



DHR Modular Microscopy Accessory Getting Started Guide

Revision B Issued February 2016

Notice

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Introduction

Important: TA Instruments Manual Supplement

Please click the [TA Manual Supplement](#) link to access the following important information supplemental to this Getting Started Guide:

- TA Instruments Trademarks
- TA Instruments Patents
- Other Trademarks
- TA Instruments End-User License Agreement
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Notes, Cautions, and Warnings

This manual uses NOTES, CAUTIONS, and WARNINGS to emphasize important and critical instructions. In the body of the manual these may be found in the shaded box on the outside of the page.

NOTE: A NOTE highlights important information about equipment or procedures.

CAUTION: A CAUTION emphasizes a procedure that may damage equipment or cause loss of data if not followed correctly.

MISE EN GARDE: UNE MISE EN GARDE met l'accent sur une procédure susceptible d'endommager l'équipement ou de causer la perte des données si elle n'est pas correctement suivie.

A WARNING indicates a procedure that may be hazardous to the operator or to the environment if not followed correctly.

Un AVERTISSEMENT indique une procédure qui peut être dangereuse pour l'opérateur ou l'environnement si elle n'est pas correctement suivie.

Regulatory Compliance

Safety Standards

For Canada

CAN/CSA-C22.2 No. 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements.

CAN/CSA-C22.2 No. 61010-2-010 Particular requirements for laboratory equipment for the heating of materials.

For European Economic Area

(In accordance with Council Directive 2006/95/EC of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.)

EN 61010-1:2001 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements + Amendments.

EN 61010-2-010:2003 Particular requirements for laboratory equipment for the heating of materials + Amendments.

For United States

UL61010-1:2004 Electrical Equipment for Laboratory Use; Part 1: General Requirements.

Electromagnetic Compatibility Standards

For Australia and New Zealand

AS/NZS CISPR11:2004 Limits and methods of measurement of electronic disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment.

For Canada

ICES-001 Issue 4 June 2006 Interference-Causing Equipment Standard: Industrial, Scientific, and Medical Radio Frequency Generators.

For the European Economic Area

(In accordance with Council Directive 2004/108/EC of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility.)

EN61326-1:2006 Electrical equipment for measurement, control, and laboratory use-EMC requirements-Part 1: General Requirements. Emissions: Meets Class A requirements per CISPR 11. Immunity: Per Table 1 - Basic immunity test requirements.

For the United States

CFR Title 47 Telecommunication Chapter I Federal Communications Commission, Part 15 Radio frequency devices (FCC regulation pertaining to radio frequency emissions).

Safety

WARNING: The operator of this accessory is advised that if the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

AVERTISSEMENT: L'utilisateur de cet accessoire est prévenu qu'en cas d'utilisation contraire aux indications du manuel, la protection offerte par l'équipement peut être altérée.

Required Equipment

While operating this accessory, you must wear eye protection that either meets or exceeds ANSI Z87.1 standards. Additionally, wear protective clothing that has been approved for protection against the materials under test and the test temperatures.

Thermal Safety

WARNING: Parts of the Modular Microscope Accessory and hoses that will get hot or cool during operation should not be touched when testing at high and low temperatures. Time must be allowed for these to reach ambient temperature.

AVERTISSEMENT: Certaines parties du Microscope accessoires et les tuyaux qui deviendront chaudes ou froides pendant le fonctionnement modulaire ne devraient pas être touchés lors de l'essai à des températures élevées et basses. Le temps doit être autorisé pour ces atteindre la température ambiante.

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Chapter 1:

Introducing the MMA

Overview

Microscopy is a widely used technique to analyze the microstructure of materials. Combined with a rheometer, the structure cannot only be studied in a quiescent state, structural changes can also be analyzed under flow - thus providing a more in-depth understanding of the structure rheology relationship of materials.

Microscopy is the science of investigating small objects using a microscope. There are three well-known branches of microscopy: optical, electron, and scanning probe microscopy.

Optical and electron microscopy involve the reflection, or refraction of electromagnetic radiation/electron beams interacting with the specimen, and the collection of the scattered or reflected radiation in order to create an image. This process may be carried out by wide-field irradiation of the sample (for example standard light microscopy and transmission electron microscopy) or by scanning of a fine beam over the sample (for example confocal laser scanning microscopy and scanning electron microscopy).

Optical or light microscopy involves passing visible light transmitted through or reflected from the specimen through multiple lenses to allow a magnified view of the same. (Abramowitz M, Davidson MW (2007). "Introduction to Microscopy". Molecular Expressions. Retrieved 2015-04-28). The resulting image can be detected directly by the eye, imaged on a photographic plate or captured digitally. The digital microscope uses a CCD camera to focus on the exhibit of interest. The image is shown on a computer screen. Optical microscopy resolution is limited by the diffraction to approximately $0.2 \mu\text{m}$. This limits the practical magnification limit to $\sim 1500\times$.

Types of mostly used optical microscopy techniques are:

- 1 Bright field microscopy is the simplest of all the light microscopy techniques. Sample illumination is usually via transmitted light. Limitations include low contrast of most samples and low apparent resolution due to the blur of out of focus material.
- 2 Dark field microscopy is a technique for improving the contrast of unstained, transparent specimens (Abramowitz M, Davidson MW (2003-08-01). "Darkfield Illumination". Retrieved 2015-10-28). Dark field illumination uses a carefully aligned light source to minimize the quantity of directly transmitted (unscattered) light entering the image plane, collecting only the light scattered by the sample. Dark field can dramatically improve image contrast - especially of transparent objects. However, the technique suffers from low light intensity in the final image of many samples, and continues to be affected by low apparent resolution.
- 3 When certain compounds are illuminated with high energy light, they emit light of a lower frequency. This effect is known as fluorescence. Fluorescent microscopy is of critical importance in the modern life sciences and material characterization. Many different fluorescent dyes can be used to stain different structures or chemical compounds. Examples of commonly used fluorophores are fluorescein or rhodamine. Since fluorescence emission differs in wavelength (color) from the excitation light, an ideal fluorescent image shows only the structure of interest that is labeled with the fluorescent dye. This high specificity led to the widespread use of fluorescence light microscopy. To block the excitation light from reaching the observer or the detector, filter sets of high quality are needed. These typically consist of an

excitation filter selecting the range of excitation wavelengths, a dichroic mirror, and an emission filter blocking the excitation light.

- 4 Confocal microscopy uses a scanning point of light and a pinhole to prevent out of focus light from reaching the detector. Compared to full sample illumination, confocal microscopy gives slightly higher resolution, and significantly improves optical sectioning to produce clear images of focal planes deep within a thick sample.

The DHR Modular Microscopy Accessory is capable of imaging samples in brightfield, polarization, and fluorescence microscopy modes.

MMA Components

The following section describes the components of the DHR Modular Microscopy Accessory (MMA).

Base module

The Base module includes the light source, the camera, a linear 3D-translation stage (xyz-stage) with the microscope main body attached to the mounting ring, a separate electronic control module, and the objective mounting ring. Additional details on the individual components of the base module are given below.

3D Stage

The 3D manual stage consists of 3 linear translation stages stacked onto a mounting plate to allow easy positioning of the microscope in all 3 directions. The stages can be locked to prevent accidental movement once the objective is aligned.

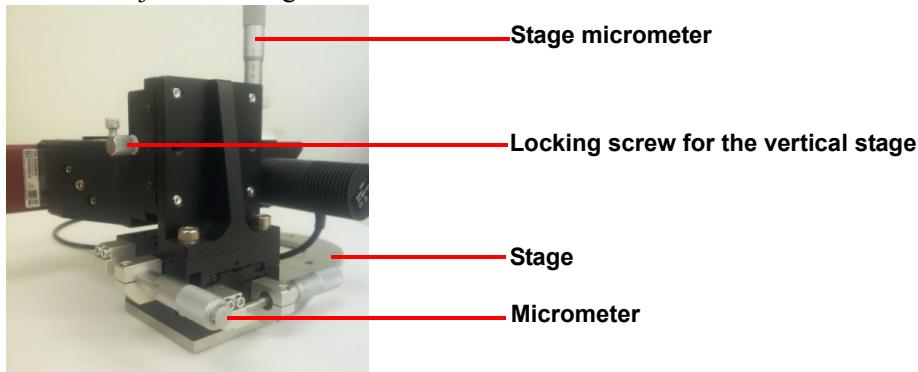


Figure 1 Manual 3D stage with precision micrometers.

Microscope Main Body

The microscope main body integrates all the optical elements and is rigidly attached to the 3D stage assembly. The base module includes the light source, the camera and the filter bock with the 50/50 beam splitter.

Light Source

The light source is an LED light with a peak illumination wave length of 470 nm (standard). The light from the LED passes a fixed polarizer before reaching the filter block.

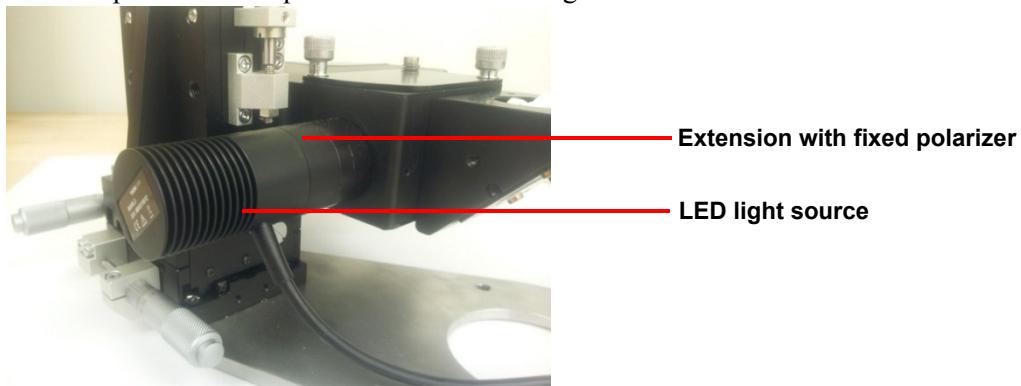


Figure 2 LED light source with a wave length of 470 nm.

Camera

The standard camera is a VGA GigE Vision camera with a Sony CCD sensor and a resolution of 640x480 pixels. The camera interfaces directly with the PC via IEEE 802.3 1000baseT protocol. The maximum frame rate at full resolution is 90 fps. The camera is attached to a mounting plate which interfaces with the microscope body to allow easy removal of the camera. A variable polarizer is attached to the camera.

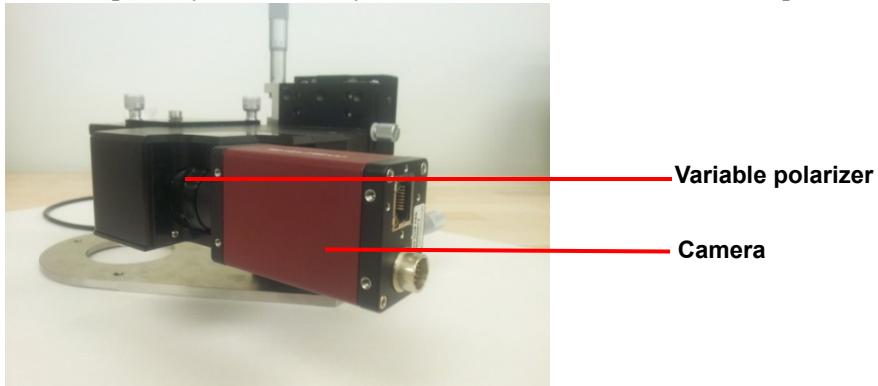


Figure 3 Camera with variable linear polarizer attached to the microscope main body.

Electronic control module

The electronic control module interfaces with the rheometer and controls the optical components of the microscope. The electronic control module communicates with the DHR firmware via a CAN bus to set the illumination intensity, the position of the optional piezo scanner, and, if equipped, adjust the counter-rotation ratio. In addition to software control, three rotary knobs allow the manual adjustment of these settings.

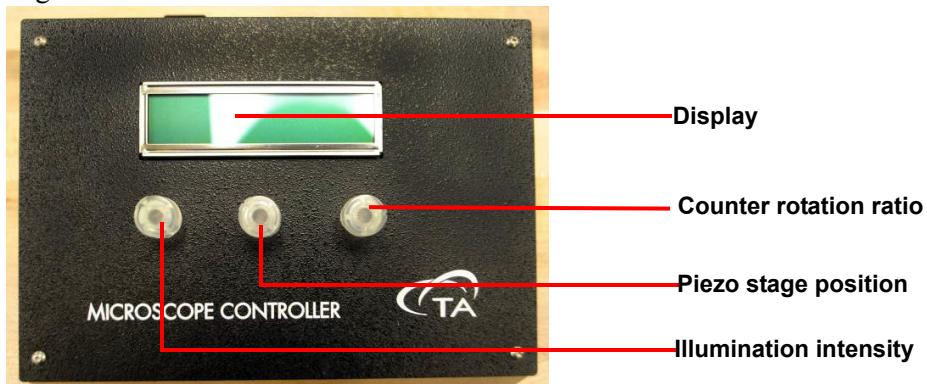


Figure 4 Electronic control module with knobs to adjust the illumination intensity, the piezo scanner position, and the counter rotation ratio.

Optional Components

Filter Block

The 50/50 beam splitter (included in the base module) is used for bright field applications. An optional filter block with dichroic beam splitter and filters to separate the incident light from the emitted light provides capability for fluorescence microscopy. The filter block is designed for incoming light between 460 - 490 nm and fluorophores emitting at approximately 500 nm.

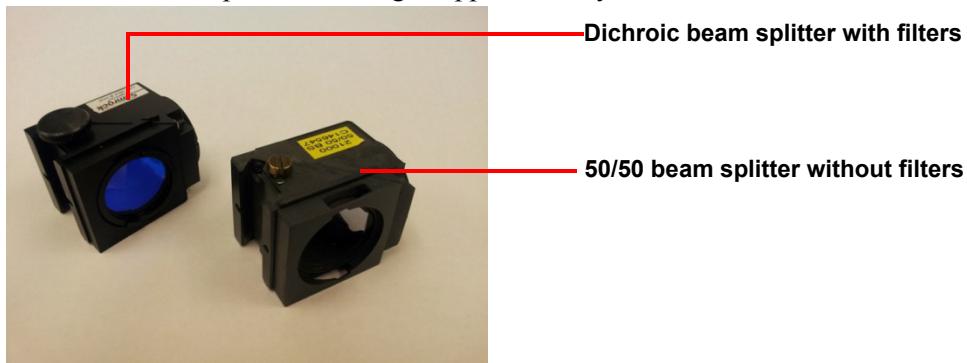


Figure 5 Filter block with dichroic beam splitter for fluorescence and 50/50 beam splitter for bright field applications.

Piezo Scanner

The optional piezo scanner and controller are used for fine adjustment in the objective's positioning. When equipped with the piezo scanner, the specimen can be scanned in the z-direction over a distance of 100 µm in steps of 0.1 µm. The motion of the piezo stage can be controlled manually from the electronic control module or from the TRIOS operation software.



Figure 6 Piezo scanner (without controller).

Objectives

The optional objectives used are high quality industry-standard microscope objectives from Nikon (M25x0.75 threaded objective) with magnifications from 5 to 100x. They are mounted directly onto the microscope body or the piezo stage.



Figure 7 Long-working distance Objective with adjustment for glass thickness.

Optical Plate

Two types of optical plates with and without counter-rotation are available to support the sample. The optical plate provides the lower plate of a parallel plate or cone plate geometry.

The base optical plate is a stand, mounted to the Smart Swap™ support and features a top glass plate holder for a 1.1mm thick glass plate or for the optional 0.17 mm thin coverslip. In the version with counter-rotation, the glass plate or coverslip holder are built into a ball bearing supported ring and actuated by a timing belt driven by a DC motor.

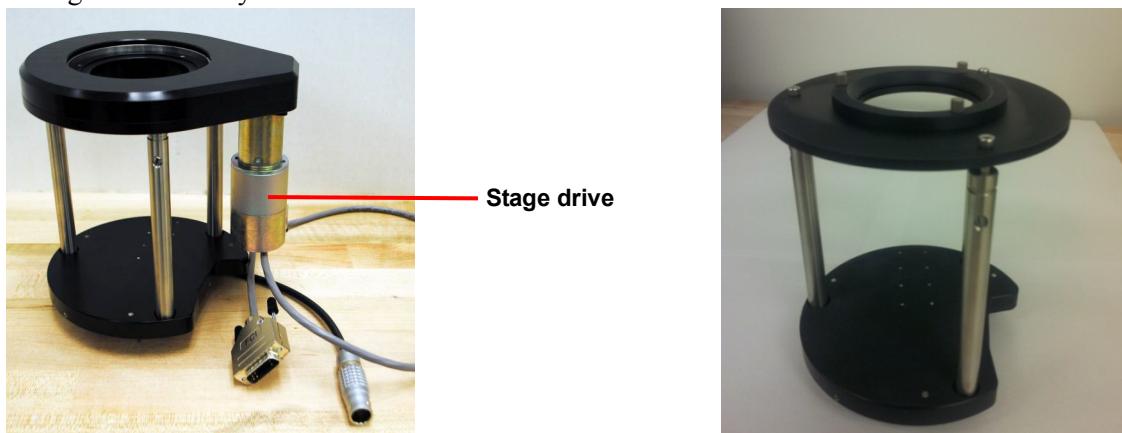


Figure 8 Optical plate with and without counter-rotation.

MMA Specifications

Table 1: MMA Specifications

| Item/Area | Specification |
|--|--|
| Camera (Manta G-033) <ul style="list-style-type: none">• Camera resolution• Frame rate | <ul style="list-style-type: none">• 640x480 pxl• 90 fps |
| Piezo stage | 100 μm in 0.1 μm steps |
| Illumination <ul style="list-style-type: none">• LED light | 470 nm |
| Filter Block <ul style="list-style-type: none">• Single band exciter• Long pass dichroic• Long pass emitter | <ul style="list-style-type: none">• 457–487 nm• 495 nm• 496 nm |
| Objectives (magnification/NA M25x0.75 threaded) <ul style="list-style-type: none">• PLAN 20x/0.4• ELWD 20x/0.45• ELWD 40x/0.6• PLAN 50x/0.9• EPLAN 100x/1.25 | <ul style="list-style-type: none">• CS 0.17, WD 1.2, FD~3 μm• CS 0-2, WD 8.2-6.9, FD~2.5 μm• CS 0-2, WD 2.8-3.6, FD~2 μm• CS 0.1-1.3, WD 0.35, FD~1 μm• CS 0.17, WD 0.23, FD<1 μm <p>CS= Coverslip/glass plate thickness WD= Working distance FD= Focus depth</p> |

Chapter 2:

Installing the MMA

This chapter briefly describes the installation of the Modular Microscopy Accessory on the DHR.

The basic module of the MMA consists of the microscope assembly with camera, light source and 50/50 beam splitter, and the separate electronic control module. The microscope assembly is designed to directly install onto the rigid DHR base to eliminate vibration. Once the MMA is connected to the rheometer and registered by the instrument, the TRIOS software identifies the MMA option and allows the accessory specific test forms to be accessed.

NOTE: Refer to TRIOS Software Online Help for detailed operation of the MMA.

Preparing the DHR

Before installing the MMA, proceed as follows:

NOTE: Refer to your instrument documentation for detailed procedures on removing and reassembling components.

- 1 Raise the DHR stress head to maximum height.
- 2 Remove all upper test geometries as well as any lower Smart Swap™ base attachments.
- 3 Remove the gold protection cover at the Smart Swap base. Turn counter-clockwise to detach the cover plate.



Figure 9 Remove the protection cover from the Smart Swap base.

- 4 Remove the three screws using a 4 mm hex key and replace them with the stand offs (PN 546623.001)

supplied with the MMA. Tighten with the supplied wrench (PN 202294.001).

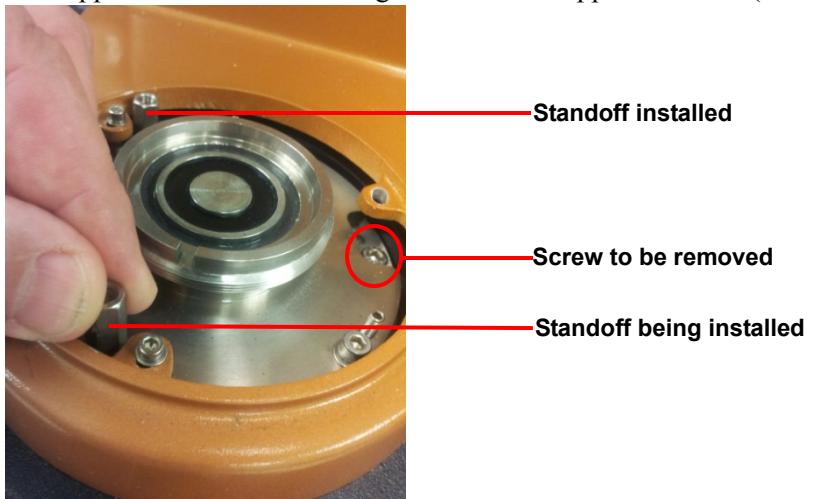


Figure 10 Remove the screws and install the 3 standoffs at the Smart Swap™ base.

- 5 Thoroughly inspect the mounting surfaces of the Smart Swap base and clean off any material that may interfere with mounting the lower accessory.
- 6 Provide bench space next to the instrument (preferably to the left).

On the Controller PC, proceed as follows:

- 1 Insert a second network card in the card rack of the controlling PC (if not already available).
- 2 Install the necessary drivers.

NOTE: Refer to your PC documentation for detailed procedures on removing and reassembling components.

- 3 Install the drivers for the camera. For the Manta G-033, install the Vimba V1.3 drivers for AlliedVision cameras with GigE Vision. Download the driver from www.alliedvision.com/en/products/software.html. Select the downloads for Windows.

When the download is complete, run the Vimba-v1.3-Windows.exe to install the driver. Select **Custom** and make sure that all features are checked. After the installation is complete and the camera has been properly connected (refer to “[Mounting the MMA to the DHR](#)”), verify the operation of the camera with the AVT Vimba viewer. Select Manta_G_033B from the list of detected cameras. The viewer window displays. Use the **FreeRun Start** button to enable the live image monitor.

NOTE: NetFramework 2.0SP or 3.x must be installed on the computer for Vimba V1.3 to function correctly.

Installing the MMA on the DHR

This section details the installation for the MMA. In order to operate, the MMA requires the installation of the base module and the optional optical plate. The MMA module has to be bolted to the 3 standoffs, already installed on the instrument base. The optical plate is installed onto the Smart Swap base. The MMA base module must be configured to accept the piezo scanner (optional) and objective prior to mounting.

Assembling the base MMA module

Depending on the configuration (with or without piezo scanner), a different objective adapter is installed.

Without piezo scanner

- 1 Remove the black protection cap (rotate counter-clockwise to unscrew).

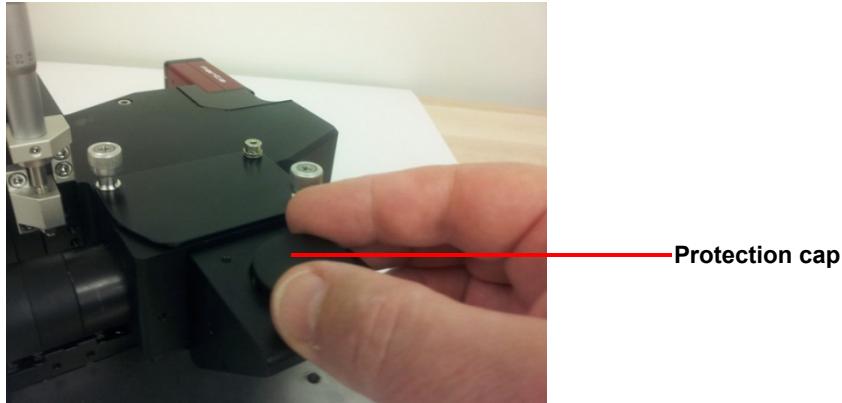


Figure 11 Remove the protection cap.

- 2 Screw in the lens tube (PN 203130.001–supplied with the MMA).

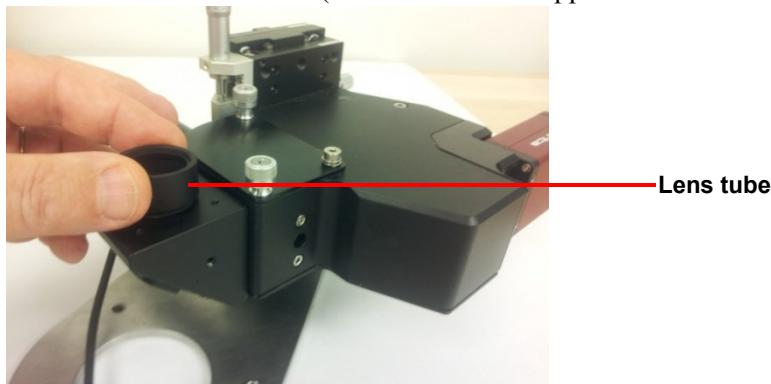


Figure 12 Mount the lens tube.

- 3 Attach the thread adapter (PN 203127.001–supplied with the MMA).

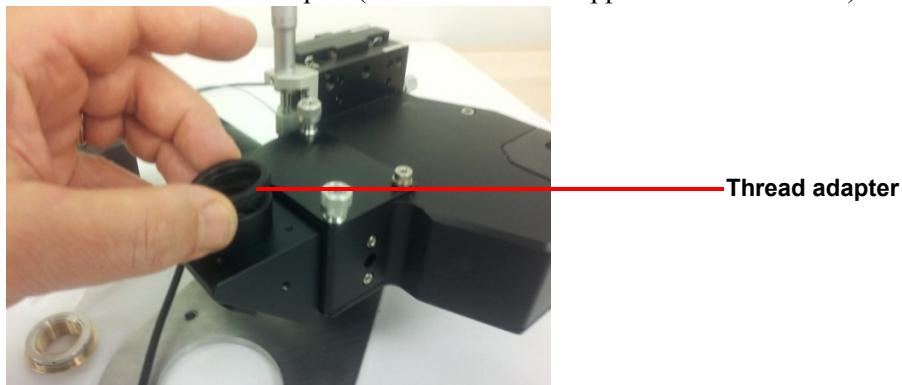


Figure 13 Thread adapter installed on the lens tube.

- 4 Protect the opening with an antistatic paper/wiper.

NOTE: Always cover the objective mount with an antistatic tissue when no objective is installed to avoid dust from entering the MMA body. Use an air duster to remove dust from the optical parts if necessary.

With a piezo scanner

- 1 Remove the black protection cap (see [Figure 11](#)).
- 2 Screw on the thread adapter (PN 203127.001—supplied with the MMA).

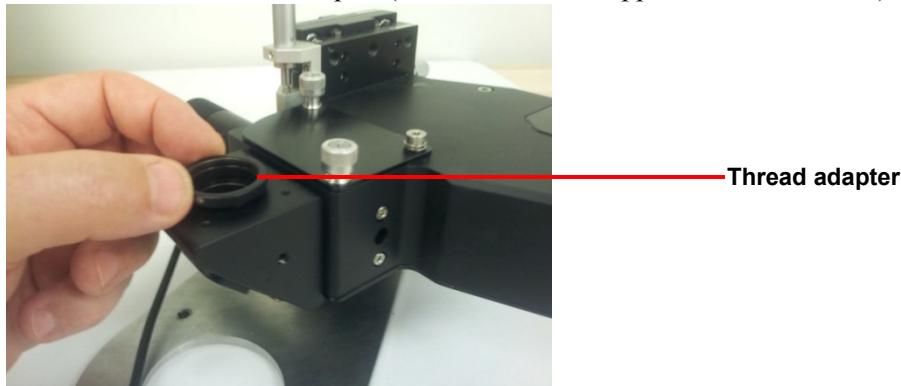


Figure 14 Install the thread adapter.

- 3 Remove the piezo scanner from the shipping box, unlock the assembly using the provided pin by turning the silver ring in counter-clockwise, and remove the mounting socket from the threading ring.

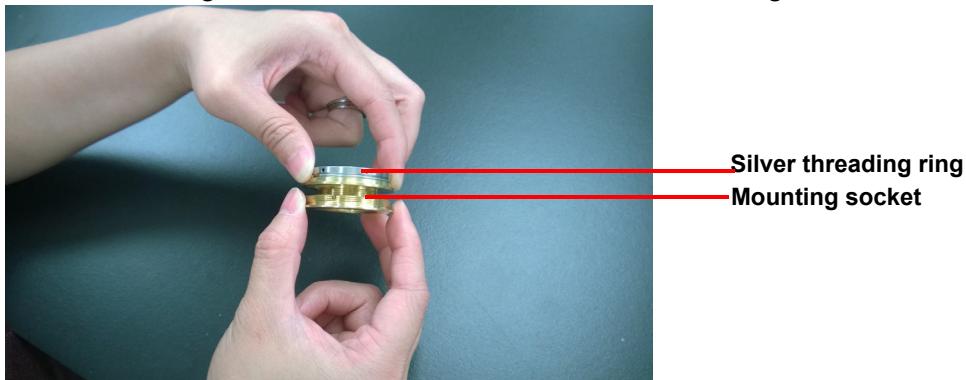


Figure 15 Separate the piezo scanner mounting socket and threading ring.

- 4 Install the mounting socket on the thread adapter. Tighten with the supplied fastener tool.

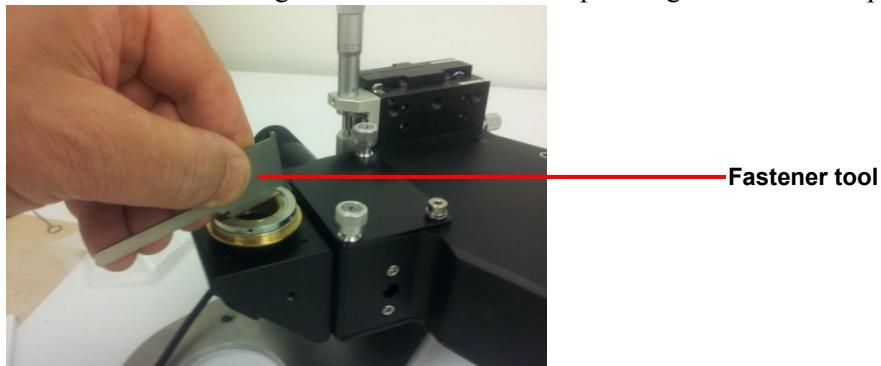


Figure 16 Secure the piezo bottom piece.

- 5 Install the threading ring on the piezo stage. Do not overtighten.



Figure 17 Install threading ring.

- 6 Insert the piezo scanner onto the mounting socket so that the pin holes of the silver ring are displayed through the piezo stage slit.

NOTE: If the silver ring is too tight, the split ring that sits directly below it will be pushed out and the piezo stage will not sit low enough to be able to see the pin holes.

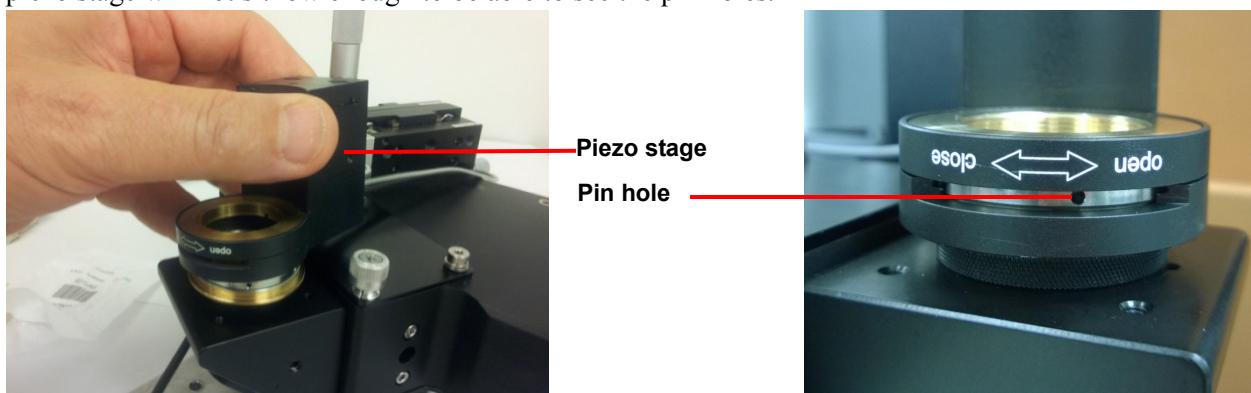


Figure 18 Install the piezo scanner.

- 7 Lock the piezo scanner with the pin provided by turning it toward “close.” The body of the piezo element should be oriented at a 45 degree angle towards the back of the rheometer.

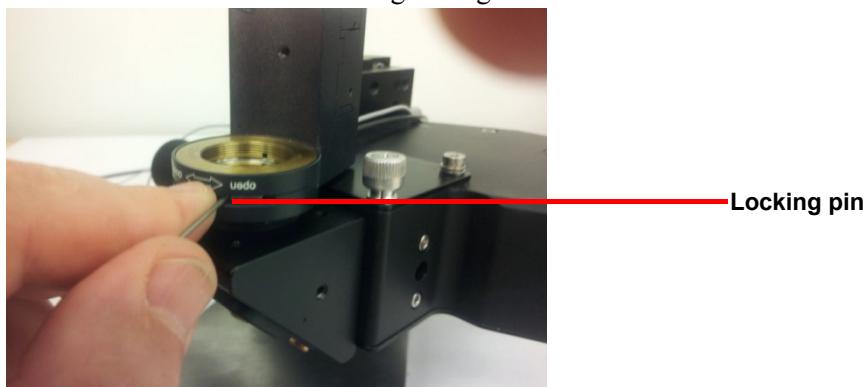


Figure 19 Secure the piezo in place.

- 8 Protect the opening with an antistatic paper/wiper.

Mounting the MMA to the DHR

Make sure the DHR has been properly prepared (see: Preparing the DHR) and the standoffs are securely tightened.

- 1 Lift the MMA base with the camera facing to the left and align the screw holes in the mounting plate with the standoffs attached to the rheometer base.



Figure 20 Mount the microscope to the rheometer.

- 2 Insert all three screws and tighten.
- 3 Connect the network cable to the camera and the second network card at the PC. Insert the connector for the power supply in the camera and the opposite end into a suitable power outlet.

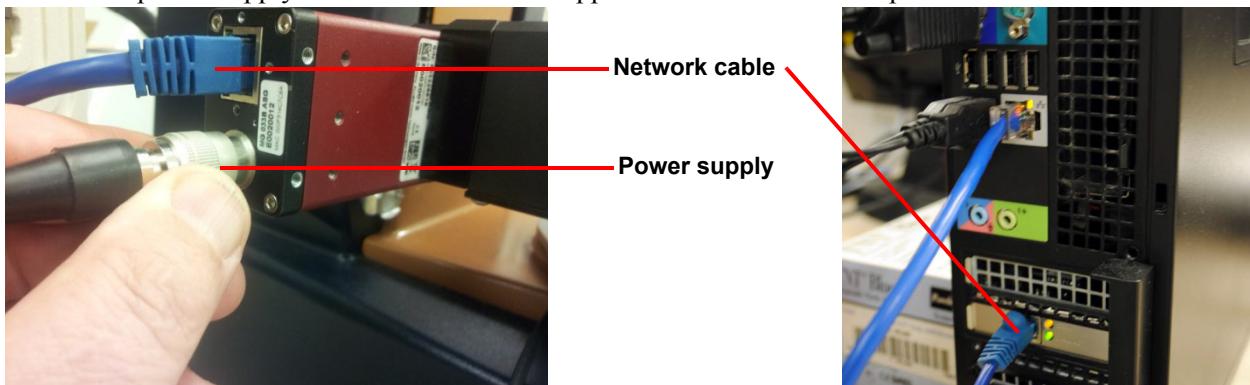


Figure 21 Install the network cable and power supply at the camera.

NOTE: The PC needs a second network card in order to interface with the camera.

- 4 Place the electronic control module to the side (preferably to the left) of the DHR.
- 5 On the rear of the control module, connect the LED light source's power cable. Next, connect the CAN

bus terminator into the **CAN OUT** port on the control module.

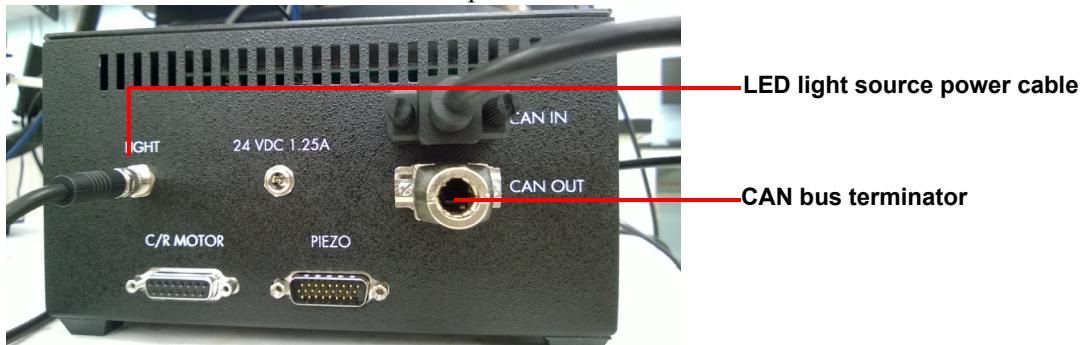


Figure 22 Connect the light source and CAN bus terminator at the rear of the electronic control module.

- 6 Connect the 9 pin communication cable from **CAN IN** port on the electronic control module to the CAN port at the rear of the DHR electronics box.

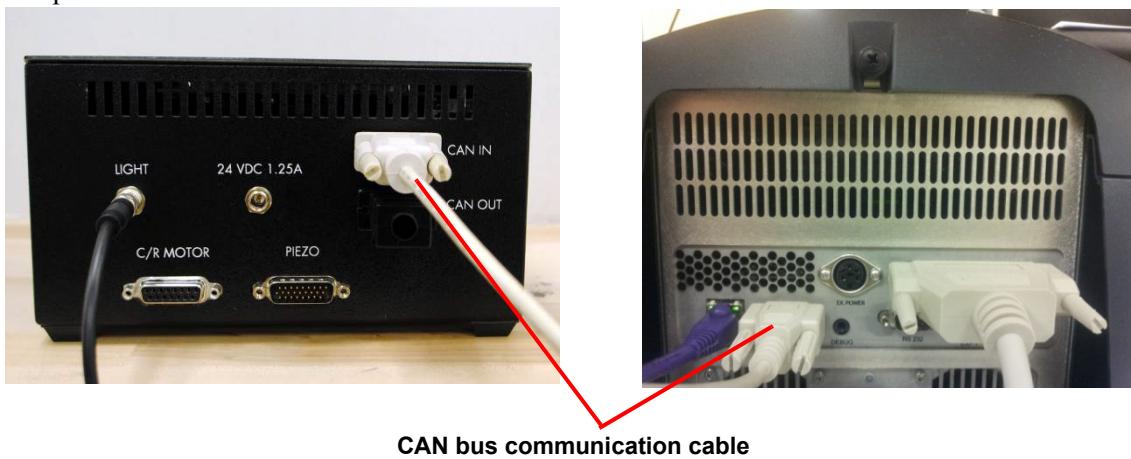


Figure 23 CAN bus cable connection between the microscope and rheometer.

- 7 If a piezo scanner has been installed, connect the two cables with the Lemo connector to the piezo controller adapter cable, and then plug the adaptor cable into **PZT and Sensor** port on the back of the digital piezo controller..

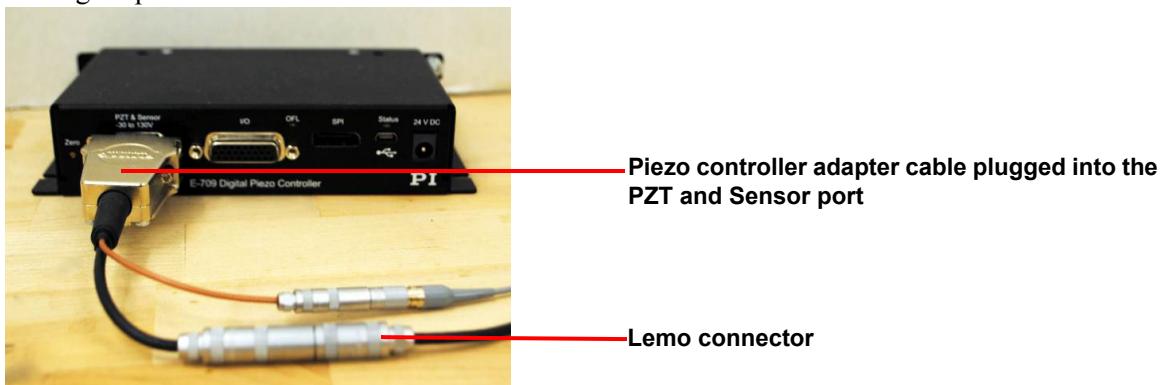


Figure 24 Connecting the piezo cables to the digital piezo controller.

- 8 Connect the 15 pin connector from the piezo controller to the electronic control module.

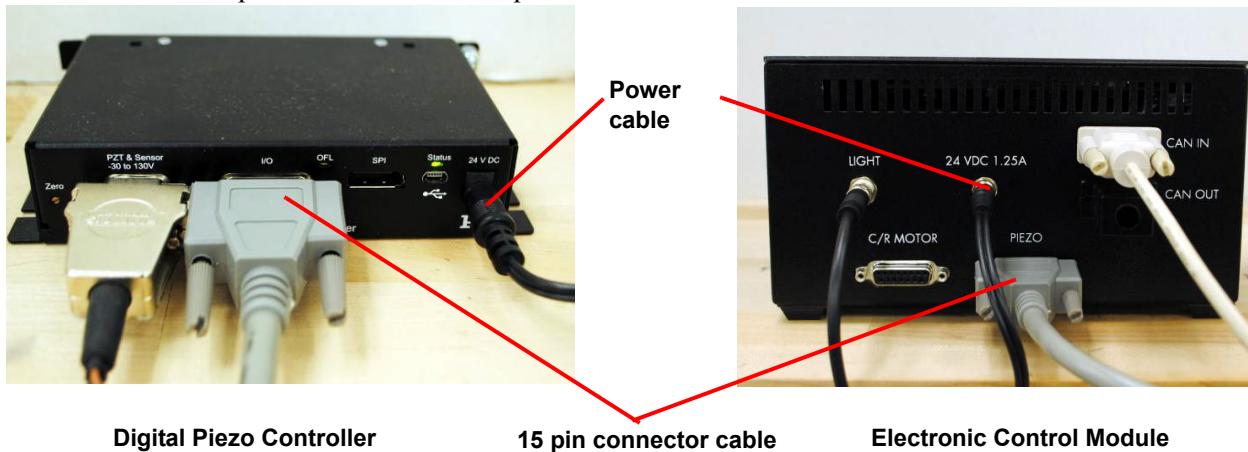


Figure 25 Connect 15 pin communication between piezo controller and electronic control module.

- 9 Attach the respective power supply cables to the digital piezo controller and electronic control module.

Installing the Objective and Filter Block

After the MMA has been installed on the DHR, the desired objective can be mounted.

NOTE: If temperature control is required, mount the Upper Heated Plate (UHP) before installing the objective. Refer to "[Installing the Upper Heated Plate \(UHP\)](#)".

- 1 Carefully remove the objective from the storage container and adjust the collar of the objective to the glass plate thickness (0.17 for coverslip and 1.1 for the glass plate).

NOTE: Oil objectives are designed to work with 0.17 mm thick coverslips and no adjustment is necessary.

- 2 Remove the antistatic paper/wiper and install the objective by turning in a clockwise direction. Do not overtighten.



Figure 26 Install the objective.

- 3 Remove the foam insert from the filter block by unlocking the thumbscrews securing the filter block cover and sliding it to the left.

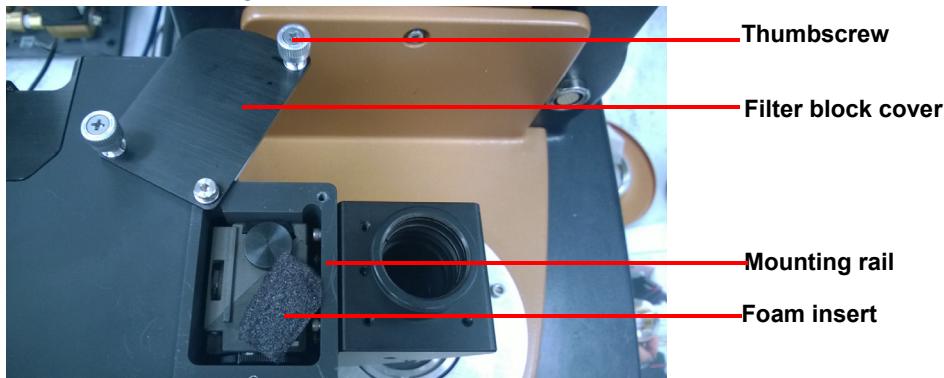


Figure 27 Remove the cover.

- 4 The MMA ships with the 50/50 beam splitter required for bright field operation installed in the filter block. For operation with fluorescence, carefully remove the 50/50 beam splitter and replace with the filter block containing the dichroic mirror by sliding the filter block down the mounting rail.

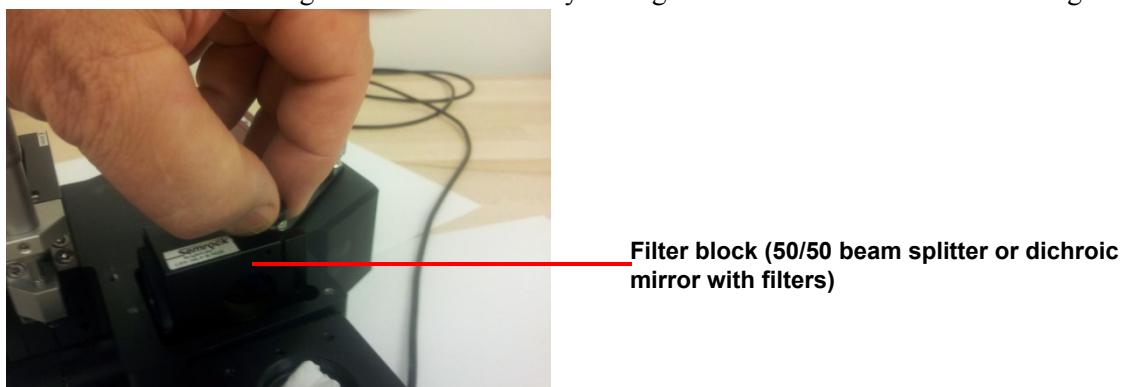


Figure 28 Inserting the 50/50 beam splitter.

Installing the Optical Plate on the DHR

Remove the optical plate from the shipping box. Mount the optical plate on the Smart Swap™ base before installing the glass plate/coverslip glass.

Install the optical plate onto the Smart Swap

Install the optical plate following the instructions below:

- 1 Raise the rheometer head to the top most position



- 2 Press the **Release** button on the control panel.

- 3 A continuous green light indicates that the rheometer is ready for the optical plate to be fitted.

NOTE: The release state will only stay active for 10 seconds.

- 4 Fit the optical plate, ensuring the white alignment line is to the front of the rheometer.

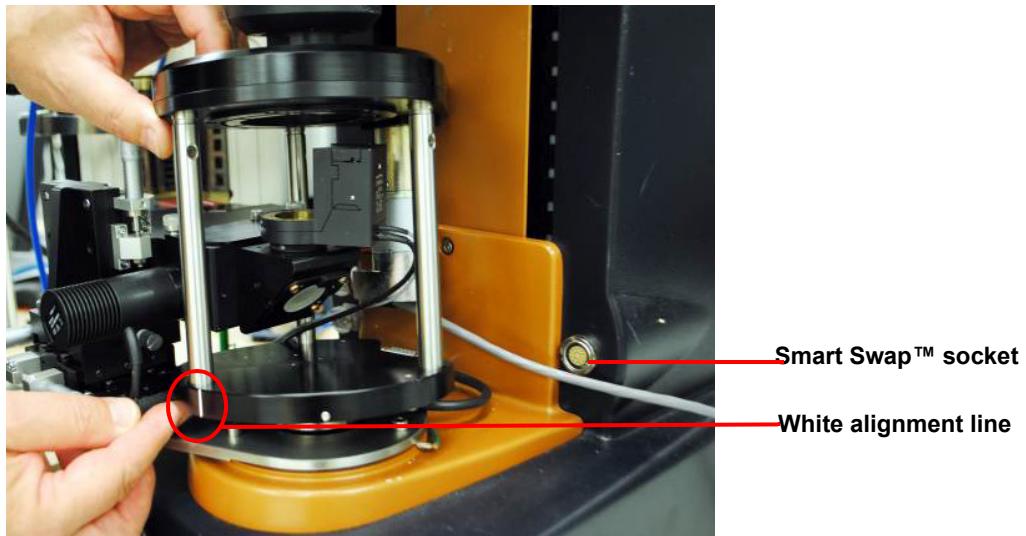


Figure 29 Fitting the optical plate onto the Smart Swap base.

- 5 Connect the optical plate cable to the Smart Swap socket.
- 6 If the optical plate is configured for counter rotation, also connect the 15 pin connector attached to the optical plate drive at the rear of the electronic control module. Skip this step if the optical plate has no counter rotation.

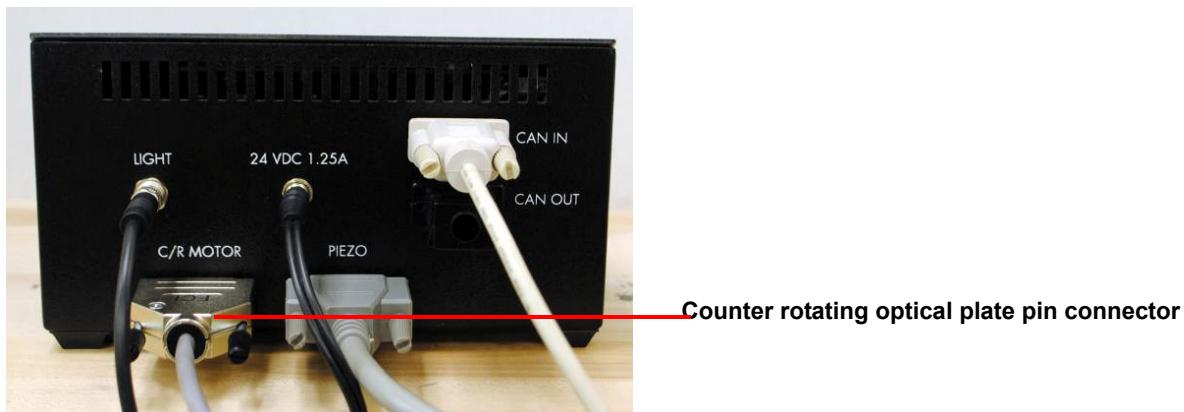


Figure 30 Connect 15 pin connector from the counter rotating optical plate to the electronic control module.

Install glass plate and coverslip on the optical plate

NOTE: Oil objectives have to be used with the thin 0.17 mm coverslip glasses. Objectives with large working distance (>1.5 mm) can be used with the 1.1 mm glass plate as well as with the 0.17 mm coverslip glass.

NOTE: The 1.1 mm glass plate and the clamping ring are included with the Optics Plate Accessory and the Counter-Rotating Optics Plate Accessory. The coverslip support and clamping ring kit is a separate item (546812.901).

Installing the 1.1 mm glass plate

The microscope stage is shipped with the 1.1 mm glass plate already installed. In order to replace the glass plate after cleaning, proceed as follows:

- 1 Make sure that the glass plate has been thoroughly cleaned.
- 2 Position the glass plate on top of the optical plate.



Figure 31 Position the glass plate at the rotating stage.

- 3 Make sure that the O-ring is seated correctly in the circular groove on the underside of the clamping ring. Position the ring over the glass and align the 3 thumb screws with the threads on the support ring. Manually tighten the screws. Screw all three screws in first before tightening them evenly. Do not over tighten.

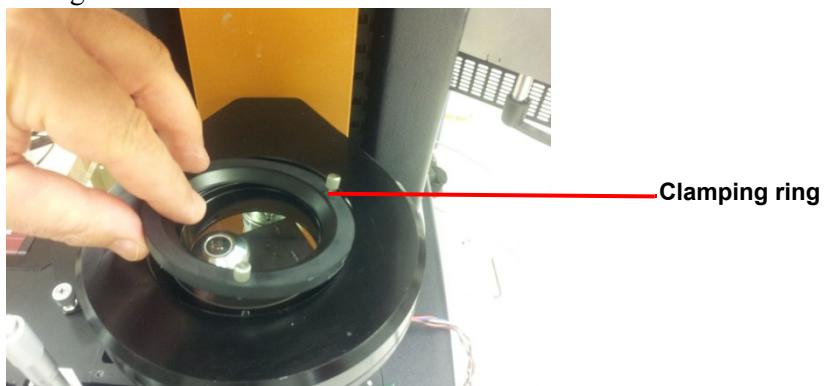


Figure 32 Install the clamping ring.

Installing the coverslip glass

- 1 Remove the standard optical plate clamping ring using the three thumbscrews.



Figure 33 Thumbscrew.

- 2 Install the support ring. If an oil objective is used, bring it up close to the support ring opening and put a drop of immersion oil on top of the objective.

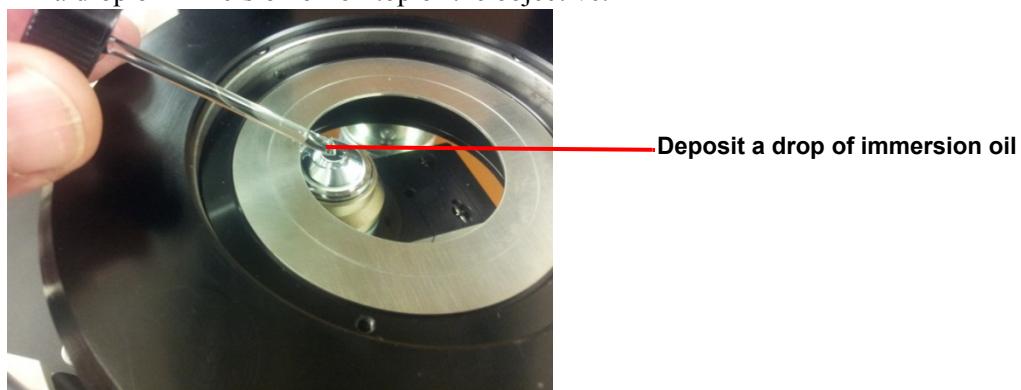


Figure 34 Depositing a drop of immersion oil on the objective.

NOTE: If counter rotation is not required, the support plate with the smaller opening (546840.001) can be used, providing better support for the thin cover slip.

NOTE: If the microscope has been aligned with the upper geometry, the objective can be positioned at the correct radial location and the support plate with the smaller opening (546840.001) can be used. If this location is unknown, use the support ring (546832.001) to determine the radial location of the objective first.

- 3** Position the coverslip into the slot in the support ring/plate. The immersion oil must bridge and fill the space between the objective and the coverslip glass.

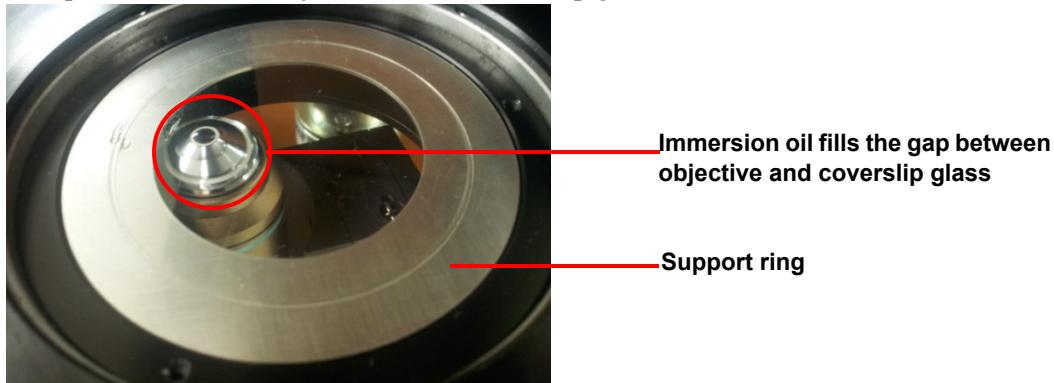


Figure 35 Position the coverslip into the slot of the support ring.

- 4** Make sure that the O-ring is seated correctly in the ring channel of the clamping ring. Position the ring over the glass and align the 3 thumb screws with the threads on the support ring. Manually tighten the screws. Screw all three screws in first before tightening them evenly. Do not over tighten.



Figure 36 Install and tighten the clamping ring.

Installing the Upper Heated Plate (UHP)

The MMA accessory may be operated at ambient temperature. Controlled temperature is possible in conjunction with the Upper Heated Plate (UHP) option. Refer to the Upper Heated Plate Getting Started Guide for more detailed information.

Follow the steps below to attach the Upper Heated Plate to the rheometer head.

- 1** Make sure air is supplied to the air bearing and the rheometer is turned on. Raise the head to the maximum height (use the Head UP button located on the instrument control panel). Remove the optical plate as well as the objective from the microscope. Protect the opening for the objective with an antistatic paper/wiper.

- 2 Insert the draw rod to attach the upper geometry first. Then insert the upper plate/cone into the heat spreader and attach the Upper Heated Plate fixture with the geometry to the mounting ring on the underside of the instrument head, using the three captive screws provided. Hold the heater and the geometry as shown in [Figure 37](#). Secure the geometry to the instrument shaft by rotating the draw rod. Note that the power cable should project to the right of the instrument when viewed from the front, with the ports for the coolant and inert gas to the left.

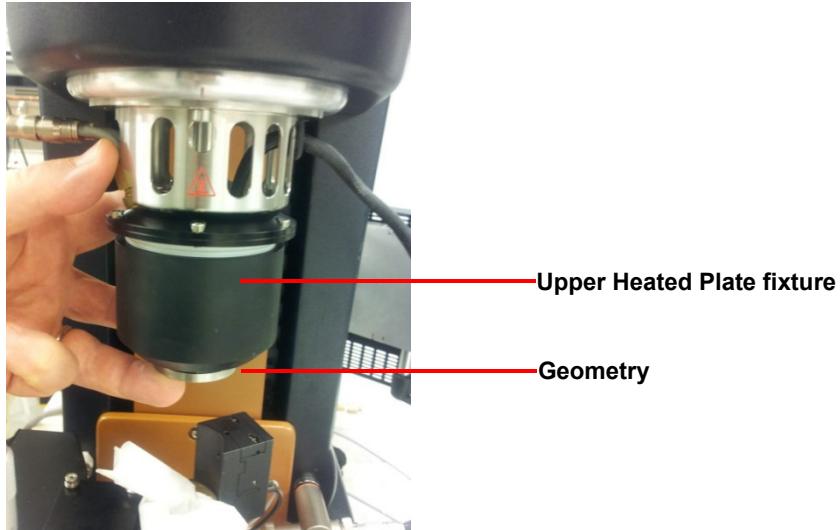


Figure 37 Hold the Upper Heated Plate fixture together with the geometry while tightening the captive screws.



- 3 Press the **Release** button on the control panel.
- 4 A continuous green light indicates that the rheometer is ready for the optical plate to be fitted.
NOTE: The release state will only stay active for 10 seconds.
- 5 Fit the optical plate, ensuring it is aligned correctly. See [Figure 29](#).
- 6 Remove the antistatic paper/wiper from the objective opening and reinstall the objective.
- 7 Connect the Optical Plate and Upper Heated Plate cables to the left and right sockets on the Smart Swap Upper Heated Plate adapter, respectively (see the [Figure 38](#) below). For proper system identification, it is important that this step be completed before step 8.

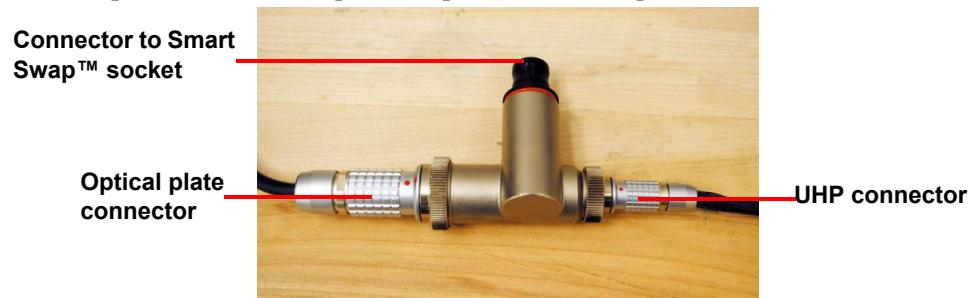


Figure 38 The Smart Swap UHP adapter.

- 8** Connect the Upper Heated Plate adapter to the Smart Swap™ socket on the right of the rheometer base.

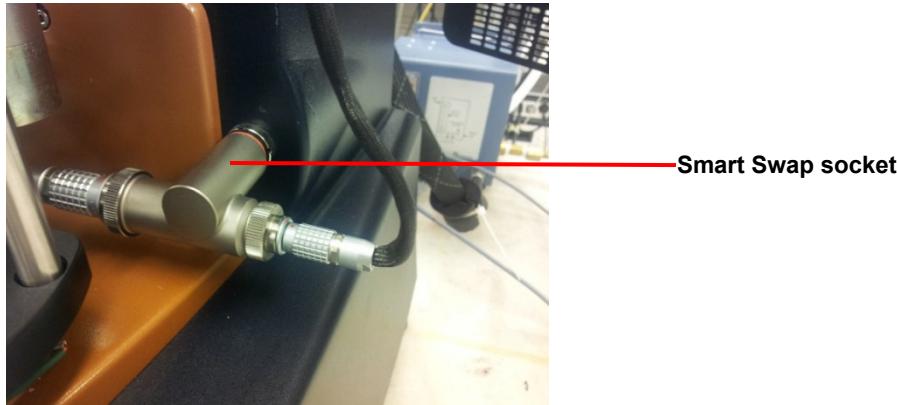


Figure 39 Connection of the UHP adapter to the Smart Swap socket.

WARNING: Do not remove the heating element cover.

AVERTISSEMENT: Ne retirez pas l'enrobement de l'élément chauffant.

NOTE: Refer to the Upper Heated Plate Getting Started Guide Chapter 2 for the configuration of the cooling options.

Chapter 3:

Operating and Maintaining the MMA

This chapter briefly describes the operation and maintenance of the DHR Modular Microscope Accessory.

Establishing Connection with TRIOS

In order to operate the MMA, connection through the instrument control software (TRIOS) must first be established. TRIOS V3.3.0.4195 and firmware V9.35 or later must be installed.

- 1 Verify that the correct driver for the camera has been installed on the same computer as TRIOS software.
- 2 Make sure that the MMA module has been properly installed and powered up.
- 3 TRIOS automatically connects to the MMA and a “Microscope: Ready” message displays on the Status bar.
- 4 Click on the **Image** icon in the **View** toolbar of the **Experiment** tab. Undock the Image panel and expand it, preferably on a second monitor. It is convenient to undock the Instrument panel as well, and place it side-by-side with the Image panel on the second monitor.

Calibrating the Objectives

Before operating the MMA (see TRIOS online help: Calibrating the MMA objectives), the available objectives must be configured in the software.

Perform the following steps:

- 1 In TRIOS select **Options** from the Instrument tab.
- 2 Select **Microscope** from the list below Discovery HR.
- 3 Click **Add** to add the calibration for an objective. Enter a name (ex.: E-PLAN 20x); Enter the calibration value (ex. 2 pixel/ μm).
- 4 Click **Add** to add other objectives. Click **OK** to save and exit.

NOTE: Enter the following nominal values for the objectives: 20x \rightarrow 2.0 pxi/ μm ; 40x \rightarrow 4.0 pxi/ μm ; etc.

Refer to TRIOS online help “Calibrating the MMA objectives” for instruction on how to measure the exact calibration values.

NOTE: Oil objectives require the installation of the coverslip glass plates (0.17 mm)

Align the Objective in Reference to the Rotation Axis

Before running experiments, the objective must be aligned in reference to the rotation axes of the upper geometry. The easiest way to do this is with the 1.1 mm glass plate and a parallel plate upper geometry and a 20x objective.

NOTE: Each micrometer controlling the translation stages must be unlocked prior to positioning the objective. Not unlocking the translation stages before attempting to position the objective may damage the objective and MMA.

NOTE: The optical plate and the MMA module have been factory aligned horizontally to the Smart Swap™ attachment and the base of the instrument.

Follow the instructions below to align the objective.

- 1 Unlock all three translation stages by rotating the three locking thumbscrews in the counter-clockwise direction.

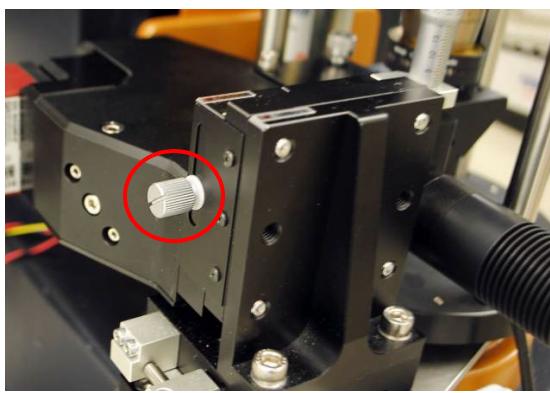


Figure 40 Thumbscrew.

- 2 Position the objective near the center of the glass plate using the micrometers of the two horizontal linear translation stages.

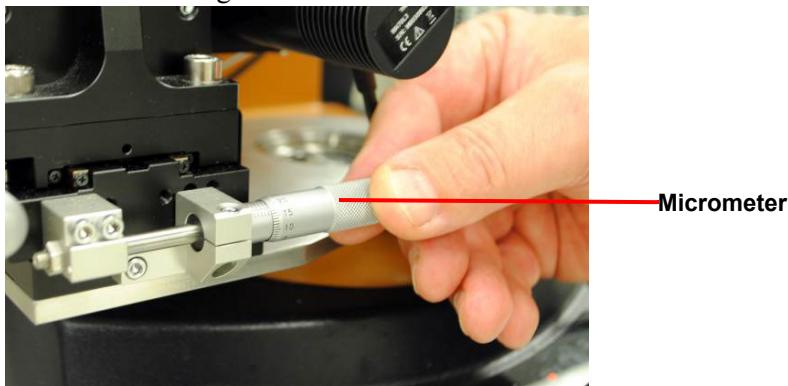


Figure 41 Changing the position of the objective in the horizontal plane with the xy-stage.

- 3 Install an upper 40 mm Peltier plate geometry on the DHR and activate the geometry in TRIOS.

NOTE: If the Upper Heated plate is used, use the 40 mm UHP plate geometry with heat spreader.

- 4 Set the piezo stage to zero using the middle knob on the electronic control module.



Figure 42 Manually set the piezo stage to zero.

- 5 In **Options > Discovery HR > Gap** set the maximum loading force for the gap setting to 2 N (for details refer to TRIOS online help: “Operating the DHR”). Zero the gap from the **Instrument Gap** panel. Then set the gap and the piezo stage to 100 μm .
- 6 Make sure that the camera is connected and operational, and the **Image source** set to live on the Microscopy form. Using the micrometer of the vertical linear stage, adjust the z position until the image focus is on the surface of the upper plate. It will be necessary to adjust the illumination during this operation. Record the position of the vertical stage micrometer. (see TRIOS online help: “Operating the Microscopy Accessory”)
- 7 From the **Instrument Motor panel** set the shear rate to 0.1 s^{-1} . Using the micrometers of the two horizontal linear stages, find the center of the rotating image. This center aligns with the rheometer rotation axis. Record the micrometer positions.
- 8 Position the objective at the desired radial position on the left of the rotation axis using the front stage micrometer. Typically this position is chosen as 0.76 of the plate radius.

NOTE: During the shift along the plate radius, the image should not go out of focus by more than 20 μm . Refer to service for realignment when 20 μm are exceeded.

Align the Piezo Position With Glass Plate

For 3D imaging along the z-axis, the position of the piezo stage needs to be aligned with the glass plate. The easiest way to do this is to use a small piece of shim or deposit monodisperse polystyrene beads of a few microns on the glass surface. Proceed as follows:

- 1 Set the piezo stage to the zero position and set the illumination to a few percent by adjusting the left knob on the electronic control module. Press the knob to activate the light if necessary. The knob will light up green when activated.

- 2** Place a small piece of shim over the light beam on the glass plate. Load a small weight to make sure that the shim is flush with the glass. Alternatively deposit some polystyrene beads.

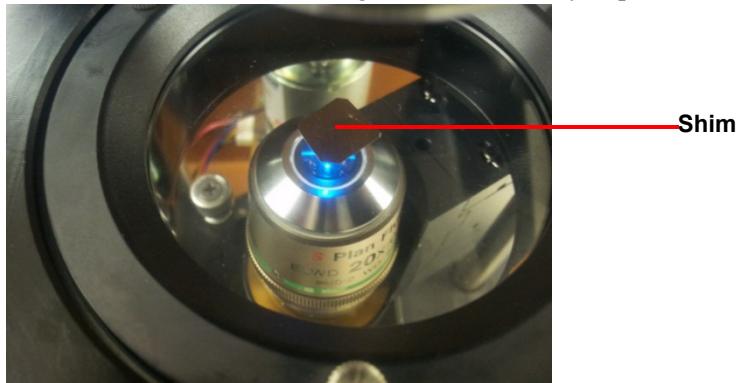


Figure 43 Position a small shim on the glass surface to adjust the focus with the linear z-stage at the glass surface.

- 3** Adjust the linear z-stage (vertical) until the shim surface or the glass beads are in focus. Record the micrometer position.
- 4** Remove the shim or the polystyrene beads.

Operating the MMA

The MMA on the DHR can be operated in manual or procedure-based mode (see TRIOS online help: “Operating the MMA” for details).

Manual mode

In manual operation mode, the rheometer is typically used to apply a shear strain or shear rate without recording the stress and/or normal force. Select **Hide Main TRIOS Panel** (located below the settings of the Image panel) to minimize the main TRIOS application. The undocked Instrument and Image panels remain open. The sample deformation (rate) can be set on the instrument motor panel. The counter-rotation ratio (if counter-rotation is available) can also be set from the motor panel. The conditions for the microscope as well as images and video clips recording are set on the Image panel (see TRIOS online help: “Operating the MMA” for details).

- 1** Zero the gap and load the sample.

NOTE: To avoid damaging the glass or coverslip plate, adjust the zero gap settings to 2 N when using a parallel plate geometry and 1 N when using a cone geometry (for details see TRIOS online help: Operating the DHR”).

- 2** Select the best camera and microscope settings.
- 3** Choose the desired recording mode. Select **Wait on motor command** if you would like the recording to start with the motor command. In this case, start the recording before you manually initiate the motor command on the Instrument Motor panel.
- 4** The image or video clips are kept as temporary files. Make sure to save the files before exiting TRIOS if you want to keep the media files.

Procedure-based mode

In procedure-based mode, microscope recordings are performed simultaneously with the rheological tests. The video/image files can be saved embedded in the TRIOS file or as separate media files. The defaults are set in **Options > Microscope**. The microscopy settings are controlled from within the procedure in a microscopy conditioning test (see TRIOS online help: “Operating the MMA” for details).

- 1** Zero the gap and load a sample.

NOTE: To avoid damaging the glass or coverslip plate, adjust the zero gap settings to 2 N when using a parallel plate geometry and 1 N when using a cone geometry (for details see TRIOS online help: Operating the DHR”).

- 2** Program a TRIOS procedure with a microscope conditioning test followed by a test mode test. This can be an oscillation, flow or transient test.
- 3** Start the experiment like any other TRIOS procedure (see TRIOS online help: “Operating the DHR”)
- 4** The rheological test results can be viewed in the graph/table in real time and the video stream can be viewed at the same time in the Image panel.
- 5** At the end of the test the rheological data and the media files are saved.

Maintaining the MMA

The maintenance required for the DHR MMA consists of the following tasks:

- Microscopy is very sensitive to dust. It is important to prevent dust from entering the main body of the microscope assembly. If necessary, use a duster to blow the dust from the optical parts.
- If possible, do not touch lenses or mirrors with fingers. Use antistatic paper tissues or wiper to handle and clean the optical elements.
- Clean the glass of the optical stage carefully. Depending on the test sample, use adequate solvents to remove all sample residues.
- Remove the glass clamping holder to remove sample residues from the glass below the clamping ring. Clean the clamping ring and the O-ring before assembling.

Changing the camera

The MMA is supplied with a Manta G-033 digital camera from Vision Technologies. If space allows, other cameras might be able to be accommodated by using a specially-designed mounting block, but the output format may not be compatible with TRIOS. Check compatibility with your TA Instruments representative.

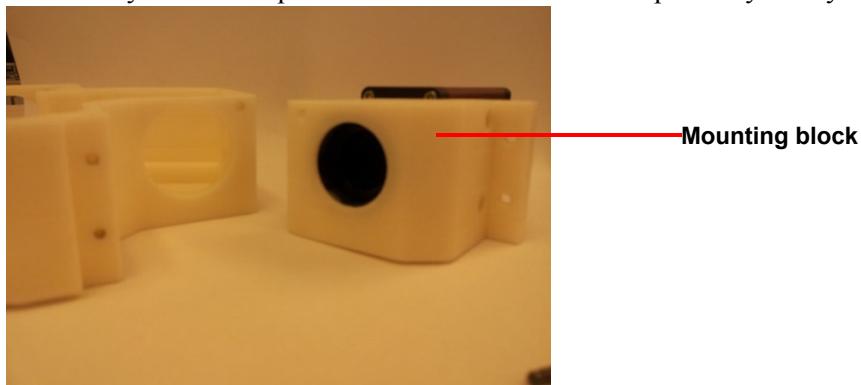


Figure 44 Main microscope body with camera mount.

- 1 To change the camera, remove the three screws on the mounting block. Swap the camera assembly and reattach the mounting block.

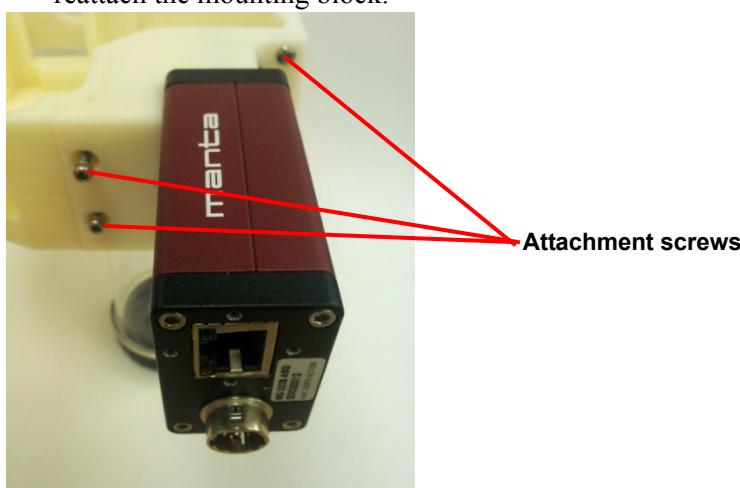


Figure 45 Camera assembly with camera and mounting block attached to the main microscope body.

Changing the illumination

The light source provided with the MMA is the M470L3 from ThorLabs. If another wave length is required, the LED light can be easily changed.

- 1 Switch off the illumination on the Electronic Control module and unplug the cable of the light source. Remove the LED assembly by rotating the end piece of the light source assembly in counter clockwise direction. Hold the other part of the assembly stationary to make sure that only the LED assembly is removed.

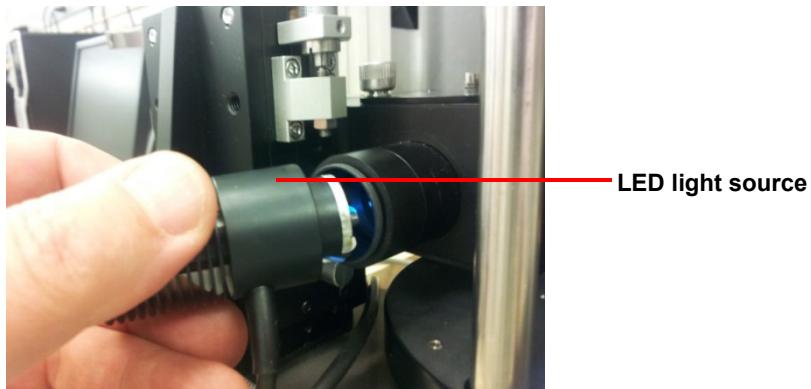


Figure 46 Removing the LED light source.

- 2 Insert the new LED assembly (for example, the M490L3 from ThorLabs with a wavelength of 490 nm) and secure it by rotating in clockwise direction. Reconnect the cable with the Electronic Control module (see also [Figure 22](#)).

Replacement Parts

The table below lists the replacement parts available for the MMA.

Table 2: Replacement Parts for MMA

| Part Number | Description |
|-------------|--|
| 546812.901 | Thin (0.17 mm) glass kit (3 coverslips, 3 O-rings, support plate, and clamping holder) |
| 546809.901 | Replacement thin (0.17 mm) glass kit (10 coverslips and 3 O-rings) |
| 546801.901 | Replacement thick (1.1 mm) glass kit (3 glass plates and 3 O-rings) |