The Use of Forensic Fibre Examinations for Microplastic Studies

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Outline of Presentation
Thinking Points....

- Could this approach aid your microplastic work?
- How does this existing research influence analysis/interpretation methods?
- How does new technology in fibre finding and automated analysis fit into microplastic analysis standardisation?
What is Forensic Fibre Analysis?

For the Criminal Justice System it must be:

- Robust
- Use standardised and validated approaches – ISO standards
- Use data to support all decisions
We have (some of) the same questions...

- How much is present?
- What is it?
- Where is it from? How certain are we?
- Where is it going?
- How long has it been there?
And we have the same requirements....

- Want more data!
- Want the analysis to be quicker!
- Want the analysis to be cheaper!

"Standardised, cheap and simple methods for sorting and enumerating plastic fragments" Thomas Maes, 2017

"Monitoring & Modelling, incl. Distribution and abundance Sources and types Spatial and temporal trends Hotspots" Thomas Maes, 2017
Where can forensic fibre examination processes be helpful in MP work?
Overlapping areas: CSI Meets MPs!

Contamination Prevention Procedures
Monitoring of environmental fibre contamination
Fibre free environments/use of Personal Protective Equipment

Better Understanding of Source Level
Focus on improved discrimination between fibres
Categorization of samples via use of optical, morphological and chemical properties

Better Understanding of Transfer and Prevalence
Many transfer studies of different garment types
Ability to quantify the sheddability of fabrics
Use of population studies for fibre prevalence in different environments

Faster and More Effective Quantification
Initial polymer identification without use of FTIR
Development of automated systems for fibre characterization and quantification

Improved Interpretation and Evaluation
Collation and use of large datasets
Integrated databases for identification,
Contamination minimisation for microplastic analysis

Using a forensic science approach to minimize environmental contamination and to identify microfibres in marine sediments

Lucy C. Woodall, Claire Gwinnett, Margaret Packer, Richard C. Thompson, Laura F. Robinson, Gordon L.J. Paterson

- Conduct monitoring of the environment
- Count fibres
- Initial screening using polarizing light microscope
- Isolate fibres to be screened with more detailed analysis techniques (e.g., FT-IR)

Screening and picking

- Mark area at least 400cm²
- Clean laboratory including marked area
- Conduct first tape lift
- Seal tape onto clean acetate sheet and seal edges
- Screen filter papers with microscope at X20 magnification

Reporting

- Report results and methods of contamination monitoring
- Report results of field samples
- Comment on similarity of data of field samples and contamination monitoring
How well do fabrics shed? Sheddability of Fabrics in FS

- Helps identify how many fibres could be lost from the fabric to environment
- Dependent upon fabric type, wear, texture, yarn type and number/type of fibres in fabric
- Many fibres shed are fragments broken from surface

1. Visual
   - Low, medium, high
2. Comparison Scale (Wael et al (2010))
3. Controlled force (Robertson and Grieve, 1999, Coxon et al, 1992)
Maximising information from MPs

- To characterise the fibres fully
- Optical properties
- Chemical properties
- Quantification of colour
- To differentiate fibres
- To identify source
- To identify activity
- To identify commonality
- To support findings with data
- To be reactive to changes
- Simple/fast
- Minimising contamination
- Complex
Common Order of Analysis

1. Initial Analysis and Screening – all retrieved fibres
   - Stereomicroscopy
   - Polarized light microscopy

2. Use of Different Light Sources - optical properties
   - Fluorescence microscopy

3. Colour quantification
   - Microspectrophotometry
   - Thin Layer Chromatography

4. Confirmation of polymer type – target fibres
   - FTIR

(Shim et al, 2016; Maes et al, 2017)
PLM....a great second stage for searching/characterisation

- Added benefits incl.
- Easy ID of;
- Natural vs synthetic
- Polymer type
- Cross-section shape
- Width/length
- Surface area
- Presence of delusterant
- Other inclusions
- Degradation features
Further Techniques... used to id source level info

Identification
- Pyr-GC
- Pyr-GC-MS

Morphology
- SEM

Colour / Dye Analysis
- HPLC
- Raman Spectroscopy

Melting Point

Damage/degradation detail
Use of SEM for fibres work
Improved recovery methods
**Improved recovery methods**

Paper being drafted:

* Easylift® tape enables effective recovery of microfibres from filter papers
* Whatman filter papers outperform glass filters in microfibre recovery
* Microfibres may be lost at edges of filter paper during filtering
* Glass frit filtration recovers more fibres than Buchner filtration from water samples

Mean recovery rate: 98%, range = 91-100%, n = 90

**NUMBER OF MICROFIBRES SEARCHING**

- Manual searching used

- Mean recovery rate: 98%

- Range: 91-100%

- n = 90
Reducing Analysis Time: Development of Easylift

- New tape system that allows analysis of fibres *in situ* without need for dissection
- Non-birefringent
- Tape and backing does not interfere with analysis
- No air bubbles
- Allows analysis by;
  - Polarized light microscopy
  - Fluorescence microscopy (some wavelengths)
  - Raman spectroscopy
  - Microspectrophotometry (MSP)
Development of Maxcan and Fx5 fibre finders

Development of in situ analysis system

Automated fibre finding using MSP

Automated counting of ‘tracers’

Use of machine learning for automated analysis

1980’s  now

SCIENTIFIC HIGH-THROUGHPUT AND UNIFIED TOOLKIT FOR TRACE ANALYSIS BY FORENSIC LABORATORIES IN EUROPE
What will it do...

Tool 1
Tape lifting system

Tool 2
Microscope system incl. polarized light, darkfield illumination, spectral information, Automated extracted

Tool 3
Image processing
Machine learning to detect, quantify, characterise microtraces

Tool 4
Database generation;
Provenance info
Pattern recognition
Allow for source level information

SPECTRAL360
Automated Detection, Characterisation and Quantification of Microplastics...
Thank you for listening!

For more information;

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