

Microplastics and their Alternatives for Intentional Use in Products An application for FT-IR Micro-Spectroscopy

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Introduction

Microplastics for intentional use in products are often linked with exfoliating microbeads added to cosmetics and personal care products. However, their use extends far beyond this abrasive function and spreads across many product groups. As **theoretical background** we give a broad working definition of microplastics that is under discussion in the EU. We will present an overview of intentionally added microplastics, and their versatile functions in the products. The **analytical perspective** covers an application example of FT-IR micro-spectroscopy for microplastic analysis.

Theoretical Background

★ Working Definition★ Microplastics are ...?

☑ ... mostly agreed, ☐ ... under discussion

- ☑ solid plastic particles smaller than **5 mm**
- ☑ made of conventional plastics e.g. PE/PP/PS/PA/PVC
- ☐ also particles of other synthetic polymers, e.g. elastomers, resins, superabsorbent polymers?
- ☐ also smaller than 1 μm (i.e. nano range)?
- ☐ bioplastic particles made from renewable feedstock?
- ☐ also water soluble and/or biodegradable particles?

Common products containing microplastics are ...?

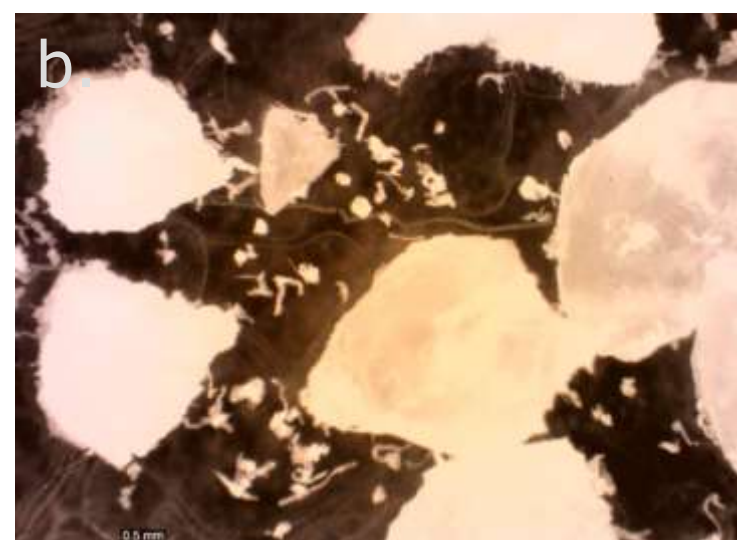


Fig.1a. Ingredient list of personal care product containing microplastic (Polyethylene)
1b. Microscope image of abrasive particles
1c. Products and their added abrasive particles

⇒ Voluntary initiatives of product brands to remove solid plastic particles used to exfoliate or cleanse in rinse-off personal care products are underway.

Many functions of ★microplastics★ in products

- Exfoliating, abrasive
- Emulsifying/suspending/dispersing agent
- Film forming, surface coating, anti-static agent
- Binding, filler, control release of ingredients
- Improve chemical/mechanical resistance
- Flocculants, dewatering, absorbent

Product categories containing ★microplastics★

- Cosmetics, personal care products, detergents
- Paints, coatings, inks; industrial abrasives
- Agricultural and horticultural applications
- Pharmaceuticals
- Additives in waste water treatment

Conclusions & Outlook

- **Small particles potentially categorizing microplastics are widely applied in consumer products for their versatile functions.**
- **For identification of both microplastic particles and their alternatives in products FT-IR spectroscopy was successfully applied.**
- **The different measurement options in FTIR provide flexibility in choosing the most appropriate method for the given analytical scope.**

Microplastic Analysis

Abrasive particles found in products



Fig. 2. Particles contained in exfoliating scrub

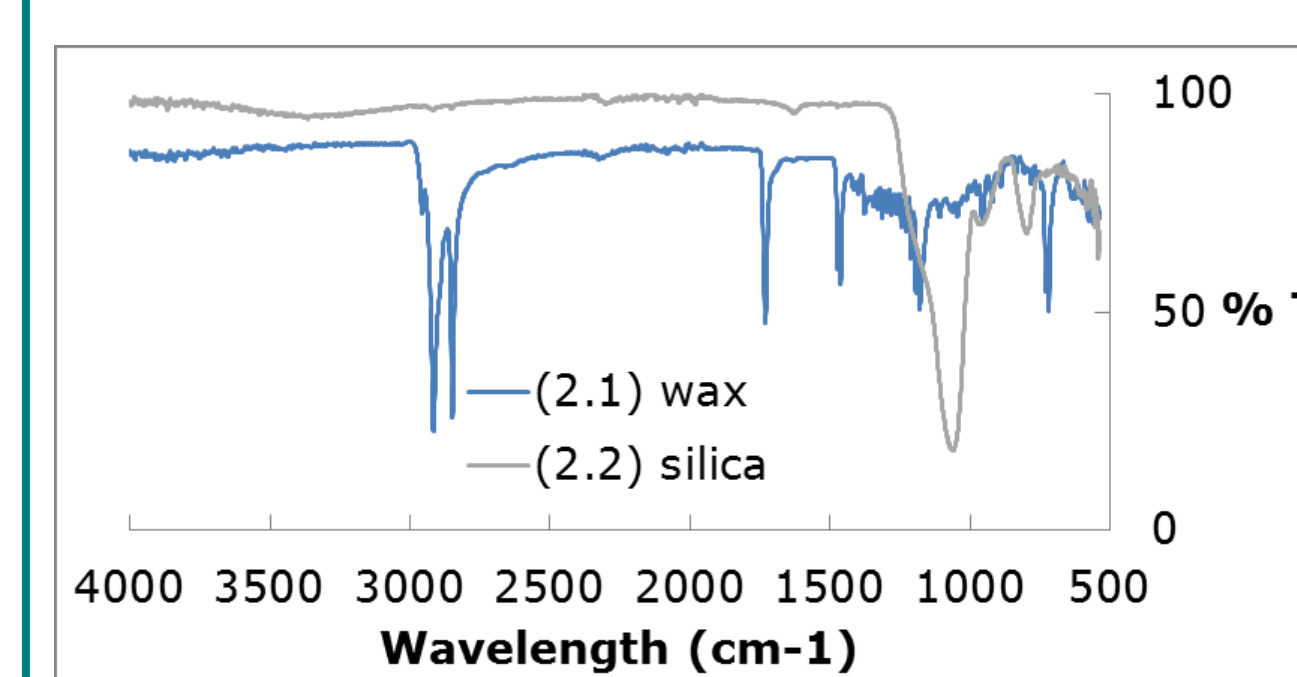


Fig. 3: Particles contained in hand cleansing paste

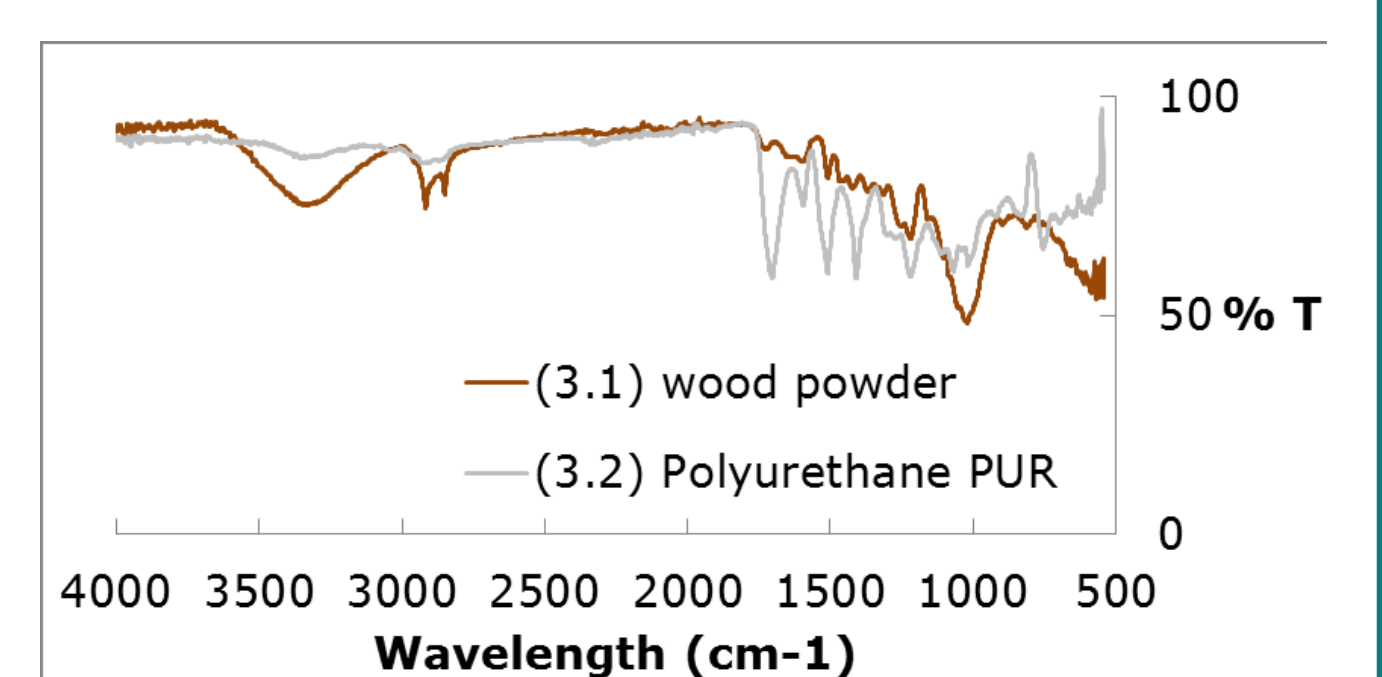
- (2.1) blue spheres ~ 0.4 mm
- (2.2) white spherical particles ~ 0.3 mm and ~ 0.05 mm

- (3.1) brown splinters $\sim 0.2-1.5$ mm
- (3.2) transparent, sharp-edged fragments $0.05-0.25$ mm

Material identification by micro-ATR-FTIR analysis

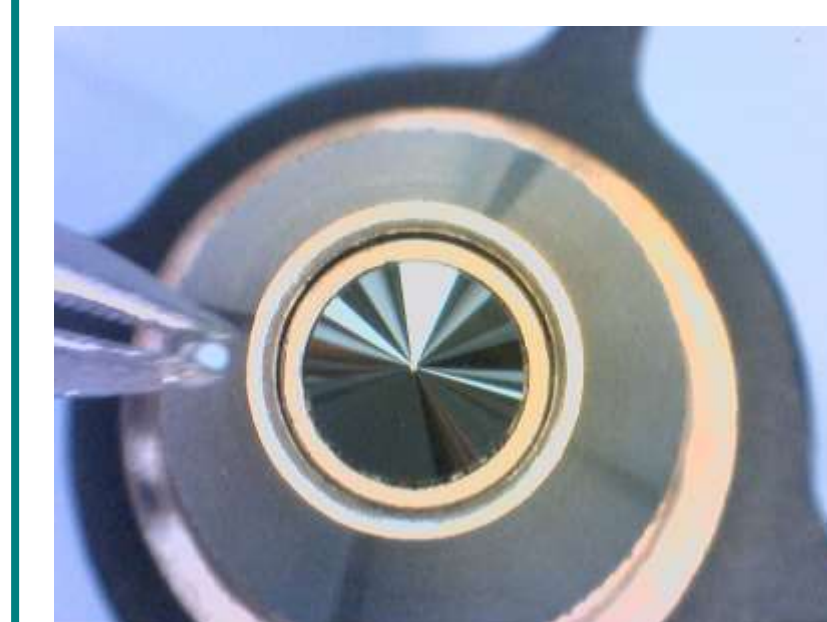


No microplastics, only alternative abrasive particles in product



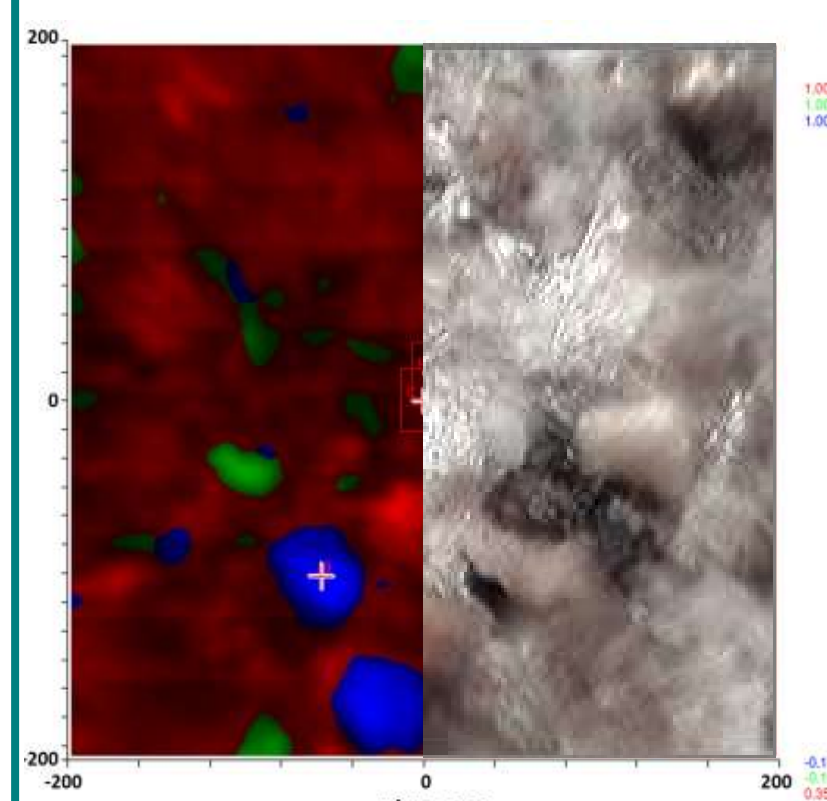
Both microplastics (PUR) and alternative abrasives in product

Options for material identification of microplastics by FT-IR using PerkinElmer Spotlight 400



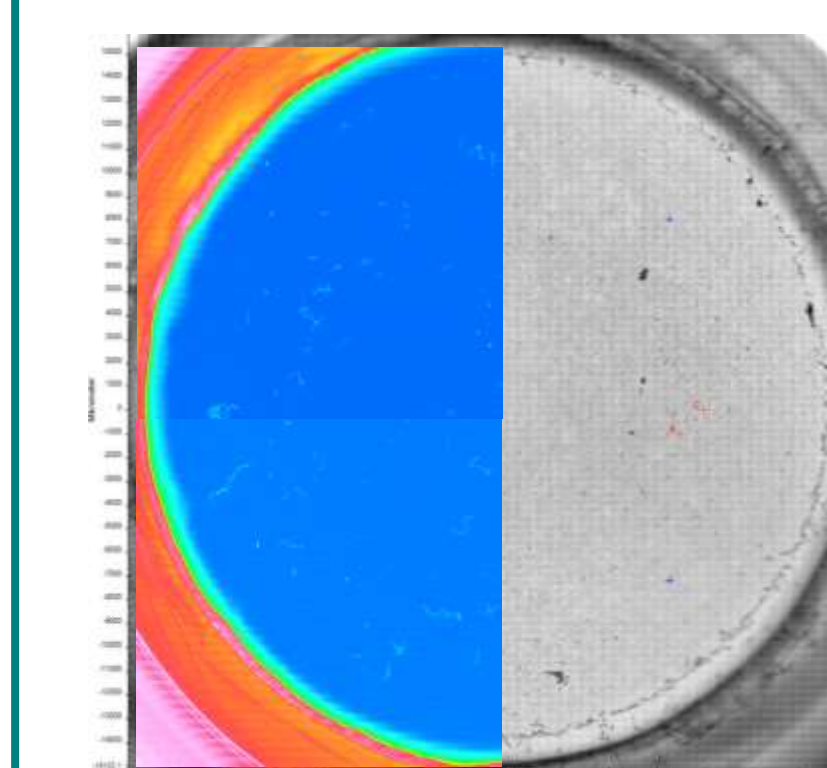
Micro-ATR-FTIR

- In-contact measurement
 - Original particle size/shape changes
 - Cleaning to avoid cross-contamination
- Fig. 4. View from below on micro-ATR-device with 200 μm particle before single particle measurement.



ATR-FTIR (+Imaging)

- In-contact measurement
 - Original particle size/shape/position changes
 - Cleaning to avoid cross-contamination
 - Evenly distribute particles to avoid overlap that deteriorates identification
- Fig. 5. Measurement area 400 x 400 μm with particles after (left) and before (right) ATR-imaging



Transmission/Reflection FTIR (+Imaging)

- Non-contact measurement of surface
 - Original particle size/shape/position remains, counting of particles possible
 - Less cross-contamination, less cleaning
- Fig. 6. Measurement area 2.5 x 2.5 cm with ~ 1.5 mg particles on filter after (left) and before (right) FTIR-Imaging in Transmission