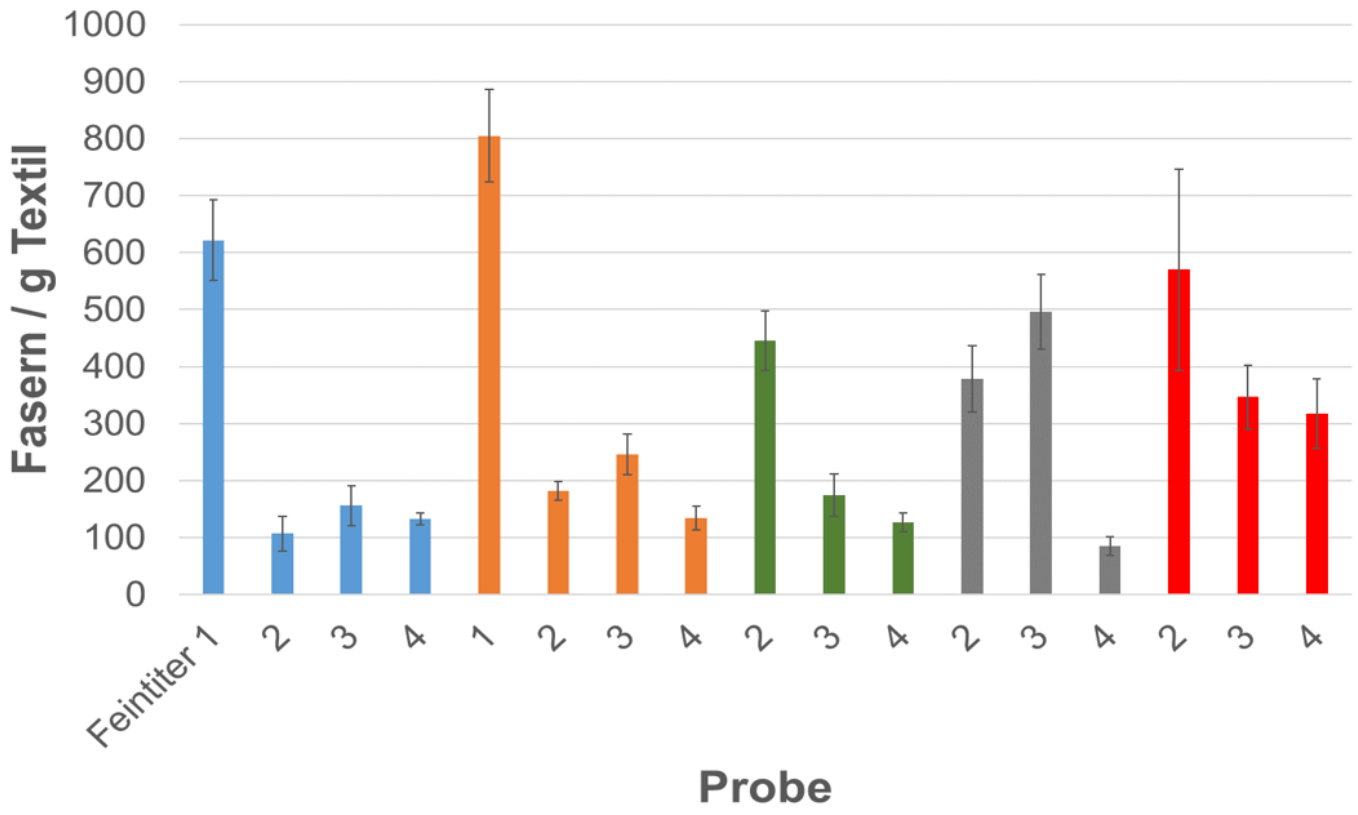




© Hohenstein

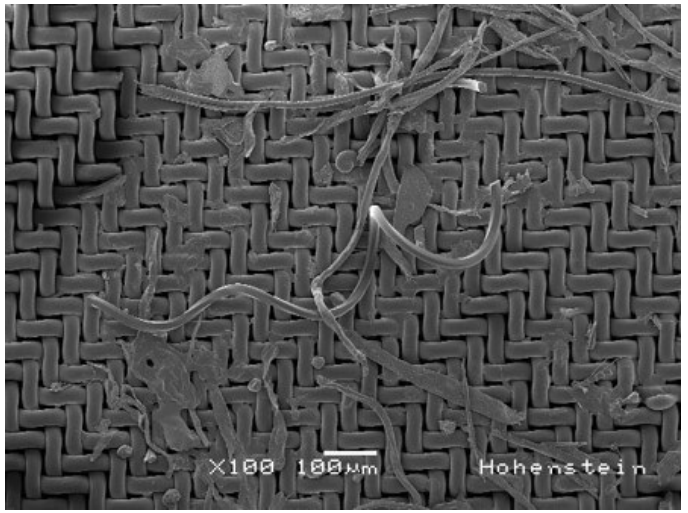
Amount of Fiber Released by Laundering of Different PES Textiles (Filament Yarn)

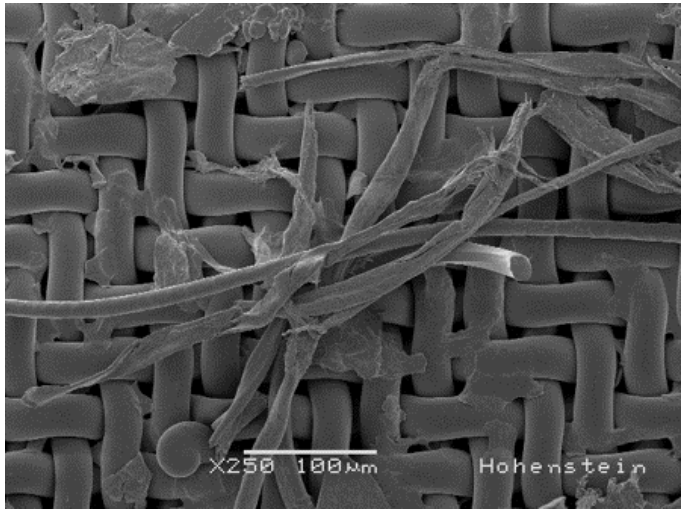
1. Fine titer
2. Medium titer
3. Medium titer
4. Coarse titer



© Hohenstein

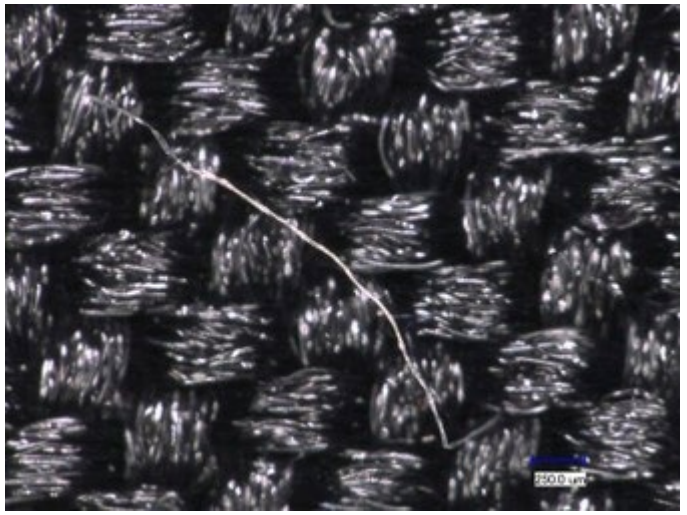
Wastewater PES

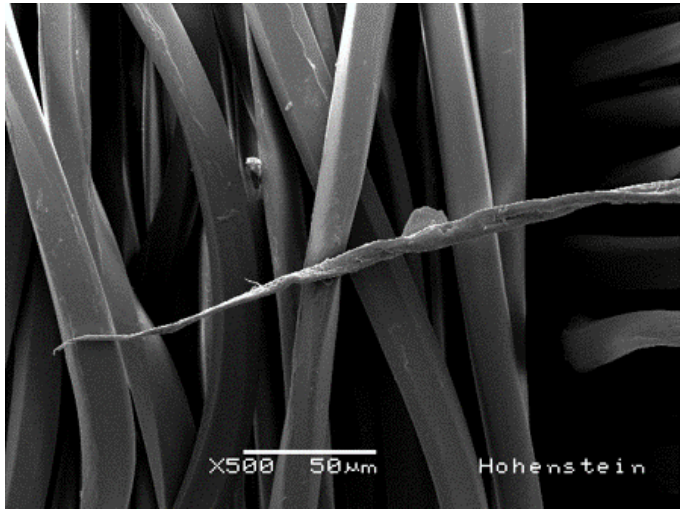




Polyester textile:
~ 90 % particles,
~ 10 % fibers

Textile Surface

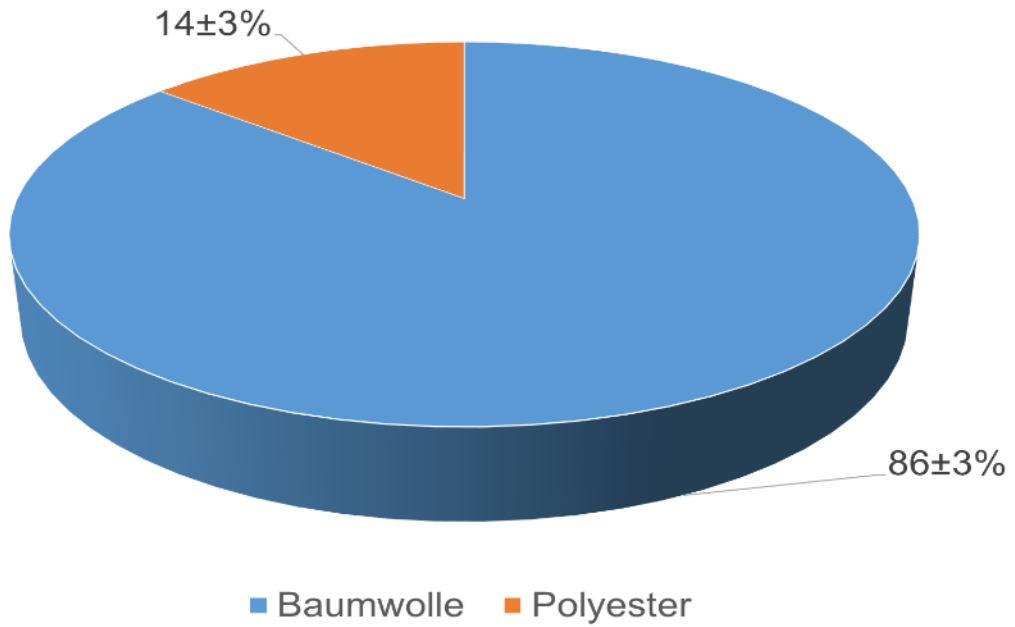




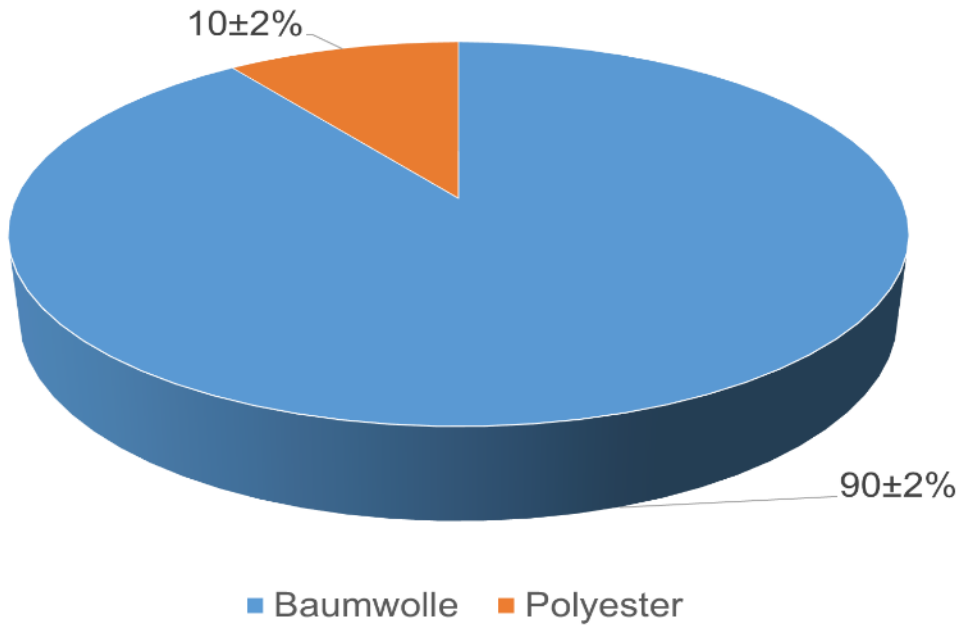
© Hohenstein

Chemical Identification of Fiber Debris from Blended Fabrics

50/50% Polyester/Cotton



65/35% Polyester/Cotton



© Hohenstein

Summary

- Quantification of total debris = filtration is fine
- But filtration collects **ALL debris**
- Full filtered debris consists of ~90% particles and 10% fibers (acc. to our and others current data)
- This results in a much higher shed weight (approx. 90% is not genuine fiber debris)
- Quantification of microfiber debris = visual analysis (i.e. DIA, SEM) is the only option

© Hohenstein

Funding Acknowledgement

We thank the Textile Research Council for their financial support for the AiF-project 19219 N, which was provided using funds from the German Federal Ministry of Economics & Technology (BMWi) via the Federation of Industrial Research Associations AIF as part of the program to support "Industrial Community Research & Development" (IGF) following an Order by the German Federal Parliament.

© Hohenstein

Regulatory Trends & Topics

- 2018 / 2019 EU Microplastic Position paper
- 27.03.2019: EU Parliament seals ban on throwaway plastics by 2021
- 2018 USA: Bills in CA & CT (pending)

...in the flow

© Hohenstein

Standardization Efforts

- EU: CIA (Cross Industry Agreement) euratex.eu/cia

  - University of Leeds (filtration)
  - Hohenstein (dynamic image analysis)

- EU / EOG: The Microfiber Consortium (Filtration)
- USA: AATCC RA 100 (Filtration)
- CEN & ISO WG‘s “Microplastics form textile sources” are currently being established

… good thing is: all 3 above are talking to each other!

Most Widely Used Method:

Filtration plus gravimetry with VARIOUS procedural options

Worldwide effort to agree on one procedure/method

© Hohenstein

Hohenstein Joins TMC as Research Member 11/2019

... to support in research & testing

© Hohenstein

Future Trends & Outlook in Microplastics Research

Establish a valid & reliable testing method – “The Tool”

Systematic investigations on fiber release vs. environmental impact from textiles in terms of construction & use

Enables informed decisions on textiles, wash processes & environment

© Hohenstein

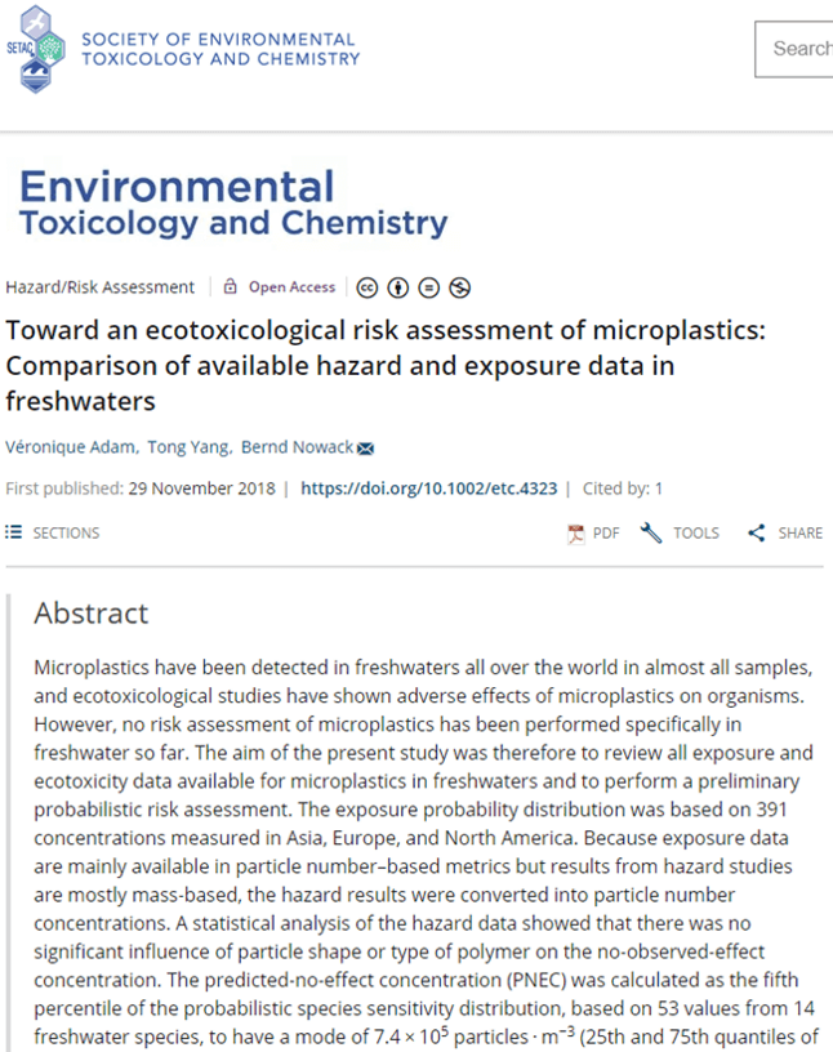
Microplastics Research from EMPA

Nowack et al.:

Ecotoxicological risk assessment of microplastics

https://setac.onlinelibrary.wiley.com/doi/full/10.1002/etc.4323

“Overall, the average risk characterization ratio is several orders of magnitude below 1, indicating no immediate risk to the environment (in the EU). However, a small risk cannot be excluded, especially in Asia, where there is a certain overlap of the exposure and hazard probability distributions.”



SOCIETY OF ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY

Search

Environmental Toxicology and Chemistry

Hazard/Risk Assessment | Open Access

Toward an ecotoxicological risk assessment of microplastics: Comparison of available hazard and exposure data in freshwaters

Véronique Adam, Tong Yang, Bernd Nowack

First published: 29 November 2018 | https://doi.org/10.1002/etc.4323 | Cited by: 1

SECTIONS PDF TOOLS SHARE

Abstract

Microplastics have been detected in freshwaters all over the world in almost all samples, and ecotoxicological studies have shown adverse effects of microplastics on organisms. However, no risk assessment of microplastics has been performed specifically in freshwater so far. The aim of the present study was therefore to review all exposure and ecotoxicity data available for microplastics in freshwaters and to perform a preliminary probabilistic risk assessment. The exposure probability distribution was based on 391 concentrations measured in Asia, Europe, and North America. Because exposure data are mainly available in particle number–based metrics but results from hazard studies are mostly mass-based, the hazard results were converted into particle number concentrations. A statistical analysis of the hazard data showed that there was no significant influence of particle shape or type of polymer on the no-observed-effect concentration. The predicted-no-effect concentration (PNEC) was calculated as the fifth percentile of the probabilistic species sensitivity distribution, based on 53 values from 14 freshwater species, to have a mode of 7.4×10^5 particles $\cdot m^{-3}$ (25th and 75th quantiles of

© Hohenstein

Open Access Article

Microplastic Fibers Released by Textile Laundry: A New Analytical Approach for the Determination of Fibers in Effluents

by Jasmin Haap [1,*], Edith Classen [1], Jan Beringer [1], Stefan Mecheels [1] and Jochen S. Gutmann [2,3]

[1] Hohenstein Institut für Textilinnovation gGmbH, Schlosssteige 1, 74357 Bönnigheim, Germany

[2] University Duisburg-Essen, Institute of Physical Chemistry and Center for Nanointegration, Duisburg-Essen, Universitätsstraße 5, 45117 Essen, Germany

[3] Deutsches Textilforschungszentrum Nord-West gGmbH, Adlerstr. 1, 47798 Krefeld, Germany

* Author to whom correspondence should be addressed.

Water **2019**, *11*(10), 2088; https://doi.org/10.3390/w11102088 (registering DOI)

Received: 19 August 2019 / Revised: 24 September 2019 / Accepted: 25 September 2019 / Published: 7 October 2019

(This article belongs to the Special Issue Microplastics in Aquatic Environments and Wastewater Treatment)

Download PDF Browse Figure

- Abstract: https://www.mdpi.com/2073-4441/11/10/2088
- PDF Version: https://www.mdpi.com/2073-4441/11/10/2088/pdf

Hohenstein Scientific Paper on the DIA Validation

© Hohenstein

HOHENSTEIN

Thank you

Dr. Jan Beringer
Scientific Expert
Hohenstein

J.Beringer@hohenstein.com
+49 7143 271 714

Hohenstein.US

HOHENSTEIN

Learn More: Hohenstein.US/Microfibers