# FORAM®x3

## Raman Spectral Comparator

## User Manual

## (Hardware)


foster+freeman

(0083-H-03)
February 2015

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### Sales Support and Feedback

Foster + Freeman welcome feedback from Customers regarding this product. Please contact one of our offices if you would like to pass on your comments.

Foster + Freeman are pleased to offer advice, installation, training and on-site maintenance worldwide for all of their products.

### Specification

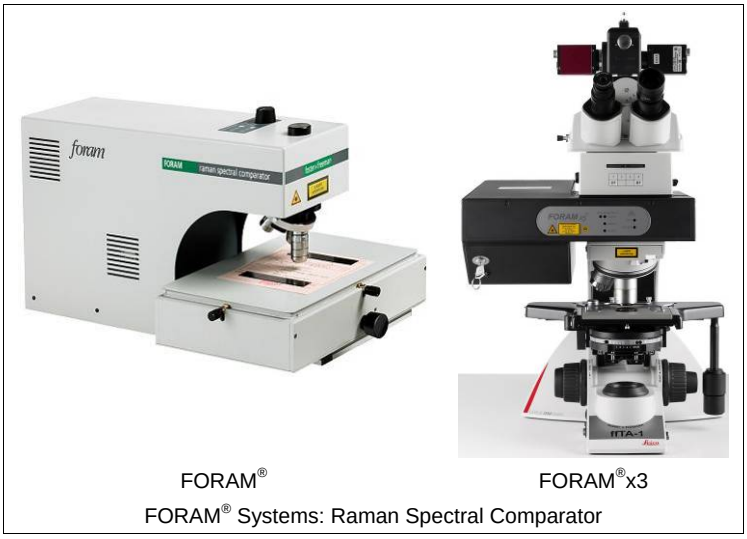
Foster + Freeman reserve the right to alter the specification of this product, accessories and consumables without prior notice.

### Copyright



# CONTENTS

# WELCOME




FORAM® FORAM®x3

FORAM® Systems: Raman Spectral Comparator

Welcome to the Foster + Freeman range of FORAM® Raman Spectral Comparators.

This equipment allows you to examine trace deposits by analysing and comparing Raman spectra.

## About this manual

### Text

Text formats are used as follows:

Important operating information

Additional notes and advice

☑ Good practice. Information on recommended procedures.

☒ Bad practice. Information on procedures to avoid.

☞ Control features

### Illustrations

Illustrations are for explanatory purposes only. The appearance of the product, its components, accessories and consumables may differ from that shown.

### Safety and Warning Markers

| | |
|---|---|
| **PROHIBITED** | Red markers prohibit certain actions or procedures. Disregard of these warnings may pose a health or safety risk to the user or cause damage to the equipment. |
| **CAUTION** | Yellow markers warn of a hazard. The user should be aware of the associated risk and take appropriate precautions. |
| **MANDATORY** | Blue markers advise of mandatory health and safety procedures. Disregard of the advice may increase an associated risk. |

Before using the equipment for the first time, please read the safety information on the following pages.

## About this product

### Compliance

When correctly employed by appropriately trained personnel, this equipment is fully compliant with the relevant standards laid down by the UK Health & Safety Executive (HSE).

### Hazard protection

When correctly employed, this equipment provides the user with the necessary level of protection from operating hazards.

⚠ Protection provided by the equipment may be impaired if the equipment is used in a manner not specified in the operating instructions.

### Certificate of conformity

A certificate of conformity for this product is available from Foster + Freeman Ltd

This equipment is manufactured in conformity with the requirements of the relevant directives of the European Community through compliance with a number of harmonised standards.

## Calibration and adjustment

In the event of query, contact Foster + Freeman Technical Support: technical@fosterfreeman.com

This equipment is correctly calibrated and adjusted at the time of manufacture.

Provided that the equipment is used in accordance with its operating instructions and is not maltreated, no further calibration or adjustment is required.

### Calibration standard (Wavelength calibration)

The equipment is calibrated using the Raman spectrum of polystyrene. The FORAM® Systems software includes a facility to verify the calibration of the equipment.

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# SAFETY INFORMATION

(0083-004-02) February 2015

# FORAM®x3: RAMAN SPECTRAL COMPARATOR

## General safety

In the event of query, contact Foster + Freeman Technical Support: technical@fosterfreeman.com


Read this manual


Employ safe work practices


Do not tamper with interlocks

⚠ Use the equipment only for the intended purpose.
⚠ Use the equipment only in accordance with the operating instructions.
⚠ Use only with equipment specified by Foster + Freeman.
⚠ Use only with spares, accessories and consumables supplied by Foster + Freeman.
⚠ Do not use damaged equipment.
⚠ Dispose of the equipment only in a responsible manner.
⚠ Do not remove any access covers.

Removal of any access cover will invalidate the warranty on this product and may be hazardous.

⚠ Do not operate the equipment with any access cover removed.
⚠ Do not attempt to defeat the safety interlocks.
⚠ Do not attempt to remove the FORAM®x3 main unit from the microscope.

### Location


Indoor use only

⚠ Do not operate the equipment outdoors.

### Disposal




Do not discard with normal commercial or domestic waste


Comply with all relevant legislation

This equipment falls within the scope of the European Directive 2002/96/EC on Waste Electrical & Electronic Equipment (WEEE).

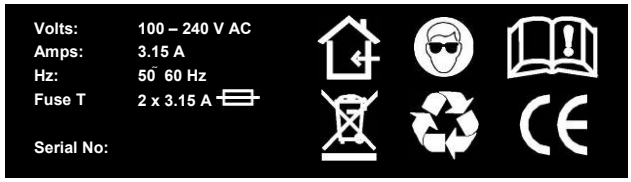
⚠ Dispose of the equipment only where appropriate disposal or recycling facilities exist.

## Electrical safety


Indoor use only


Equipment must be earthed

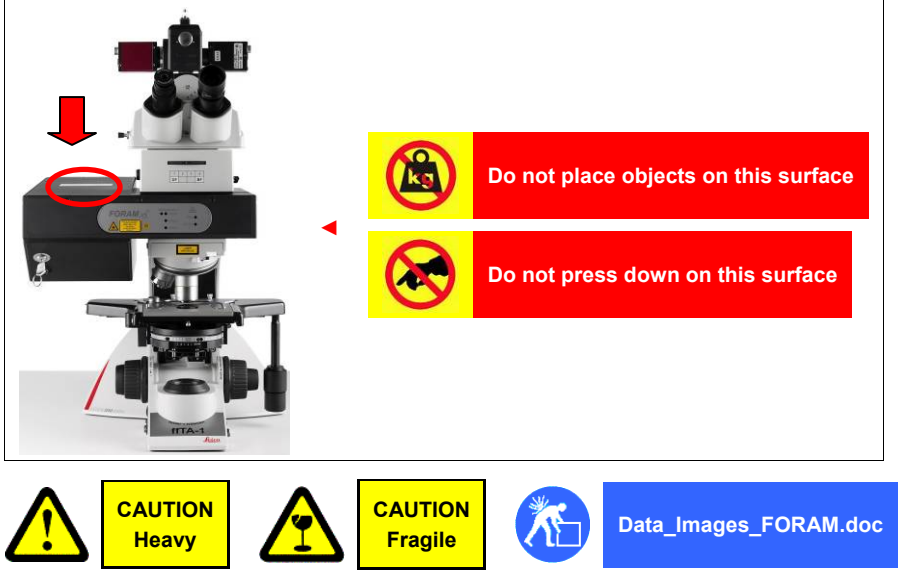
FORAM®x3: Labelling (Rear view)




⚠ Operate the equipment only from a compatible electrical power source specified by Foster + Freeman.
⚠ Do not operate the equipment with an incompatible mains electricity supply.
⚠ Do not operate the equipment without a reliable earth connection.
⚠ Do not operate the equipment with damaged electrical connection cables.
⚠ Do not replace electrical spares without first disconnecting the equipment from its power supply.
⚠ Do not replace electrical spares except with those of the correct and specified rating.

## Mechanical safety

FORAM®x3: Labelling (Top view)







⚠ Use safe lifting and handling procedures.

## Optical safety

### Laser safety

#### Product class (IEC/EN 60825-1:2007)

The FORAM®x3 main unit is classified as a Class 3B laser product. See: Laser safety labels (Product class) (p. x).

The FORAM®x3 main unit complies with all safety requirements for this class of laser product.

The accessible part of the laser beam path (i.e. the gap between the microscope objective and the sample) is short and is directed vertically downwards.

| FORAM®x3: Raman Spectral Comparator | | | |
|---|---|---|---|
| Wavelength (nm) | Colour | Accessible laser beam power | Product class |
| 785 | IR | < 80 mW | Class 3B |
| 638 | Red | < 4.5 mW | Class 3R |
| 532 | Green | < 4.5 mW | |

Removal of the key switch prevents the operation of the 785 nm laser and allows the FORAM®x3 to be used as if it were a Class 3R laser product. See: Key switch (p. ix).

#### Compliance

- Complies with IEC/EN 60825-1:2007 (Safety of Laser Products Part 1: Equipment classification and requirements).
- Complies with FDA performances standards for laser products except for deviations pursuant to Laser Notice No. 50.

### Safety requirements (IEC/EN 60825:2007)

| FORAM®x3: Raman Spectral Comparator | | | |
|---|---|---|---|
| Safety requirements | 785 nm | 638 nm | 532 nm |
| Laser protective eyewear | Strongly recommended | Not required | |
| Access restrictions | • Key switch<br>• Safety interlock connection | | |
| Laser safety warning signs | Recommended | | |
| Laser Safety Officer | The installation and use of this equipment should be approved by the authorised Laser Safety Officer | | |

**CAUTION**
**USE OF CONTROLS OR ADJUSTMENTS, OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE**

⚠ Do not attempt to defeat the safety interlocks.

⚠ Do not remove any access cover.

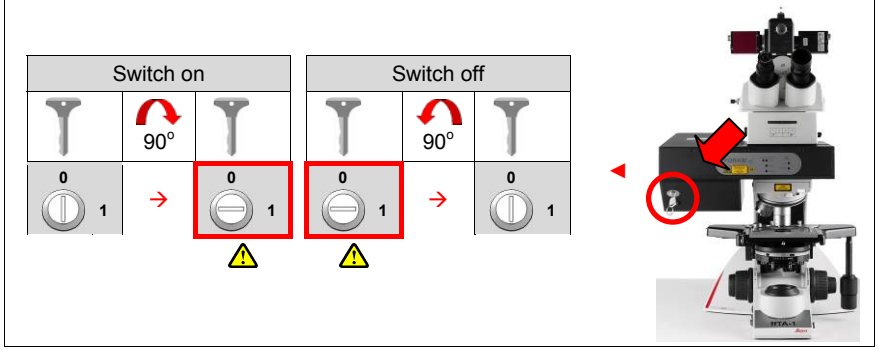
Removal of any access cover will invalidate the warranty on this product and may be hazardous.

### Key switch (785 nm)

⚠ Remove the key from the key switch when the equipment is not in use.

Removal of the key switch prevents the operation of the 785 nm laser and allows the FORAM®x3 to be used as if it were a Class 3R laser product. See: Product class (p. viii).

FORAM®x3: Main unit (Key switch)




## Laser specification

| FORAM®x3: Embedded laser device | | | |
|---|---|---|---|
| Wavelength (nm) | Colour | Optical power (CW) | Beam divergence |
| 785 | IR | < 80 mW | > 8° |
| 638 | Red | < 9 mW | > 6° |
| 532 | Green | < 8 mW | 7.5 mrad |

The FORAM®x3 main unit contains an embedded laser device of Class 3B.

The laser beam is enclosed by protective covers which are securely fastened. The protective covers do not need to be removed for the normal operation of the instrument.

⚠ Do not remove any access cover.

Removal of any access cover will invalidate the warranty on this product and may be hazardous.

⚠ Exposure to radiation from the embedded laser can be hazardous to eyes.

## Eye safety (638 nm/532 nm)

**CAUTION**
**Risk of dazzle**

Although laser protective eyewear is not required during normal use of the equipment, laser light reflected from a very smooth and shiny sample can cause temporary dazzle.

⚠ Do not resist the natural aversion response (the blink reflex) in the event of inadvertent exposure to reflected laser light.

⚠ Do not exchange microscope objectives without first engaging the beam shutter.

## Eye safety (785 nm)

**Wear filtered eye protection**

**CAUTION**
**Invisible IR Radiation**

**CAUTION**
**Risk of eye damage**

**CAUTION**
**Invisible IR Radiation**

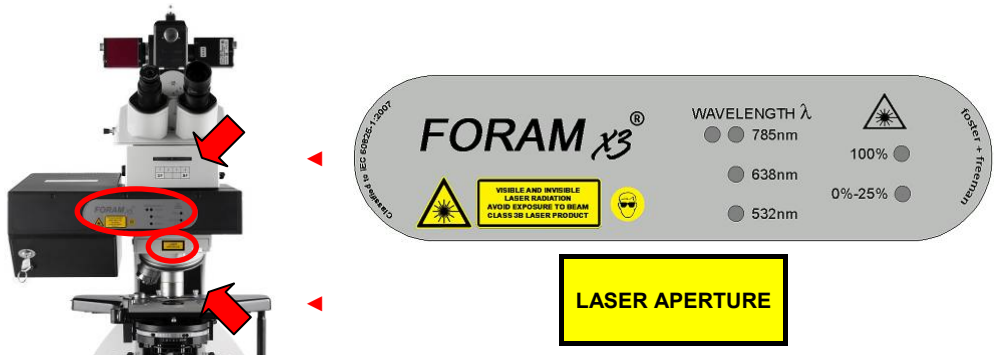
**CAUTION**
**Avoid direct eye exposure**

⚠ Direct exposure to the laser beam is hazardous to the eye and should be avoided.

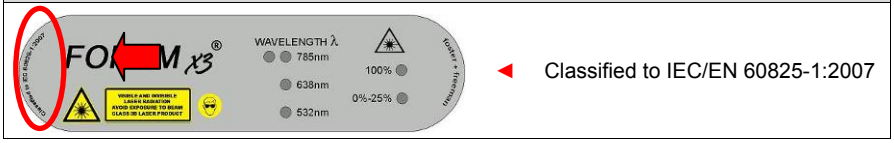
## Laser safety labels

### External labels (Front view)

FORAM®x3: Labelling (Front view)

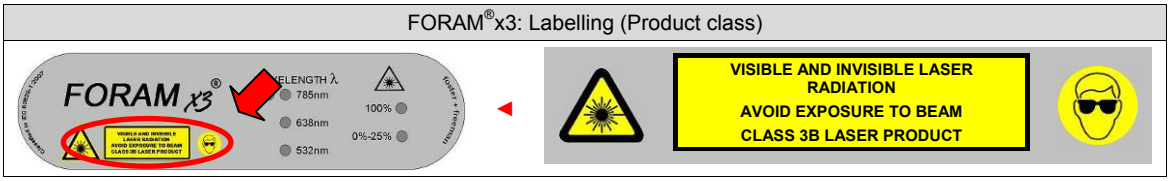



FORAM®x3: Labelling (Front view)



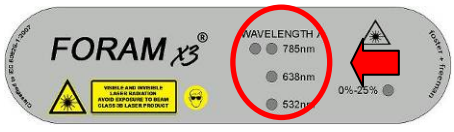

### Product class

FORAM®x3: Labelling (Product class)




### Laser emission indicators

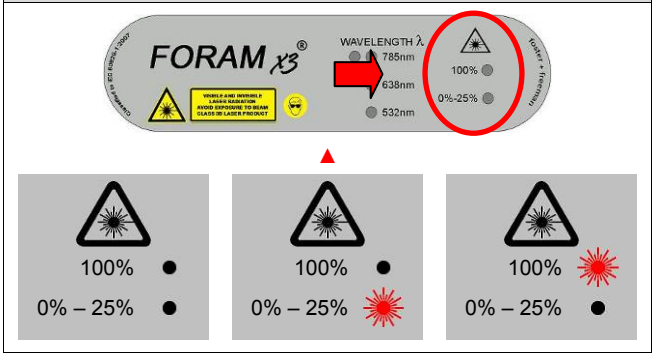
FORAM®x3: Labelling (Laser emission indicators)




| WAVELENGTH | WAVELENGTH | WAVELENGTH | WAVELENGTH |
|---|---|---|---|
| ● ● 785 nm | ✸ ✸ 785 nm | ● ● 785 nm | ● ● 785 nm |
| ● 638 nm | ● 638 nm | ✸ 638 nm | ● 638 nm |
| ● 532 nm | ● 532 nm | ● 532 nm | ✸ 532 nm |

### Laser power indicators

FORAM®x3: Labelling (Laser power indicators)




### External labels (Rear view)

FORAM®x3: External labels: Rear view

**LASER RADIATION OUTPUT AND STANDARDS**
**Max Accessible Output 80 mW CW at wavelength 785 ± 2 nm**
**Max Accessible Output 4.5 mW CW at wavelength 638 ± 2 nm**
**Max Accessible Output 4.5 mW CW at wavelength 532 ± 1 nm**

**Complies with FDA performances standards for laser products except for deviations pursuant to Laser Notice No. 50**

### Internal labels

⚠ Labels are visible only during servicing.

⚠ Do not remove any access covers.

Removal of any access cover will invalidate the warranty on this product and may be hazardous.

⚠ Do not attempt to defeat the safety interlocks.

FORAM®x3: Internal labels: Top view


**CAUTION – CLASS 3B VISIBLE AND INVISIBLE LASER RADIATION WHEN THIS COVER IS REMOVED**
**AVOID EXPOSURE TO THE BEAM**

FORAM®x3: Internal labels: Bottom view

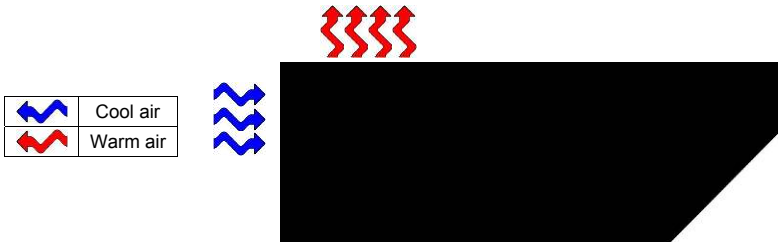

**AVOID EXPOSURE – LASER RADIATION IS EMITTED FROM THIS APERTURE**
**CLASS 3B LASER PRODUCT**

# Thermal safety


The equipment generates heat that is removed by fan-assisted ventilation.

⚠ Do not obstruct the ventilation ports or the air flow around them.

FORAM®x3: Main unit (Air flow)

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# QUICK START GUIDE

(0083-02-02) February 2015

# FORAM®x3: GETTING STARTED

Refer to the relevant User Manual for full details. ⚠ Use safe lifting and handling procedures.

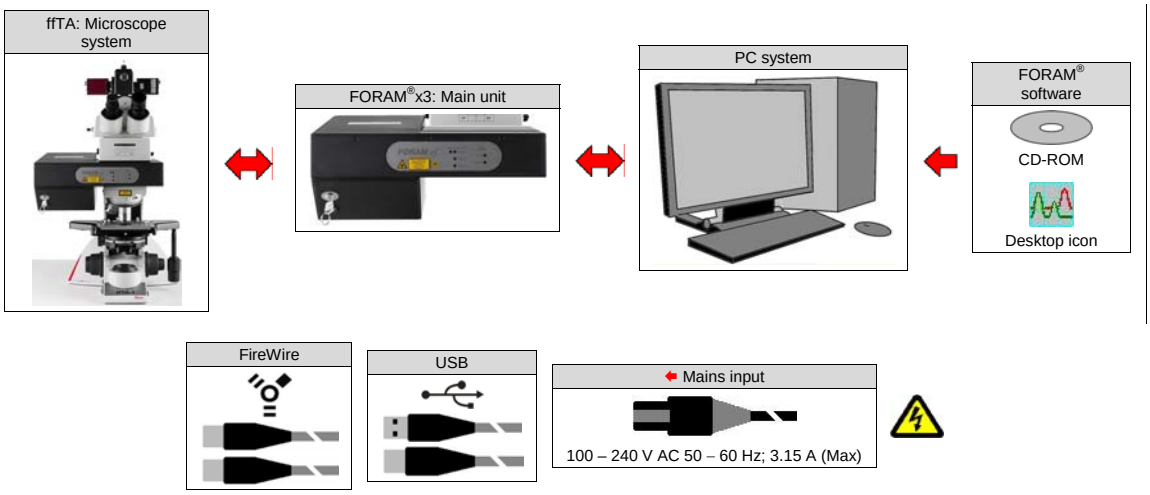
Carefully unpack all items. Check the items supplied against your original purchase order and packing list. Report any discrepancy to your nearest Foster + Freeman Sales Office immediately. Account for all items before discarding any packing material.

## Installation

The equipment should be located in a clean, well-ventilated, dust free environment, away from sources of heat, air currents and risk of contamination. For best results, locate the equipment away from areas of high ambient lighting, direct sunshine or unscreened windows. The equipment should be used on a flat, level working surface of adequate strength and of convenient height for the operator, within reach of a mains power outlet with an earth connection.

⚠ Do not obstruct the ventilation ports or the air flow around them.

Specification and appearance may vary according to user requirements.




### PC system

Specification and appearance may vary according to user requirements. For full details, refer to the relevant Operating Manual supplied by the Manufacturer.

A suitable PC System is supplied for use with the FORAM®x3 main unit.

### FORAM® software

FORAM® software is a custom product supplied by Foster + Freeman on one or more CD-ROM. Software will normally have been installed on the PC.

## Connecting the hardware

1. Interconnect the hardware with the cables provided. See: Connection diagram (p. 02-2).

⚠ Connect the *FireWire* before connecting the mains power.

2. Connect the mains power.

⚠ Do not connect any unit to an incompatible mains electricity supply.

### Switching on

3. Switch on the PC system and wait until the Windows desktop is displayed.

#### Safety interlock (785 nm)

**Wear filtered eye protection**

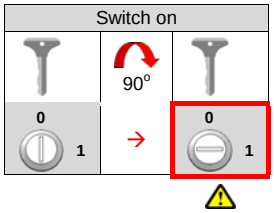
**CAUTION**
**Invisible IR Radiation**

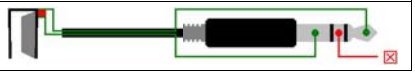
**CAUTION**
**Risk of eye damage**

The operation of the 785 nm laser is prevented unless the safety interlock circuit has been completed by the user:

- Key switch: Switch on;
- Safety interlock connection: Local connection; Remote connection,

Removal of the key switch prevents the operation of the 785 nm laser and allows the FORAM®x3 main unit to be used as if it were a Class 3R laser product.




| FORAM®x3: Safety interlock connection | |
|---|---|
| Local connection (Override plug) |  |
| Remote connection (e.g. Door sensor) |  |

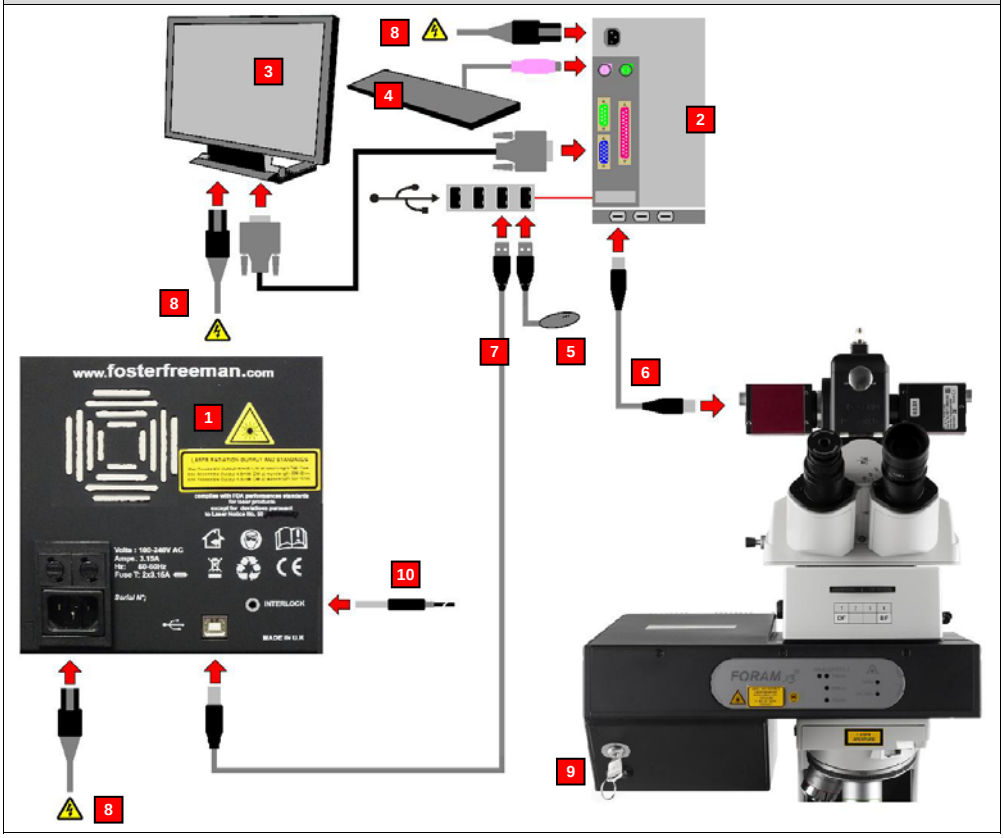
4. Switch on the FORAM®x3 main unit.

Before attempting to use the equipment, allow sufficient time for the FORAM®x3 main unit to stabilise: 5 minutes (Min)

5. (Windows desktop): Start the FORAM® software.
6. The equipment is now ready for use. Refer to the relevant User Manual for full details.

## Connection diagram

FORAM®x3: Connection diagram




| | | | |
|---|---|---|---|
| 1 | FORAM®x3: Main unit | 6 | Video connection (*FireWire*) |
| 2 | PC | 7 | Control connection (USB 2.0) |
| 3 | Monitor | 8 | Mains power |
| 4 | Keyboard | 9 | Key switch (785 nm) |
| 5 | Mouse | 10 | Safety interlock connection (785 nm) |

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(0083-02-02)

# FORAM®x3: MAIN UNIT

FORAM®x3: Main unit (Front view)

The FORAM®x3 main unit is a modular form of Raman spectrometer which is factory-attached to a suitable microscope system, e.g. Leica DM2500M.

Raman spectroscopy provides the forensic scientist with a useful tool for the examination and comparison of a variety of trace evidence: Inks; Pigments; Paint chips; Polymers; Fibres; Explosives; Drugs. In practice, the sample of evidence is placed on the microscope stage under the chosen objective lens and a region of interest selected. By irradiating the sample with a high intensity laser beam, Raman emission is stimulated which is then analysed in a spectrometer and presented to the user as a spectrum. The peaks within the Raman spectrum are characteristic of the molecular composition of the sample. See: Technical Notes (Raman spectroscopy).

The FORAM®x3 main unit contains three different laser diode sources and a diffraction grating spectrometer. The required excitation wavelength is selected by activating the corresponding laser diode:

FORAM®x3: Raman Spectral Comparator

| Wavelength (nm) | Colour | Accessible laser beam power | Product class |
|---|---|---|---|
| 785 | IR | < 80 mW | Class 3B |
| 638 | Red | < 4.5 mW | Class 3R |
| 532 | Green | < 4.5 mW | |

The accessible part of the laser beam path (i.e. the gap between the microscope objective and the sample) is short and is directed vertically downwards.

The FORAM®x3 main unit is controlled by the PC system and FORAM® software. Refer to the relevant User Manual for full details.

## Environmental specification

FORAM®x3: Environmental specification (BS EN 61010-1:2010)

| | |
|---|---|
| Location | Indoor use only |
| Altitude | 2000 m (Max) |
| Ambient temperature | 5 – 40°C |
| Ambient humidity, RH% (5 – 31°C) | 80%* (Max) |

* Decreases linearly to 50% within the temperature range 31 – 40°C

## Electrical specification

The FORAM®x3 can be operated from a compatible electrical power source specified by Foster + Freeman. See: Quick Start Guide (Getting started). See also: Safety information (p. vii).

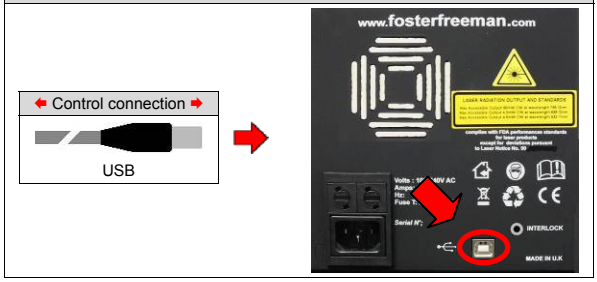
FORAM®x3: Electrical specification (Main unit)


# Control features

The FORAM®x3 main unit is controlled by the PC system and FORAM® software.

## Control connections

FORAM®x3: Main unit (Control connections)



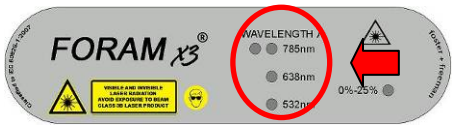

See also: Quick Start Guide (Getting started).

# Indicator lights

## Laser emission indicators

⚠ Infrared radiation is invisible.

FORAM®x3: Labelling (Laser emission indicators)




| WAVELENGTH | WAVELENGTH | WAVELENGTH | WAVELENGTH |
|---|---|---|---|
| ● ● 785 nm | ✸ ✸ 785 nm | ● ● 785 nm | ● ● 785 nm |
| ● 638 nm | ● 638 nm | ✸ 638 nm | ● 638 nm |
| ● 532 nm | ● 532 nm | ● 532 nm | ✸ 532 nm |

## Fault condition

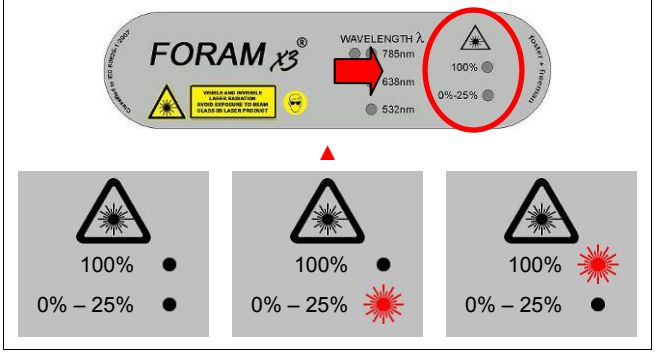
Contact Foster + Freeman Service Department: technical@fosterfreeman.com

FORAM®x3: Fault condition

| WAVELENGTH | | WAVELENGTH |
|---|---|---|
| ✸ ● 785 nm | ⚠ | ● ✸ 785 nm |
| ● 638 nm | | ● 638 nm |
| ● 532 nm | | ● 532 nm |

### Laser power indicators

FORAM®x3: Labelling (Laser power indicators)




## Safety interlock (785 nm)

**Wear filtered eye protection**

**CAUTION**
**Invisible IR Radiation**

**CAUTION**
**Risk of eye damage**

The operation of the 785 nm laser is prevented unless the safety interlock circuit has been completed by the user:

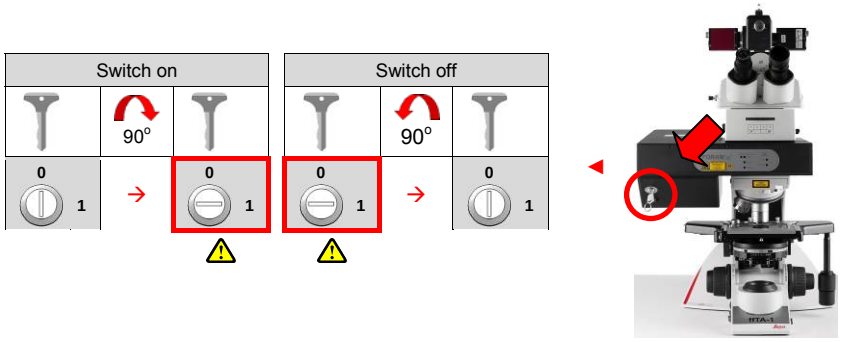
- Key switch: Switch on;
- Safety interlock connection: Local connection; Remote connection.

### Key switch

⚠ Remove the key from the key switch when the equipment is not in use.

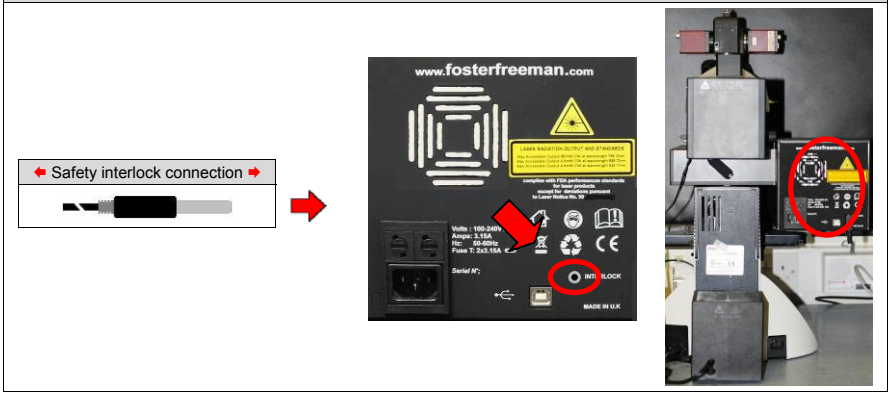
Removal of the key switch prevents the operation of the 785 nm laser and allows the FORAM®x3 main unit to be used as if it were a Class 3R laser product. See: Product class (p. viii).

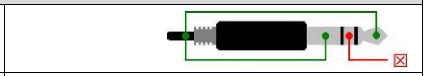
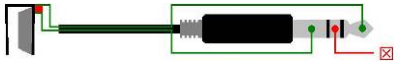
FORAM®x3: Main unit (Key switch)




### Safety interlock connection

FORAM®x3: Main unit (Safety features)



| FORAM®x3: Safety interlock connection | |
|---|---|
| Local connection (Override plug) |  |
| Remote connection (e.g. Door sensor) |  |

The safety interlock circuit can be completed in two alternative ways:

- Local connection: Insert the override plug.
- Remote connection: e.g. Door sensor (Item not supplied).

## Connecting the hardware

Refer to the relevant Quick Start Guide for full details.

## Service, care and maintenance

See also: Safety information (p. vii).

### Servicing

⚠ Refer all servicing to qualified Foster + Freeman personnel. ⚠ Unauthorised servicing may void the warranty on this product.

### Care

⚠ Protect the equipment from damage and contamination. ⚠ Handle with care. ⚠ Do not subject the equipment to excessive mechanical shock. ⚠ Do not drop.

### Maintenance

#### Cleaning

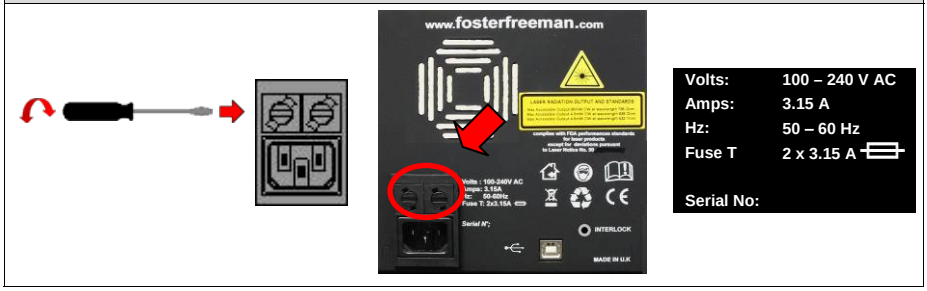
⚠ Do not use abrasive cleaning materials or those containing strong acids or alkalis. ⚠ Do not allow the ingress of liquids or other contaminants. ⚠ Do not immerse.

Remove dust and deposits from external surfaces using a soft dry cloth or paper tissue. When necessary, use a soft cloth or paper tissue dampened with a mild cleaning solution. Allow all surfaces to dry thoroughly before resuming use. Water-based solutions should contain only a little liquid soap, detergent or mild bleach. Alcohol-based cleaning agents may eventually degrade the surface of some types of plastic and should be used sparingly on such materials.

## Replacing the fuses

⚠ Switch off and disconnect the equipment from the mains electricity supply before replacing fuses. ⚠ For continued protection against fire, use replacement fuses of only the correct size and rating.

FORAM®x3: Main unit (Replacing the fuses)




The mains power fuses are located in the IEC input socket at the rear of the equipment. Release each fuse by using a suitable screwdriver to unscrew the top of the fuse holder.

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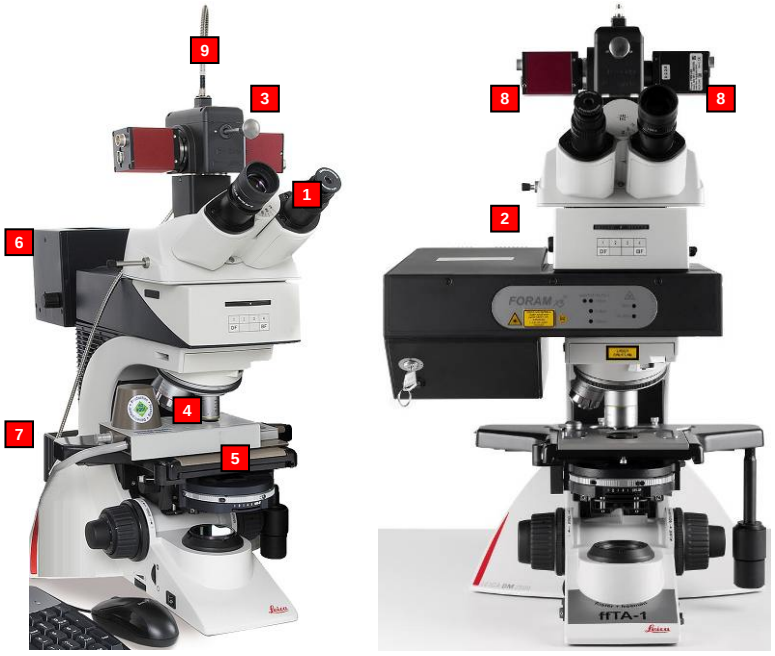
# ffTA: MICROSCOPE SYSTEM




ffTA-RI/IP/MS ffTA-FORAM®x3

ffTA: Microscope System

| | | | | | |
|---|---|---|---|---|---|
| 1 | Binocular eyepieces | 6 | Reflected light source |
| 2 | Beam splitter | 7 | Transmitted light source |
| 3 | Image multiplexer | 8 | Video camera |
| 4 | Objective lenses | 9 | Optical fibre (Microspectrometer) |
| 5 | Hotstage/Slide holder | | |

| | | ffTA/SYS/RI | ffTA/SYS/IP | ffTA/SYS/IPMS | ffTA/SYS/IPRI | ffTA/SYS/COM |
|---|---|---|---|---|---|---|
| Application | Glass Refractive Index Measurement System (GRIM) | ✓ | | | ✓ | ✓ |
| | Image processing (IP) | | ✓ | ✓ | ✓ | ✓ |
| | Microspectrometer (μSpec) | | | ✓ | | ✓ |
| Components | Binocular eyepieces | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Beam splitter | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Hotstage | ✓ | | | ✓ | ✓ |
| | Transmitted light source | ✓ | | | ✓ | ✓ |
| | Phase contrast objective lens (x 10) | ✓ | | | ✓ | ✓ |
| | Video camera (Monochrome) | ✓ | | | ✓ | ✓ |
| | Image multiplexer | | ✓ | ✓ | ✓ | ✓ |
| | Slide holder | | ✓ | ✓ | ✓ | ✓ |
| | Reflected light source | | ✓ | ✓ | ✓ | ✓ |
| | Objective lenses (Various) | | ✓ | ✓ | ✓ | ✓ |
| | Video camera (Colour) | | ✓ | ✓ | ✓ | ✓ |
| | Mode control | | | ✓ | | ✓ |

## Beam splitter

| | ffTA/SYS/RI | ffTA/SYS/IP | ffTA/SYS/IPMS | ffTA/SYS/IPRI | ffTA/SYS/COM |
|---|---|---|---|---|---|
| Beam splitter | ✓ | ✓ | ✓ | ✓ | ✓ |

The beam splitter divides the light that forms the image and directs it to different destinations. Different beam-splitting ratios can be specified:

| | Beam splitter: Splitting ratio | |
|---|---|---|
| | Binocular eyepieces | Video camera |
| | 100% | |
| | 50% | 50% |
| | | 100% |

Microscope System: Beam splitter

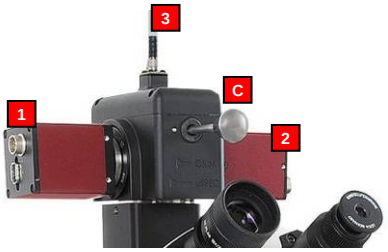
## Image multiplexer

| | ffTA/SYS/RI | ffTA/SYS/IP | ffTA/SYS/IPMS | ffTA/SYS/IPRI | ffTA/SYS/COM |
|---|---|---|---|---|---|
| Image multiplexer | | ✓ | ✓ | ✓ | ✓ |

The image multiplexer divides the light that forms the image and directs it to different destinations. Different beam-splitting ratios can be specified:

| | | Control | 1 | 2 | 3 |
|---|---|---|---|---|---|
| GRIM | | | | 100% | |
| µSPEC | | | 50% | | 50% |

Microscope System: Image multiplexer




| | |
|---|---|
| 1 | Video camera 1 (e.g. 5 Mpixel) |
| 2 | Video camera 2 (e.g. Stingray AVT) |
| 3 | Fibre coupling (e.g. Microspectrometer) |
| C | Control |

## Objective lenses

| | ffTA/SYS/RI | ffTA/SYS/IP | ffTA/SYS/IPMS | ffTA/SYS/IPRI | ffTA/SYS/COM |
|---|---|---|---|---|---|
| Phase contrast objective lens (x 10) | ✓ | | | ✓ | ✓ |
| Objective lenses (Various) | | ✓ | ✓ | ✓ | ✓ |

A number of objective lenses are supplied:

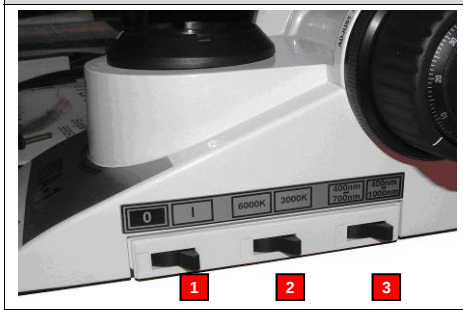
| Magnification | Microscope System: Objective lenses | | |
|---|---|---|---|
| | Illumination mode | | Comments |
| | Brightfield | Darkfield | |
| x5 | ✓ | ✓ | |
| x10 | ✓ | | |
| x20 | ✓ | ✓ | |
| x40 | ✓ | | Corrected for glass coverslip |
| x40 | ✓ | ✓ | Corrected for no glass coverslip |

## Transmitted light source

| | ffTA/SYS/RI | ffTA/SYS/IP | ffTA/SYS/IPMS | ffTA/SYS/IPRI | ffTA/SYS/COM |
|---|---|---|---|---|---|
| Transmitted light source | ✓ | | | ✓ | ✓ |

### Filter control

Microscope System: Transmitted light source (Filter control)




| | |
|---|---|
| 1 | Light shutter |
| 2 | Colour temperature (Daylight filter) |
| 3 | Wavelength range (IR blocking filter) |

#### Light shutter

Shutter closed ◄ **0** | 1 ► Shutter open

☜ ▮ ☞: Open or close the light shutter in preference to switching the light source on and off.

Light sources generally require a period of time to stabilise when first switched on.

#### Colour temperature

With daylight filter ◄ **6000 K** | **3000 K** ► Without daylight filter

| Colour temperature: Recommended setting | | |
|---|---|---|
| Forensic application | 6000 K | 3000 K |
| Visual inspection | ✓ | |
| Video camera (Colour) | ✓ | |
| Video camera (Monochrome) | | ✓ |

☜ ▮ ☞: Make the required selection.

#### Wavelength range

With IR blocking filter ◄ **400 nm 700 nm** | **400 nm 1000 nm** ► Without IR blocking filter

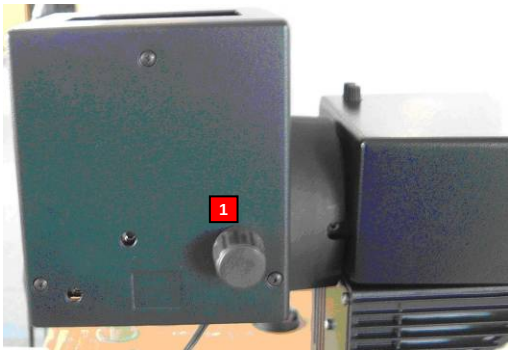
| Wavelength range: Recommended setting | | |
|---|---|---|
| Forensic application | 400 nm 700 nm | 400 nm 1000 nm |
| Heat sensitive subjects | ✓ | |
| Spectroscopy | | ✓ |
| GRIM | ✓ | |

☜ ▮ ☞: Make the required selection.

# Reflected light source

| | ffTA/SYS/RI | ffTA/SYS/IP | ffTA/SYS/IPMS | ffTA/SYS/IPRI | ffTA/SYS/COM |
|---|---|---|---|---|---|
| Reflected light source | | ✓ | ✓ | ✓ | ✓ |

Microscope System: Reflected light source




1 Collimation control

The reflected light source is of a higher specification unit than the transmitted light source.

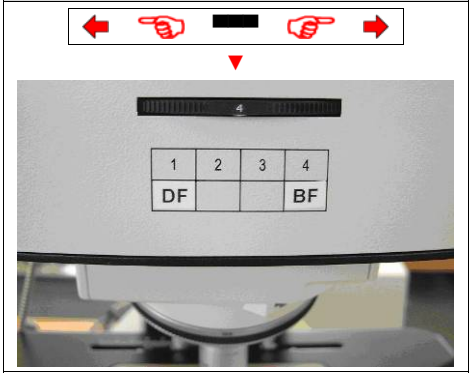
## Collimation control

Specifies the collimation of the lighting, thereby determining the uniformity of the illumination across the field of view.

: Make the required adjustment.

## Mode control

Reflected light source: Mode control




| Illumination mode | Incident light | Angle of incidence | Collected light |
|---|---|---|---|
| Brightfield (BF) | Light is incident via the centre of objective lens | Normal incidence (~ 0°) | Directly reflected light + Scattered light |
| Darkfield (DF) | Light is incident via channels in sides of objective lens | Oblique incidence | Scattered light |

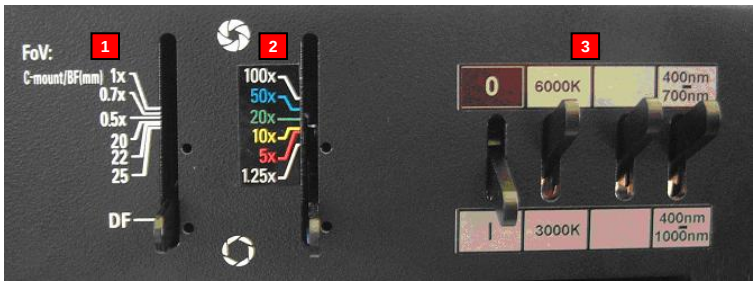
| Mode control: Recommended setting | | | | |
|---|---|---|---|---|
| Illumination mode | 1 | 2 | 3 | 4 |
| | DF | | | BF |
| Reflected light source: Darkfield | ✓ | | | |
| Transmitted light source: GRIM | | ✓ | | |
| | | | ✓ | |
| Reflected light source: Brightfield | | | | ✓ |

Darkfield illumination is less intense than brightfield illumination but can produce significant enhancement in contrast and colour rendition, particularly for semi-reflective objects.

: Make the required selection.

## Lighting control

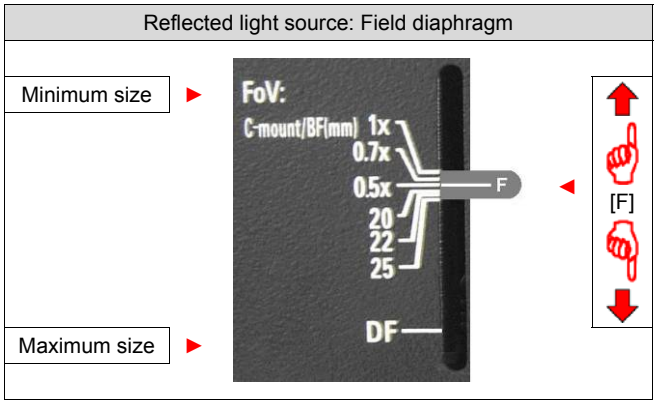
Reflected light source (Lighting control)




| | |
|---|---|
| 1 | Field diaphragm [F] |
| 2 | Aperture diaphragm [A] |
| 3 | Filter control |

### Field diaphragm [F]

Reflected light source: Field diaphragm




☜ [F] ☞: Specifies the field of illumination.

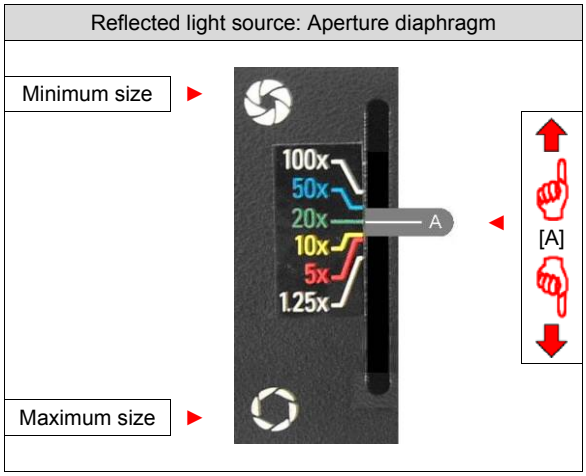
| Field of illumination (F): Recommended setting | | | | | | | |
|---|---|---|---|---|---|---|---|
| Illumination mode | C-Mount | | | Brightfield: BF | | | Darkfield |
| | 1x | 0.7x | 0.5x | 20 mm | 22 mm | 25 mm | DF |
| Brightfield | | | | ✓* | | | |
| Darkfield | | | | | | | ✓** |

* Adjust so as to illuminate just the field of view required

** Fully open: Maximum size.

### Aperture diaphragm [A]

Reflected light source: Aperture diaphragm



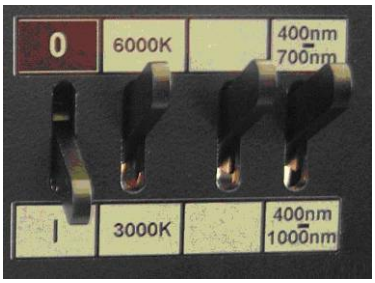

Specifies the aperture size. The recommended settings are colour coded to match the different microscope objective lenses. The recommended settings achieve the best compromise between resolution, depth of focus and contrast.

Reducing the aperture setting will increase depth of focus and contrast but reduce resolution.

☜ [A] ☞: Make the required adjustment to achieve the optimum image.

## Filter control

Reflected light source: Filter control




| | |
|---|---|
| 1 | Light shutter |
| 2 | Colour temperature (Daylight filter) |
| 3 | Wavelength range (IR blocking filter) |

### Light shutter

Shutter closed ◄ **0** | 1 ► Shutter open

☜▮☞: Open or close the light shutter in preference to switching the light source on and off.

Light sources generally require a period of time to stabilise when first switched on.

### Colour temperature

With daylight filter ◄ **6000 K** | 3000 K ► Without daylight filter

| Colour temperature: Recommended setting | | |
|---|---|---|
| Forensic application | 6000 K | 3000 K |
| Visual inspection | ✓ | |
| Video camera (Colour) | ✓ | |
| Video camera (Monochrome) | | ✓ |

☜▮☞: Make the required selection.

### Wavelength range

With IR blocking filter ◄ **400 nm 700 nm** | 400 nm 1000 nm ► Without IR blocking filter

| Wavelength range: Recommended setting | | |
|---|---|---|
| Forensic application | 400 nm 700 nm | 400 nm 1000 nm |
| Heat sensitive subjects | ✓ | |
| Spectroscopy | | ✓ |

☜▮☞: Make the required selection.

# Safety information

⚠ Use the equipment only for the intended purpose. ⚠ Use the equipment only in accordance with the operating instructions. ⚠ Use only with equipment specified by Foster + Freeman. ⚠ Use only with spares, accessories and consumables supplied by Foster + Freeman. ⚠ Do not use damaged equipment. ⚠ Dispose of the equipment only in a responsible manner.

# Disposal

**Do not discard with normal commercial or domestic waste**

**Comply with all relevant legislation**

⚠ This equipment falls within the scope of the European Directive 2002/96/EC on Waste Electrical & Electronic Equipment (WEEE). ⚠ Dispose of the equipment only where appropriate disposal or recycling facilities exist.

## Electrical safety

⚠ Switch off when not required for use. ⚠ Do not operate the equipment with damaged electrical connection cables. ⚠ Use only with equipment specified by Foster + Freeman.

# Service, Care and Maintenance

⚠ The equipment contains no user serviceable parts. ⚠ Refer all servicing to qualified Foster + Freeman personnel. ⚠ Unauthorised servicing may void the warranty on this product. ⚠ The equipment contains no user-adjustable controls. ⚠ Do not dismantle or tamper with the equipment.

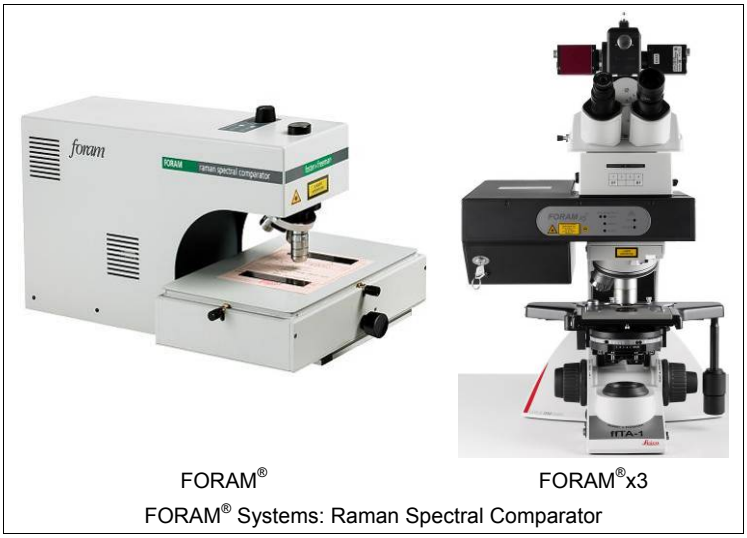
Protect the equipment from damage and contamination. When not required for use, store the equipment in its case or protective wrapping. Handle with care. Do not subject to excessive mechanical shock. Do not drop.

## Cleaning

⚠ Do not use abrasive cleaning materials or those containing strong acids or alkalis. ⚠ Do not allow the ingress of liquids or other contaminants. ⚠ Do not immerse.

Remove dust and deposits from external surfaces using a soft dry cloth or paper tissue. When necessary, use a soft cloth or paper tissue dampened with a mild cleaning solution. Allow all surfaces to dry thoroughly before resuming use. Water-based solutions should contain only a little liquid soap, detergent or mild bleach. Alcohol-based cleaning agents may eventually degrade the surface of some types of plastic and should be used sparingly on such materials.

# FORAM® SYSTEMS: RAMAN SPECTROSCOPY




FORAM® FORAM®x3

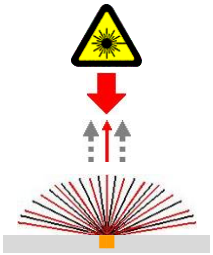
FORAM® Systems: Raman Spectral Comparator

Raman spectroscopy provides the forensic scientist with a useful tool for the examination and comparison of a variety of trace evidence: Inks; Pigments; Paint chips; Polymers; Fibres; Explosives; Drugs. The method is particularly suitable when only trace samples of material are available and where conventional chemical analysis is impractical. Direct comparison of Raman spectra can provide a rapid means of determining whether two samples of evidence can be distinguished from each other. Refer to the relevant Application Notes for further details.

Different versions of the FORAM® Systems are available, operating at a variety of laser excitation wavelengths. By irradiating the sample with a high intensity laser beam, Raman emission is stimulated which is then analysed in a spectrometer and presented to the user as a spectrum. The Raman spectrum will generally exhibit prominent peaks whose Raman shifts (i.e. the differences in wavelength from the laser excitation light) characterise the vibrational frequencies of the chemical bonds in the molecules present. The peaks within the Raman spectrum are characteristic of the molecular composition of the sample. The molecular composition of two different materials can therefore be compared by a direct comparison of their Raman shifts.

## Raman scattering

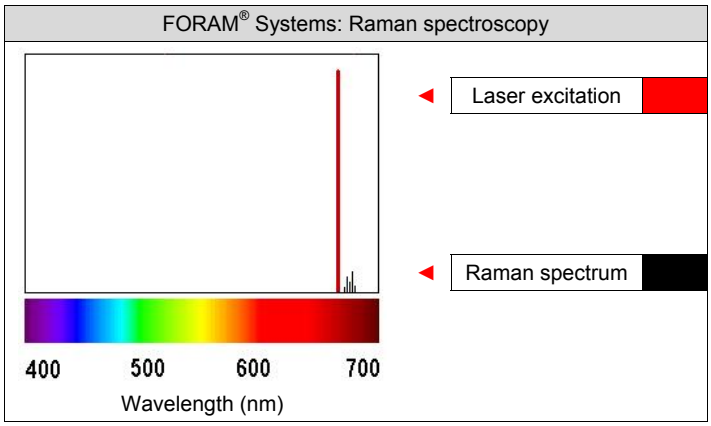
FORAM® Systems: Raman scattering



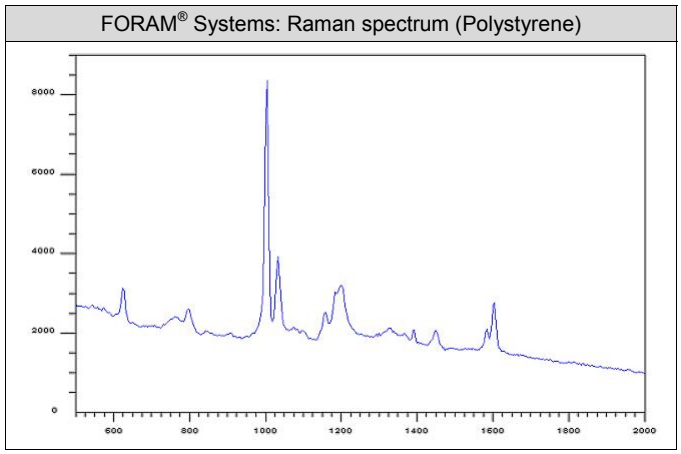
| | |
|---|---|
| | Incident laser excitation light |
| | Elastically scattered light (Wavelength is unchanged) |
| | Inelastically scattered light (Wavelength undergoes a Raman shift to a longer wavelength) |

Irradiating a surface will produce scattered light with a spectrum that is characteristic of the material in the surface.

Raman Spectroscopy relies on the process of Raman Scattering, an effect named after its discoverer, the Indian scientist C.V. Raman. The effect involves the inelastic scattering of light, in which a small proportion of the light scattered from the surface of a material is shifted to a slightly lower frequency (i.e. longer wavelength) by the atomic vibrations within the molecules.




## Raman shift




Raman spectrum of the light scattered from polystyrene showing peaks with characteristic Raman shifts

The Raman spectrum will generally exhibit prominent peaks whose Raman shifts (i.e. the differences in wavelength from the laser excitation light) characterise the vibrational frequencies of the chemical bonds in the molecules present. The molecular composition of two different materials can therefore be compared by a direct comparison of their Raman shifts.

### Wavelength/Wavenumber

Whilst spectral features are often characterised by their wavelength $\lambda$ (nm), Raman shifts are more commonly expressed in wavenumbers, n ($cm^{-1}$):

$$n = 1/\lambda$$

At the wavelength $\lambda$ = 685 nm, a Raman shift $\Delta n$ = 1000 $cm^{-1}$ corresponds to a wavelength shift $\Delta\lambda \approx 50$ nm. The FORAM® Systems can determine Raman shifts in the range $\Delta n$ = 400 – 2000 $cm^{-1}$.

foster + freeman

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