AN EVALUATION STUDY FOR FIBRE ANALYSIS BY UV-VIS MICROSPectrophotometry

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INTRODUCTION

Colour can be a highly discriminating feature in forensic fibre comparison.

VIS microspectrophotometry increased the ability for colour discrimination.

Further discrimination can be obtained in the UV spectral range.
PURPOSE

In this study, various aspects of UV-VIS microspectrophotometry were assessed to evaluate its use in a forensic laboratory for routine fibre analysis.
PURPOSE

• Instrumental stability
• Interferences from mounting materials
• Interferences from fibre polymers
• Its relative value compared to VIS microspectrophotometry
METHODOLOGY

Instrumental stability

Same-day fibre analysis reproducibility
- Green acrylic fibre absorbance was measured 6x in approx the same location over 8 hour period

Day-to-day fibre analysis reproducibility
- Green acrylic fibre absorbance was measured 6x in approx the same location over 28 day period
RESULTS
Instrumental stability

Spectral results from same-day
RESULTS

Instrumental stability

Spectral results from day-to-day
METHODOLOGY

Interferences from mounting materials

UV-VIS absorbance was measured through:

- Glass slide
- Quartz slide
- Glycerine on quartz
- XAM on quartz
RESULTS

Interferences from mounting materials

Absorbance spectra of mounting materials

![Absorbance Spectra of Mounting Materials](image)
METHODOLOGY
Interferences from fibre polymers

UV-VIS absorbance was measured for white, non-dyed fibres of different polymer types:

- Cotton, ramie, wool, silk
- Di-acetate, triacetate, viscose
- Nylon 6, nylon 66, polyethylene, polypropylene, PET, PCDT
- Modacrylics: PAN/VC, PAN/VDC, PAN/VDC/MMA, PAN/VDC/VBr/ARS
- Acrylics: PAN/MA, PAN/MMA, PAN/VA, PAN/PVP, PAN/MA/MVP, PAN/VA/MVP
RESULTS

Interferences from fibre polymers

- High UV absorbance of wool, silk, polyester, and acrylics with MVP
- Moderate to low UV absorbance of acetates, nylons, modacrylics and acrylics with PVP
- No UV absorbance of cotton, ramie, viscose, olefin and acrylic with no PVP/MVP
RESULTS
Interferences from fibre polymers

Protein fibres
RESULTS
Interferences from fibre polymers

Polyester fibres

![Absorbance graph showing wavelength (nm) vs. absorbance for PET and PCDT fibres.](image)
RESULTS

Interferences from fibre polymers

Polyamide fibres
RESULTS

Interferences from fibre polymers

Cellulosic fibres
RESULTS
Interferences from fibre polymers

Acrylic fibres
RESULTS

Interferences from fibre polymers

Modacrylic fibres
RESULTS

Interferences from fibre polymers

Modacrylic fibres

![Graph showing absorbance vs. wavelength for different modacrylic fibres](image)
RESULTS

Interferences from fibre polymers

Olefin fibres

[Graph showing absorbance against wavelength for different types of polyethylene and polypropylene fibres: Spectra Polyethylene, Boltalen Polyethylene, Bexyarn Polyethylene, Pylen Polypropylene, and Herculon Polypropylene.]
METHODOLOGY

VIS analysis vs UV-VIS analysis

- Absorbance was measured between 240-770nm with coloured fibres mounted on quartz and on glass, and
- Absorbance was measured between 380-770nm with coloured fibres mounted on glass
METHODOLOGY
VIS analysis vs UV-VIS analysis

- Wool: red
- Viscose: yellow, orange, red, pink, purple, green, blue, brown, and black
- Di-acetate: yellow, tangerine, red, pink, violet, green, blue, brown, and black
- Nylon 66: yellow, red burgundy, aqua, blue, brown, and black
- Acrylic PAN/MMA: yellow, orange, rust, fuschia, purple, green, blue, brown, and charcoal
RESULTS

VIS analysis vs UV-VIS analysis

– Peak shapes were the same in the visible range
– No trend in sensitivity
RESULTS

Fibre polymers with high UV absorbance

Red wool fibre
RESULTS
Fibre polymers with low UV absorbance

Violet and white di-acetate fibres
RESULTS
Fibre polymers with no UV absorbance

Orange viscose fibre
RESULTS

Fibre polymers with no UV absorbance

- Rust acrylic fibre

[Graph showing absorption spectra for different materials, including Rust acrylic, UV-VIS Quartz, Rust acrylic, VIS Glass, and Rust acrylic, UV-VIS Glass.]
CONCLUSIONS

The microspectrophotometry of all coloured fibres can initially be done with XAM-mounted glass slides from 300-770nm with the UV-VIS system.

– Additional peaks can be obtained for all fibres by extending the range to include 300-380nm.
CONCLUSIONS

The need for re-mounting onto quartz slides for full UV-VIS analysis at 240-770nm depends on the fibre type and spectral results.

– For fibres which have a increasing slope below 300nm need to be re-mounted.
– For fibres which have no increasing slope below 300nm should be re-mounted.
– For fibres which have polymers with high UV absorbance no re-mounting would be necessary.
CONCLUSIONS

Silk, Wool, Acrylic with MVP, and Polyester

Analyse Fibres 300-770nm

Done

No

Yes

Nylons, Acetates, Modacrylic, Cotton, Ramie, Viscose, All other Acrylics, and Olefins

Analyse Fibres 300-770nm

Absorbance at 300nm > non-dyed reference polymer spectra?

Re-analyse Fibres on Quartz Slides

Fibres Mounted on Glass Slides