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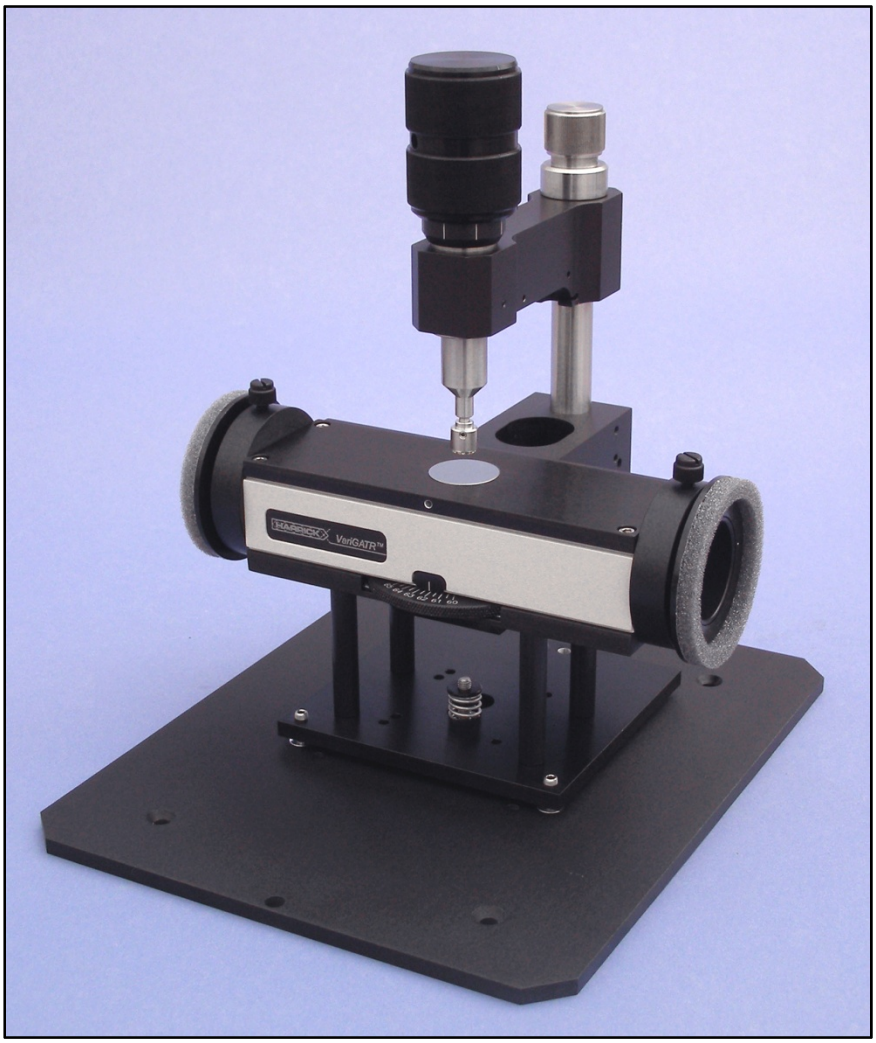
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VariGATR™

USER'S MANUAL

For use with GAT-V-NI6 and GAT-V-NI8



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UNPACKING

Before installing the VariGATR™ make sure all the parts on the included Parts Check List are present. If any parts are missing or damaged, contact Harrick Scientific immediately.

TECHNICAL SUPPORT

For additional information please contact our Technical Support Center at 800-248-3847 between 9 a.m. and 5 p.m. EST; or e-mail your questions to: techsupport@harricksci.com

FEEDBACK

Your comments and suggestions are welcome. Please send them to:

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The VariGATR™ is a single reflection horizontal ATR accessory designed for analyzing coatings (or films), including monolayers on silicon wafers and polished flat metal substrates. It employs a Ge ATR crystal and an angle of incidence which can be varied from 60º to 65º for optimizing sensitvity. The useful spectral range is from 5000 to 650 cm^{-1}.

The VariGATR™ is specifically designed to take advantage of the sensitivity enhancement that occurs for an extremely thin film sandwiched between a silicon or metal substrate and a Ge ATR crystal under the condition of supercritical internal reflection. This enhancement quickly decreases as the distance between the silicon substrate and Ge crystal increases beyond 1/100 of a wavelength. Therefore, it is critical to achieve intimate contact between the sample and the crystal. For this purpose a special pressure applicator was developed.

This pressure applicator features a non-rotating pressure head which is lined with a pressure pad. The non-rotating pressure head prevents damage to the ATR crystal and the sample. This special pad is made of an elastic material that distributes the pressure applied evenly over the active area of the ATR crystal.

The VariGATR™ incorporates a removable fixed, high torque slip-clutch, since applying greater force generally yields better contact. However, over-pressurizing should be avoided since it can cause damage and possibly deform the coating.

The accessory has a very low depth of penetration and hence is useful for analyzing samples with thin coatings or chemically modified surfaces. For greater analytical specificity, a polarizer can be incorporated into the basic accessory. The VariGATR™ is optimized for analysis of thin films on silicon or metal substrates. However, the VariGATR™ can also be used as a single reflection ATR accessory for analysis of liquids, soft solids, powders and flat solids.
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OPEN BEAM SPECTRUM

Prior to installation, collect an open beam background spectrum (no accessory in the sample compartment). This spectrum should be used later to verify the throughput of the VariGATR™.

GETTING READY

Before installing the VariGATR™, familiarize yourself with the accessory and its various components by referring to the drawing found below (Figure 1).

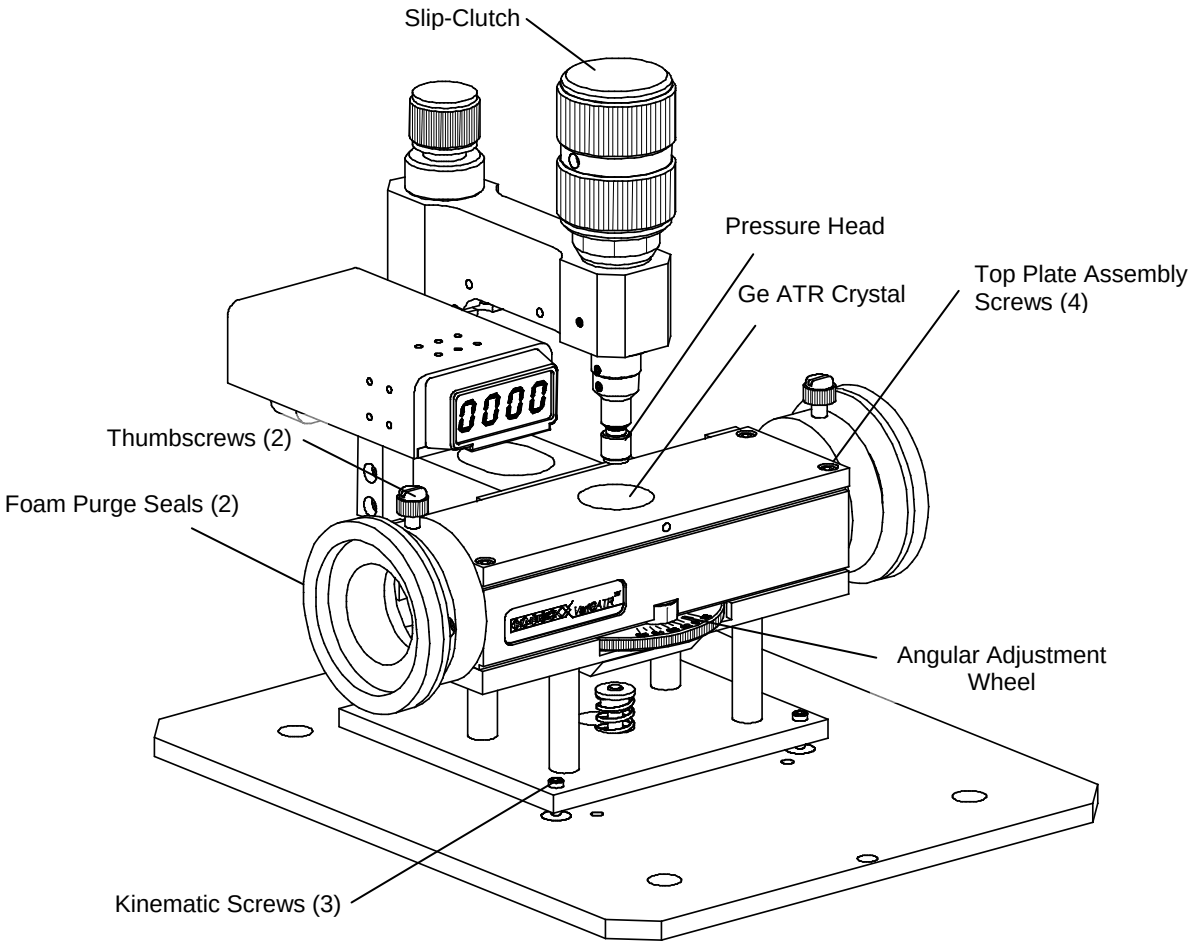


Figure 1 • VariGATR™. Shown here with Force Sensor and Display

PURGE INSTALLATION

PURGE ADAPTORS
(FOR AVATAR / NEXUS SPECTROMETERS ONLY)

Slide in the two purge adaptors, as illustrated below, until they click in place (Figure 2).

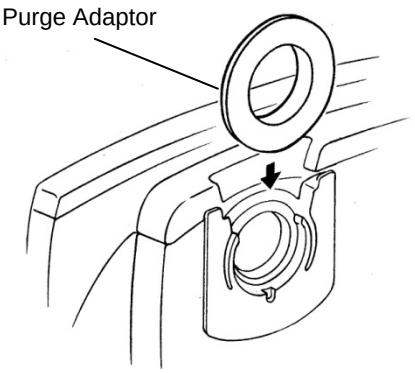


Figure 2 • Purge Adaptor

PURGE SLEEVES

Loosen the thumbscrews and push the purge sleeves in to retract them (Figure 3).

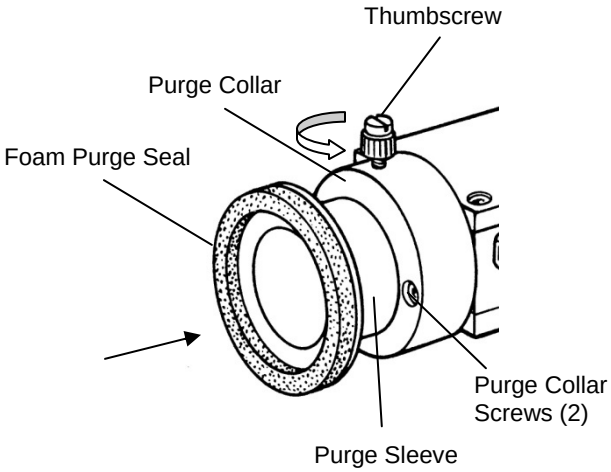


Figure 3 • Purge Sleeves

PURGE LINE

For quicker purging or if the spectrometer has windows on the beam ports, connect an additional purge line to the barbed fitting on the VariGATR™, shown in Figure 4 .

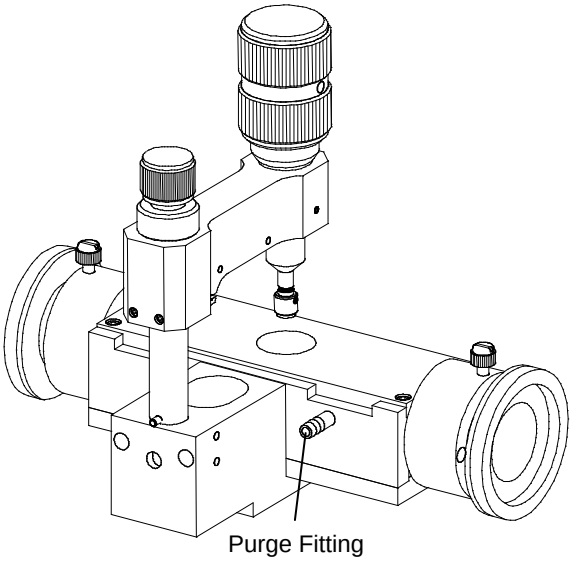


Figure 4 • VariGATR™

VariG*A*TR™ INSTALLATION

- Remove the existing base plate from the sample compartment.
- Insert the VariG*A*TR™.
- Make sure the base plate rests firmly in the spectrometer (Figure 5).

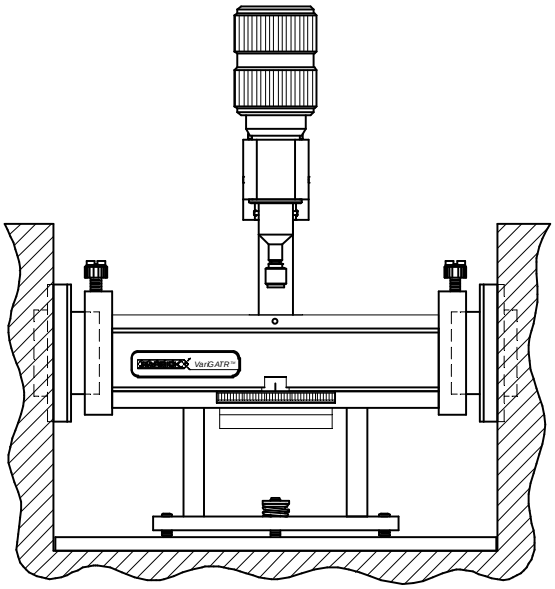


Figure 5 • VariG*A*TR™ Installation

ALIGNMENT

The VariGATR™ has been pre-aligned prior to shipment. Only minor adjustments should be required to optimize the performance of the VariGATR™ for your spectrometer:

- Once the VariGATR™ is installed, set the spectrometer to measure the “energy” on the detector.
- Using the supplied 3/32” ball driver adjust the three kinematic screws (Figure 6) one by one, moving systematically from screw to screw, optimizing the “energy” at each before moving to the next.
- Repeat this procedure several times until no further improvement is possible.
- Loosen the thumbscrews securing the purge sleeves.
- Extend the purge sleeves by sliding them until they firmly contact the sides of the sample compartment.
- Tighten the thumbscrews to keep the purge sleeves in place.

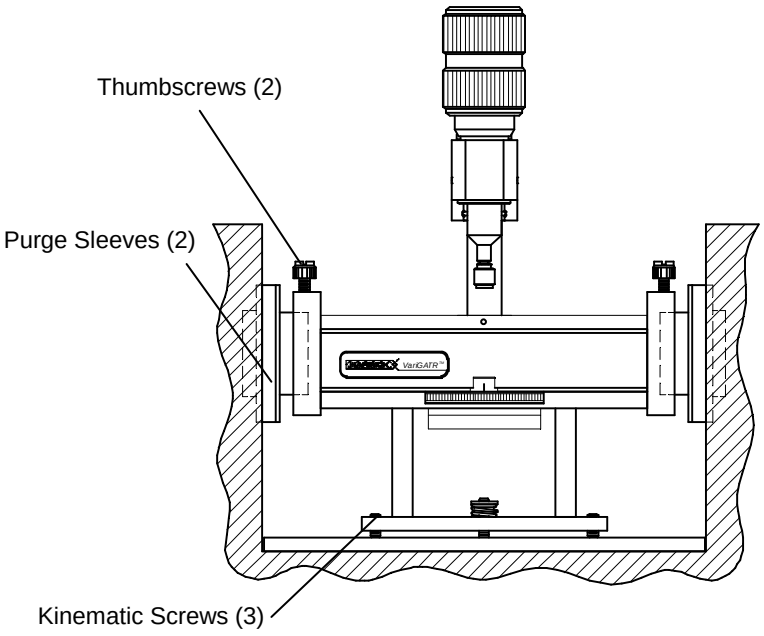


Figure 6 • VariGATR™ Alignment

FORCE SENSOR

The optional force sensor provides a highly accurate method of compressing the sample against the ATR crystal. It is ideal for reproducible results and for samples that change optical properties under compression.

Getting Ready

Familiarize yourself with the components of the force sensor of the VariGATR™ found below (Figure 7).

NOTE: *The meter can be mounted on either side of the pressure applicator. It is supplied for installation on the left.*

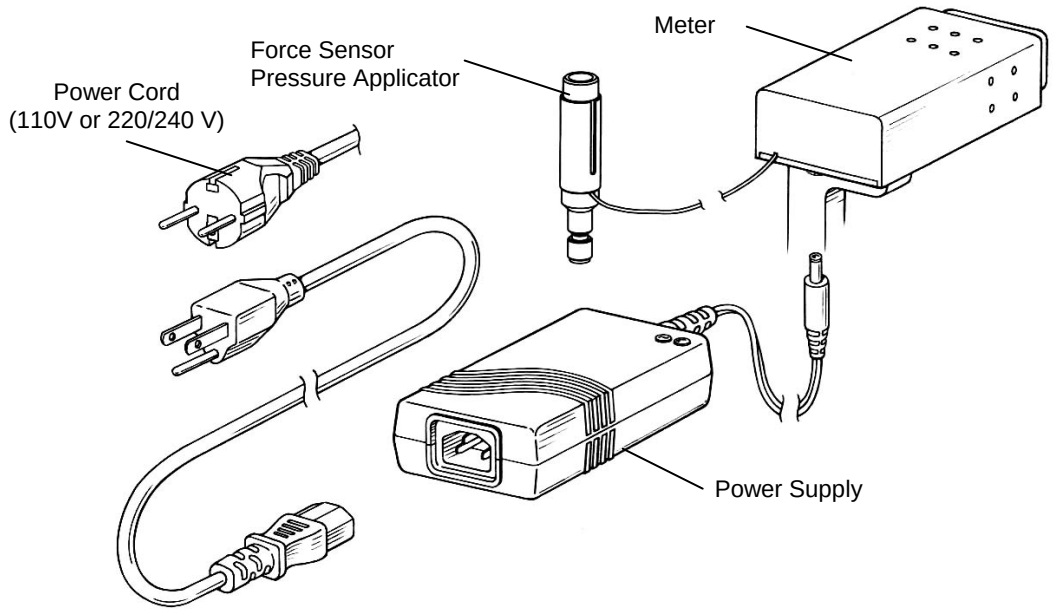


Figure 7 • VariGATR™ Force Sensor Components

> ***CAUTION:***
> *Handle the wire connecting the display to the force sensor pressure applicator with care to prevent damage.*

Installation

- Protect the ATR crystal with a hard cardboard pad so it does not get damaged during this procedure.
- Raise the pressure applicator up as far as possible.
- Turn the locking nut counter-clockwise two turns to loosen the arm,
- Grasp the built-in slip-clutch and swing it 90º, away from the desired location for the meter. To install the meter on the right, swing the slip-clutch to the left. To mount the meter on the left, swing the slip-clutch to the right.

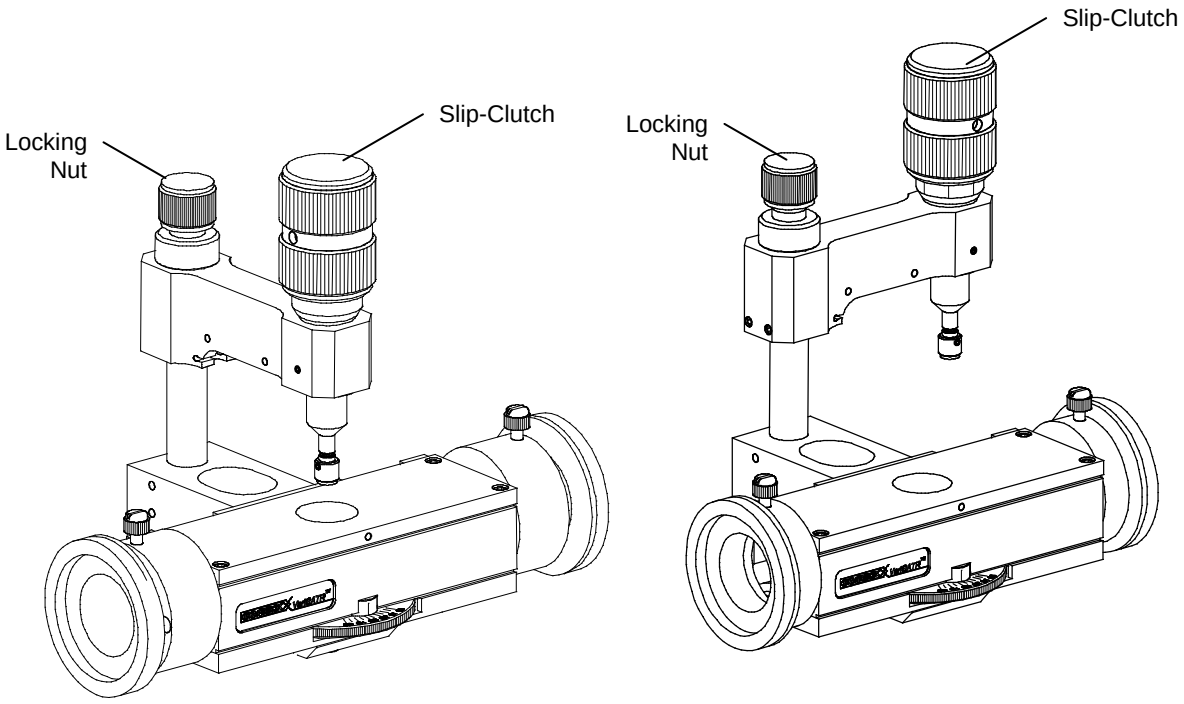


Figure 8 • Swinging the Slip-Clutch

- Hold the pressure head and loosen the setscrew using a 0.050” ball driver enough to be able to slide the pressure head off the pressure applicator assembly (Figure 9).

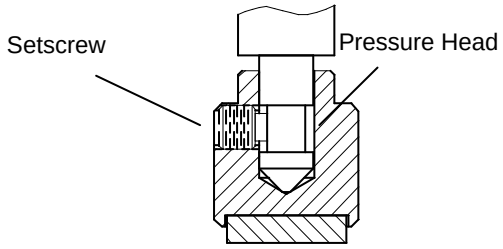


Figure 9 • Removing the Pressure Head

- While holding the pressure applicator assembly, turn the slip-clutch clockwise to lower and then remove the assembly (see Figure 10).

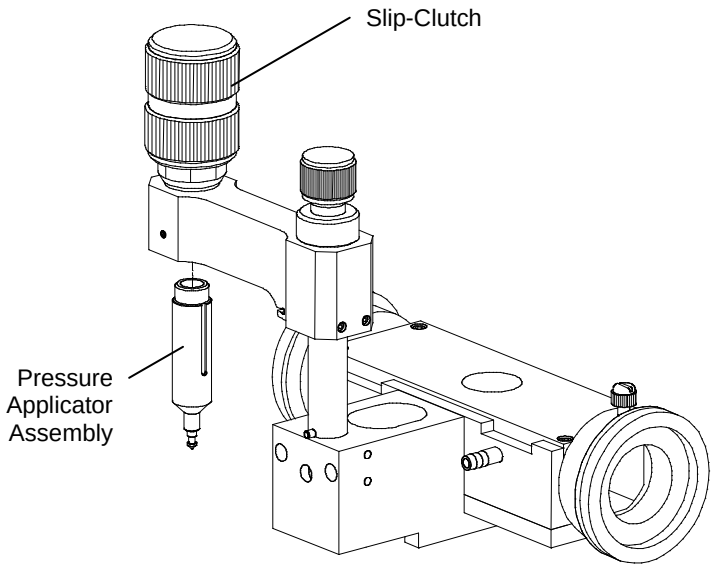


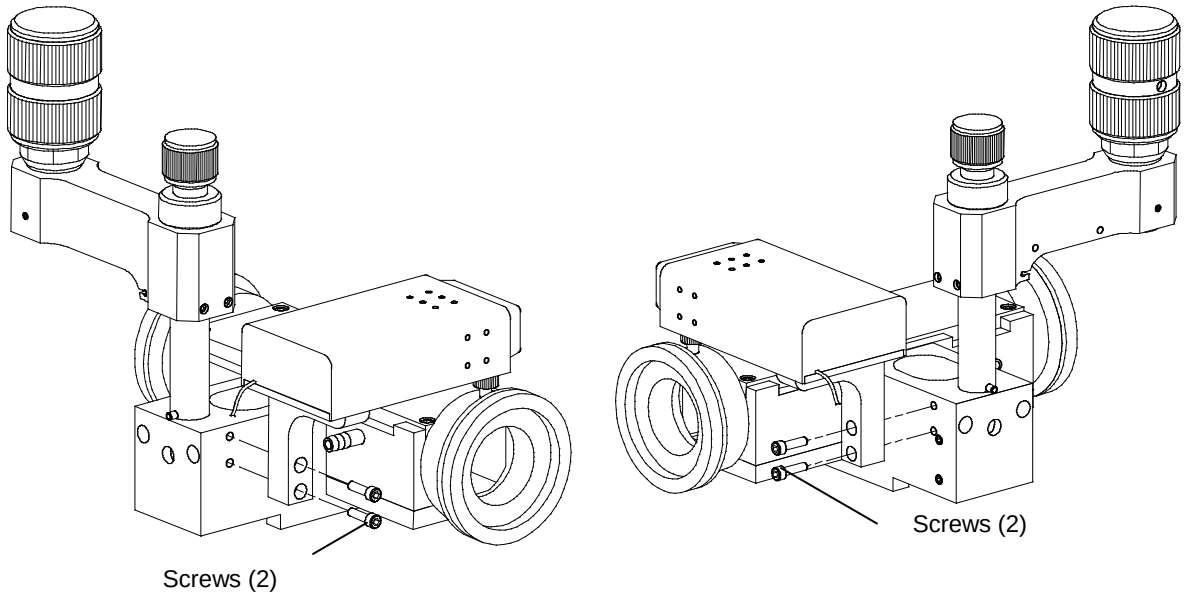
Figure 10 • Removing the Pressure Applicator Assembly

CAUTION:
Be sure to move the meter and force sensor assembly together to avoid strain on the wire connecting the two.

- The meter is configured for use on the left side of the VariGATR™. If installation on the other side is preferred, use a 7/64” hex driver to remove the screw that affixes the mounting bracket to the bottom of the meter. Pull the mounting bracket off the meter. Rotate the mounting bracket 180º and reattach it in this position using the original screw.

> ***CAUTION:***
> *Be sure to move the meter and force sensor assembly together to avoid strain on the wire connecting the two.*

- Position the meter on the desired side of VariGATR™. Be sure to rest the force sensor on the tabletop nearby so as not to strain the wire.
- Thread and tighten the two hex-head screws supplied using a 7/64" hex wrench to mount the meter onto the VariGATR™ as shown in Figure 11.



Left-Side Mounting **Optional Right-Side Mounting**

Figure 11 • Mounting the Meter

- Orient the force sensor pressure applicator as shown in Figure 12.
- Feed the pressure applicator up into the hole below the Slip-Clutch.
- While continuing to hold the pressure applicator assembly, turn the slip-clutch counter-clockwise to thread the pressure applicator assembly into its housing (see Figure 12).

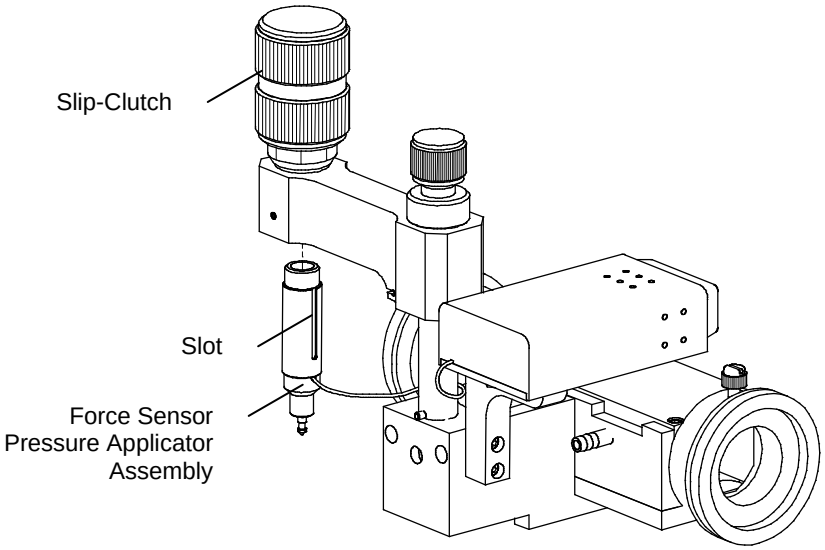


Figure 12 • Installing the Force Sensor Pressure Applicator Assembly

- Slide the pressure head onto the pressure applicator assembly (see Figure 13).
- Tighten the setscrew until it stops using the supplied 0.050" ball driver. Then unscrew it ¼ of a turn to allow free rotation of the pressure head.

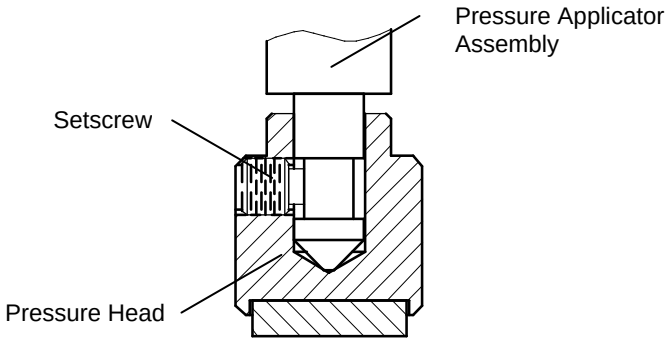


Figure 13 • Installing the Pressure Head

- Adjust the Slip-Clutch so 1” (25mm) of the shaft is exposed, as shown in the Figure 14.
- Unscrew the two setscrews on the left side of the arm using a 0.050” hex wrench.
- Gently push the wire into the recess in the bottom of the arm, leaving a loop near the pressure applicator, as shown in Figure 14.

NOTE *Figure 12 is roughly to scale and can be held up against the unit to check the length of the loop.*

- Make sure the wire is up into the recess as far as possible above one of the setscrews.
- Re-thread and tighten that setscrew.
- Make sure the wire is up into the recess as far as possible above the other setscrew.
- Re-thread and tighten the second setscrew.

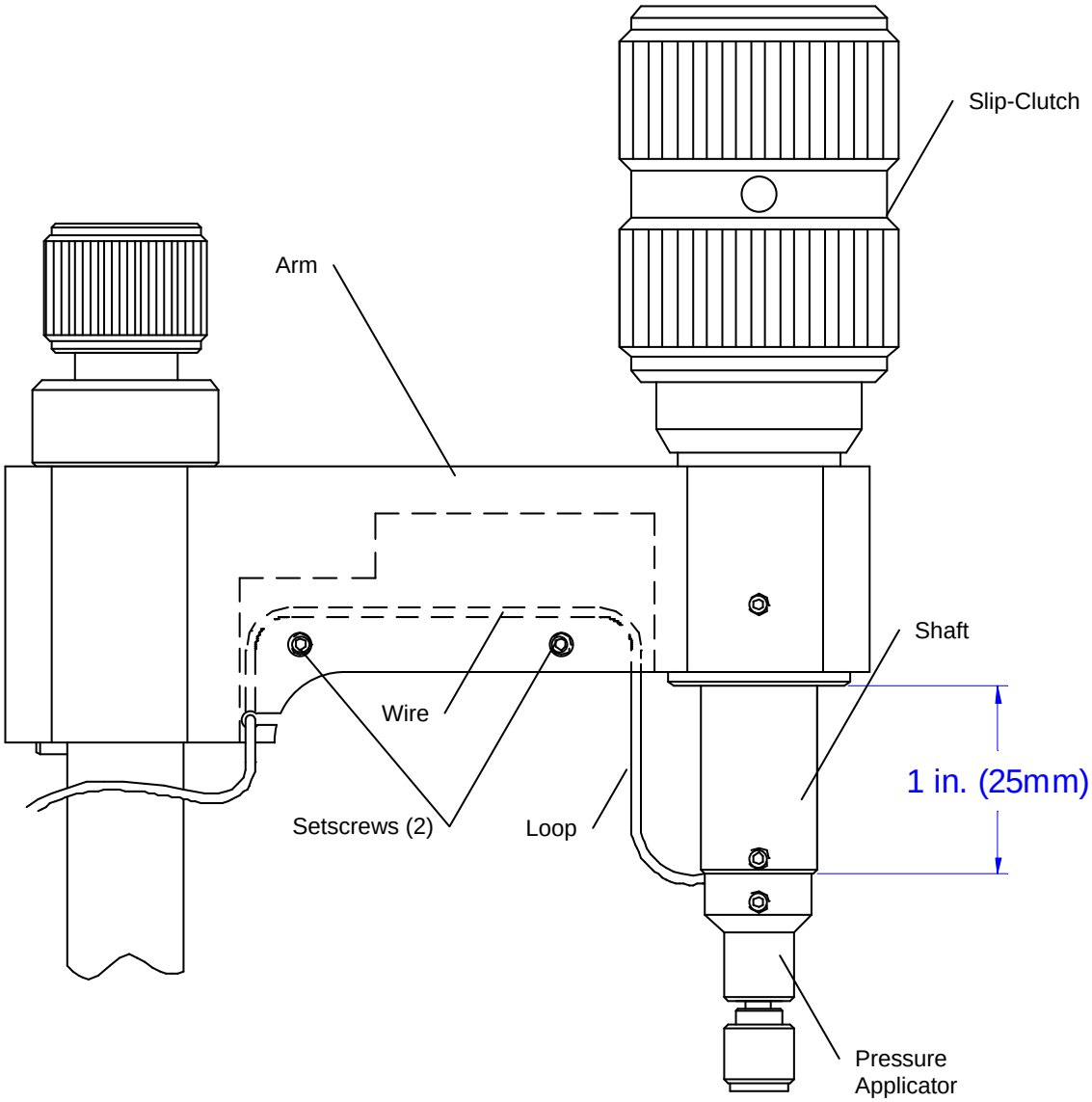


Figure 14 • Routing the wire

ANGULAR SCALE VIEWER FOR LARGE SAMPLES

The optional angular scale viewer facilitates reading the angular scale when large samples are installed on the VariGATR. To install this option:

- Orient the viewer as shown in Figure 15.
- Thread the screw into the hole in the center of the top plate at the front of the VariGATR (see Figure 16).
- Align the top surface of the viewer so it is parallel to the top surface of the plate.
- Hold the viewer in place and tighten the screw.
- When large samples are installed on the VariGATR, peek at the viewer to read the angular scale.

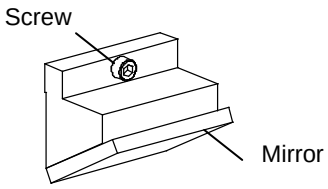


Figure 15 • The Angular Scale Viewer

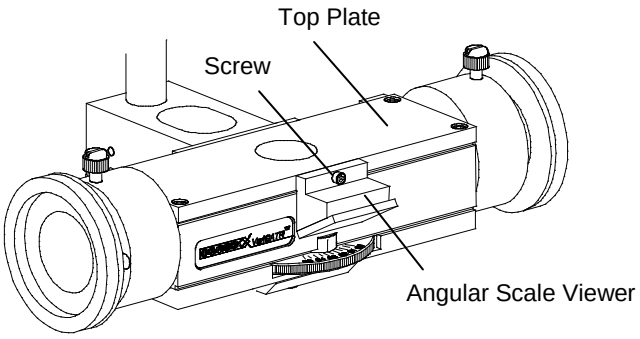


Figure 16 • The Angular Scale Viewer Installed on the VariGATR

POLARIZER

The optional wire grid polarizer comes mounted on a standard slide plate mount for use in transmission measurements and includes the appropriate purge collar adapters for the VariGATR. The polarizer should be installed on the incoming-beam side of the VariGATR as follows:

- Remove the VariGATR™ from the spectrometer if it has already been installed.
- Loosen the thumbscrew on the purge collar and slide out the purge sleeve.
- Unscrew the two purge collar screws on the purge collar with the supplied 3/32" ball driver (Figure 17).
- Remove the collar.
- Place the purge sleeves, collars and screws in a safe place.

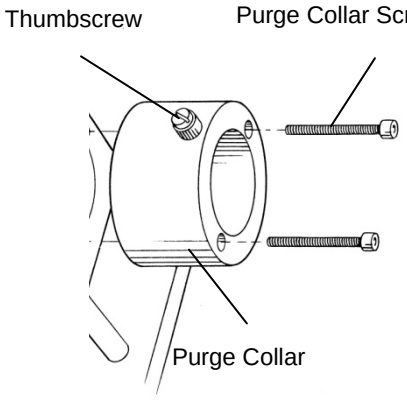


Figure 17 • Removing Purge Collars

To install the polarizer and its holder onto the VariGATR:

- Remove the two screws that secure the polarizer mount onto the slide plate to separate the two parts (Figure 18).

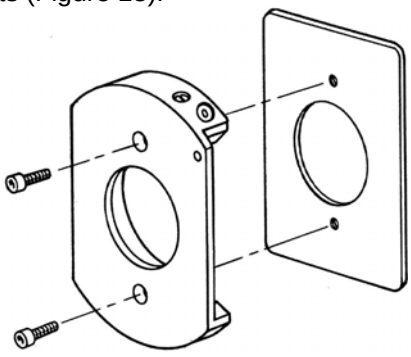


Figure 18 • Removing the Polarizer from the Slide Plate Mount.

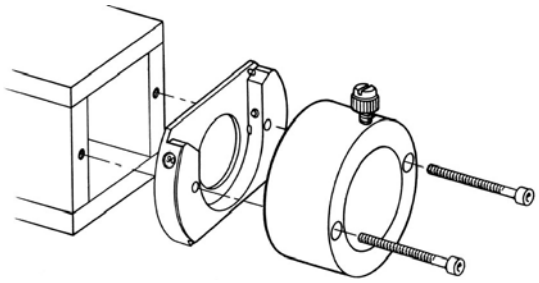


Figure 19 • Installing the Polarizer Mount.

- Using the same two screws, attach the polarizer mount to the side of the VariGATR (Figure 19).
- Attach the new purge collar to the polarizer mount, using the screws and purge collar supplied
- Slide in the new purge sleeve (if supplied).
- Grasp the polarizer by its handle and push it into the opening in the holder (Figure 20).

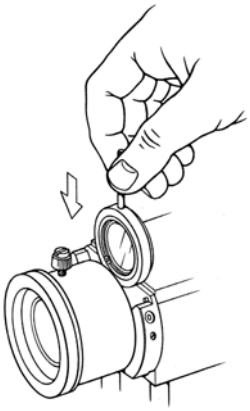


Figure 20 • Installing the Polarizer.

CAUTION:
Do not touch the polarizer optical element.

NOTES *For operation without the polarizer once its mount is installed, replace the polarizer with the supplied insert. When the polarizer is not installed, protect both sides of the optical element and store it in the supplied case.*

When the polarizer is mounted in its slide plate holder and set at 0, the transmitted electric field vector is in the horizontal plane. This provides p-polarization when the plane of incidence, which includes the incoming rays and the normal to the sample surface, is also horizontal.

To remove the polarizer holder for use elsewhere, just reverse the above procedure.

To maximize the performance of your accessory, it should be tested before first use and at regular intervals thereafter.

VERIFYING THE THROUGHPUT

- Make sure that the specified background spectrum is the previously collected open beam background spectrum.
- If the optional polarizer is installed, replace the polarizer with the insert.
- Collect a transmittance spectrum with the VariGATR™ in the sample compartment.

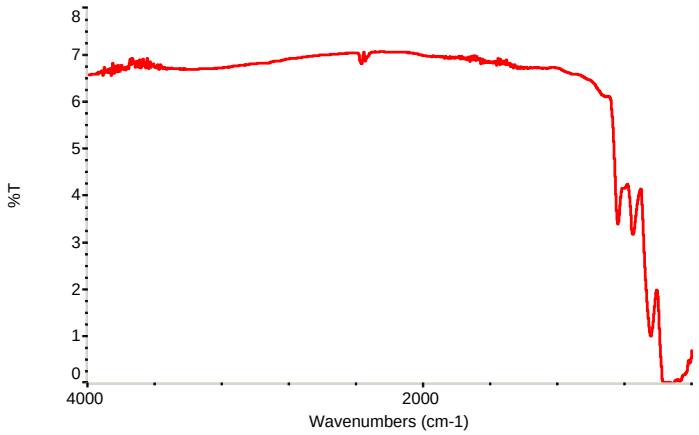


Figure 21 • VariGATR™ Throughput

- Read the maximum value at 2500 cm^{-1}.
- The VariGATR™ throughput at that wavenumber should be at least 4% (2% with polarizer) and the spectrum should resemble the VariGATR™ throughput spectrum shown in Figure 21.

NOTE: *For further VariGATR™ validation, see Appendix B.*

CLEANING THE CRYSTAL

The germanium crystal should be cleaned before each use.

> ***CAUTION*:**
> *The germanium crystal scratches easily and care needs to be taken when cleaning it.*

- To clean the crystal, wipe with a cotton swab or lens tissue dampened with low residue solvent. We recommend using methyl ethyl ketone, since it leaves virtually no residue on the crystal.
- The germanium crystal should be wiped off carefully using only soft cloths or swabs.

***NOTE*:** *The germanium crystal can be removed for a more thorough cleaning. For details on how to remove the crystal refer to the section on replacing the Ge ATR crystal (Appendix B).*

SETTING THE INCIDENT ANGLE

- Rotate the wheel to set the incident angle to the desired position (Figure 22).
- The same incident should be used for both the background and sample spectra.

***NOTE*:** *We recommend setting the incident angle for 60° initially. If dispersion is observed in the resulting spectrum, increase the incident angle. If no dispersion is observed and greater sensitivity is desired, decrease the incident angle.*

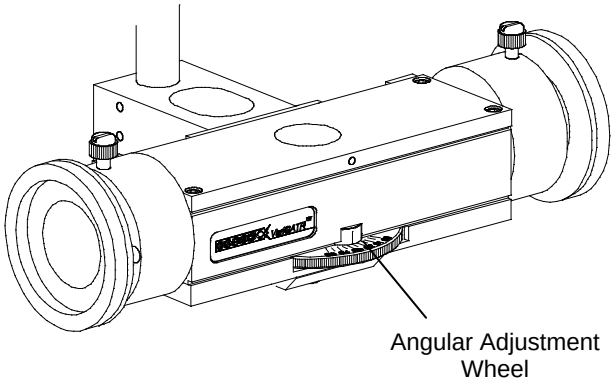


Figure 22 • Setting the Incident Angle

USING THE OPTIONAL POLARIZER

- Move the lever to set the polarizer for the desired polarization (Figure 23).
- The same polarization should be used for both the background and sample spectra.
- If high sensitivity is desired the polarizer should be set for p–polarization (polarizer lever moved to the “0” setting)

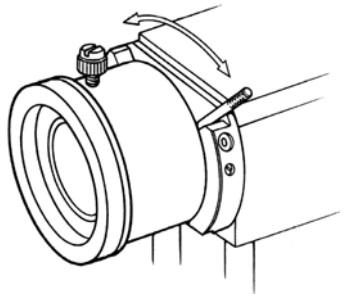


Figure 23 • Setting the Polarization

USING THE FORCE SENSOR

- Plug the power supply into the Display (see Figure 24).
- Plug the other end of the power supply into the power cord.
- Plug the power cord into an appropriate outlet.
- Allow the unit to warm up for 5 minutes.

***NOTES*:** *To use the force sensor, simply tighten the Slip-Clutch until the desired force is displayed in newtons. Apply up to 620N of force, as needed.*

The force sensor is slightly temperature sensitive and this may result in an offset of the zero of ±2N if the unit is not at thermal equilibrium.

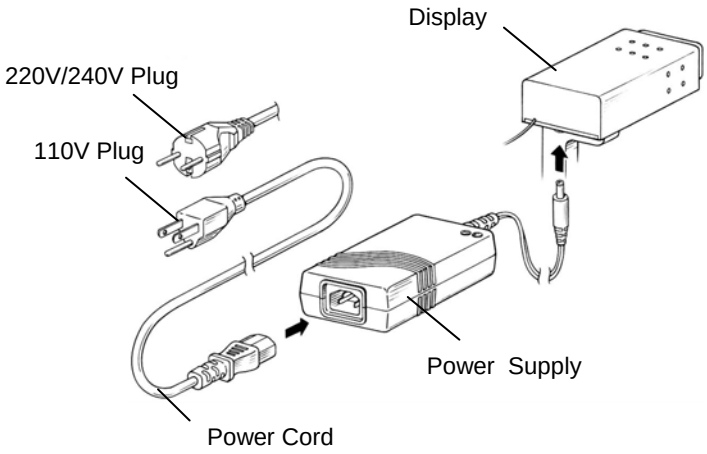


Figure 24 • Connecting the Force Sensor and Display

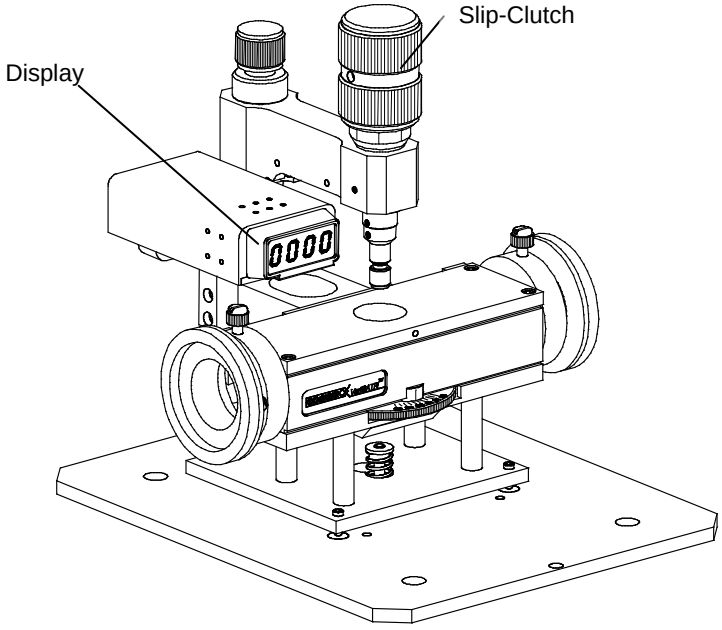


Figure 25 • VariGATR with Force Sensor and Display

EXAMINING LARGE SAMPLES

The VariGATR™ easily accommodates samples up to 6" in diameter. To easily view the incident angle during measurements of large samples, the optional angular scale viewer can be installed (see page 13).

The purge collars and polarizer can be removed to accommodate larger samples:

- Remove the VariGATR™ from the spectrometer if it has already been installed.
- Loosen the thumbscrew on the purge collar and slide out the purge sleeve.
- Unscrew the two purge collar screws on the purge collar with the supplied 3/32" ball driver (Figure 26).
- Remove the collar.
- Repeat the above procedure for the second purge collar.
- Place the purge sleeves, collars and screws in a safe place.

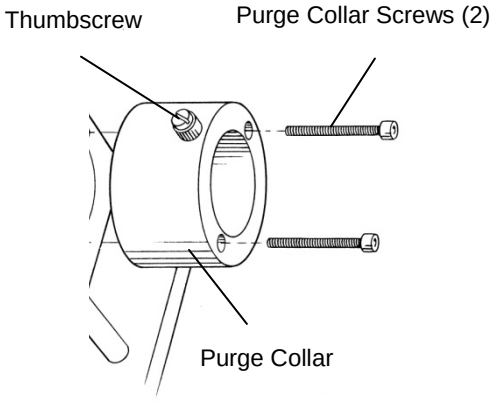


Figure 26 • Removing Purge Collars

BACKGROUND SPECTRUM

Collect the background single beam spectrum with the VariGATR™ in the sample compartment.

NOTE: *If the optional polarizer is used, be sure to set the polarlizer to the desired orientation prior to collecting the background spectrum.*

LOADING THE SAMPLE

- Retract the pressure head by turning the Slip-Clutch knob counterclockwise.
- Place the sample face down on the center of the ATR crystal.

CAUTION:
Place only highly polished samples on the crystal taking care not to slide the sample across the sampling surface. Examining hard, irregular samples with the VariGATR™ may damage the ATR crystal.

When examining wafer or disc fragments, be sure the sampling surface is free from flakes of the substrate. Flakes can scratch and/or pit the surface of the germanium crystal.

APPLYING PRESSURE

- Turn the Slip-Clutch clockwise until adequate pressure is applied (Figure 27). If using the optional force sensor, tighten the Slip-Clutch until the desired force is displayed in newtons. Apply up to 620N of force, as needed.

NOTES: *The pressure applicator can leave a residue on the back side of the sample. If sampling both sides, make sure the sample surface is clean prior to loading the sample.*

CAUTION:
The acquisition of ATR spectra requires intimate contact between the ATR crystal and the sample. The built-in Slip-Clutch is designed to prevent damage to the ATR crystal during analysis of flat samples.

Too much force on the sample can deform or otherwise alter the coating.

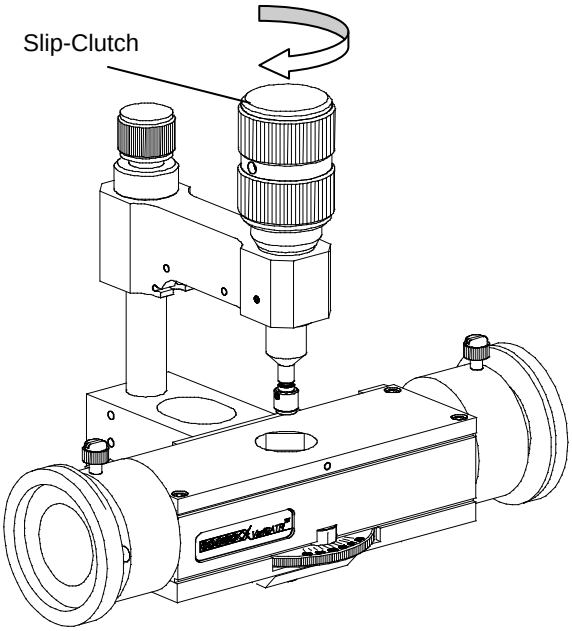


Figure 27 • Pressure Applicator Knob

SAMPLE SPECTRUM

- Record the sample spectrum.
- Loosen the Slip-Clutch.
- Remove the sample.

NOTE: *Flat samples that are smaller than the top of the crystal, like wafer and disc fragments, may stick to the crystal after the pressure applicator is removed. This is a sign that good contact was achieved. To remove the sample, use a toothpick to slide the sample off the edge of the crystal.*

- Clean the crystal prior to running the next sample.

NOTE: *Make sure the sample is free of dust. The presence of dust prevents intimate contact between the sample and the crystal.*

LIQUIDS AND PASTES

The VariGATR™ is specifically optimized to analyze thin films on silicon or metal substrates. If needed it can be used as a regular single reflection ATR accessory (with a short effective pathlength and penetration depth) to analyze liquids, pastes, soft powders and solids that can safely be compressed without damaging the Ge ATR crystal.

Because of the short effective pathlength, the absorbance levels are much lower than with conventional single reflection ATR. Accessories such as the FastIR™ are more suitable for analyzing liquids, pastes and powders.

- Place a small amount (about the size of the diameter of the pressure pad) of the sample on the center of the crystal.
- For liquid and paste analysis, no pressure is needed.
- Record the sample spectrum.
- Wipe the sample off the crystal with a soft cloth.
- Clean the crystal.

POWDERS

- Place a small amount (about the size of the diameter of the pressure pad) of the sample on the center of the crystal.
- Cover the sample with a clean microscope slide to keep the powder from getting onto the pressure pad.
- Turn the Slip-Clutch counter-clockwise to apply pressure.
- Record the sample spectrum.
- Loosen the Slip-Clutch.
- Carefully remove the microscope slide.
- Wipe the sample off the crystal with a soft cloth.
- Clean the crystal.

VariGATR™ VALIDATION

For applications requiring higher photometric accuracy, a validation procedure on a specific liquid sample is recommended. An example, using water, is shown here (Figure 28).

- Collect a background spectrum with the VariGATR™ in the sample compartment.
- Place a few drops of a liquid sample to cover most of the Ge crystal.
- Collect a sample spectrum.
- Convert the spectrum into absorbance.

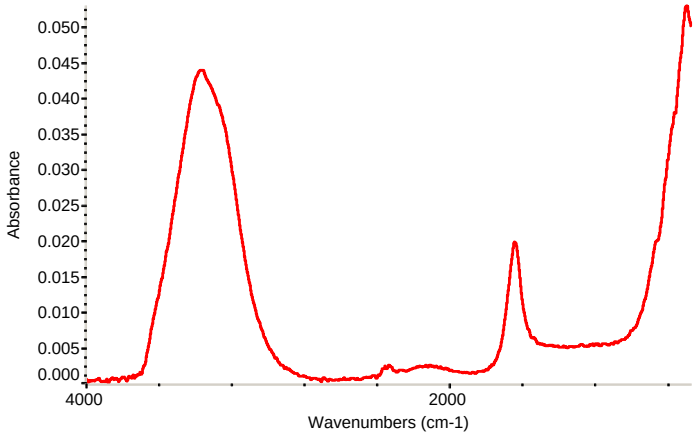


Figure 28 • Absorbance of Water at a 65° Incident Angle

- Choose two peaks at different ends of the spectrum. Write down the wavenumbers and absorbance values at these peaks. For example, if water is used as the liquid sample (Figure 28) the absorption peaks at 3360 cm^{-1} and 1650 cm^{-1} should be within 10% of 0.043 and 0.020 respectively.
- Every time thereafter the validation procedure is performed, the data should be within the noise level of those recorded the first time. On the next page a table is provided to record these values.

LIQUID SAMPLE USED				
WAVENUMBERS (cm^{-1})				
ABSORBANCE VALUES				

REPLACING THE Ge ATR CRYSTAL

The Ge ATR crystal is bonded to the top plate of the VariGATR™. To replace the top plate assembly:

- Raise the pressure applicator as far up as it will go (Figure 29).
- Turn the locking nut counter-clockwise two turns to loosen the arm.
- Rotate the arm out of the way.
- Loosen the thumbscrews on the purge collars and remove the sleeves.
- Using the supplied 3/32" ball driver loosen the two purge collar screws on each purge collar to release the top plate.
- Unscrew the four screws on the top plate assembly with the 7/64" ball driver.

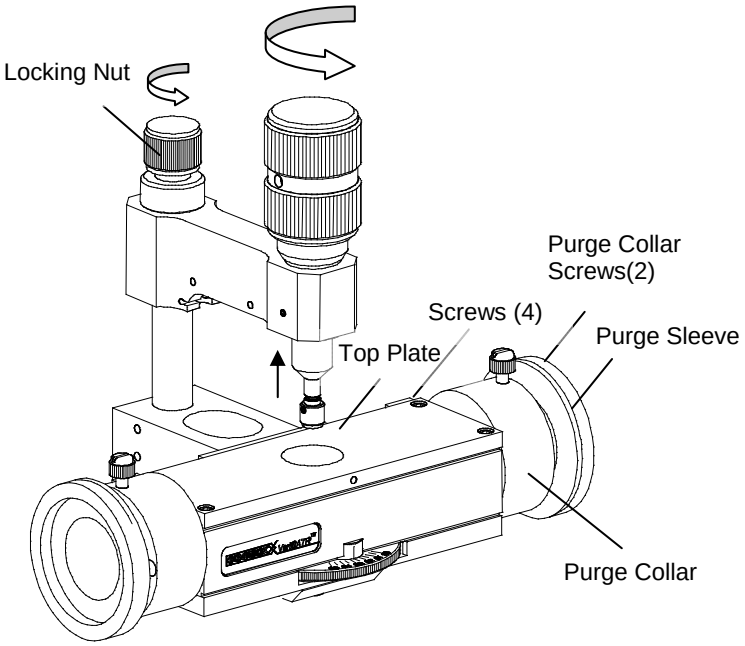


Figure 29 • Accessing the Top Plate

CAUTION:
The pressure applicator is directly above the crystal and care should be taken that the crystal does not touch the pressure applicator.

Be sure to either rest the flat portion of the ATR crystal on lens tissue or suspend it between two objects to prevent damaging the crystal when it is not mounted on the VariGATR™.

- Remove the top plate assembly by slightly raising it and then carefully bringing it out (Figure 30).
- To install the top plate assembly, reverse the above procedure.

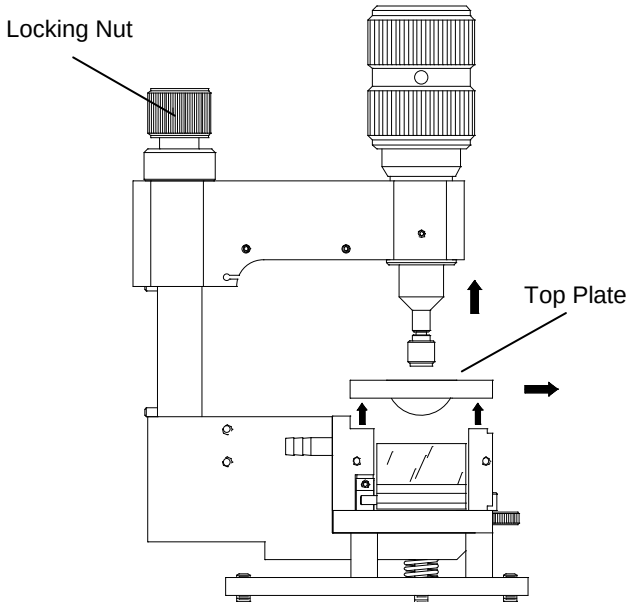


Figure 30 • Removing the Top Plate and the Ge ATR Crystal

REPLACING THE PRESSURE PAD

The bottom of the pressure head is lined with a pressure pad. This pad can be replaced as needed.

To replace the pressure pad:

- Protect the ATR crystal with a hard cardboard pad so it does not get damaged during the procedure.
- Raise the pressure applicator up as far as possible.
- Turn the locking nut counter-clockwise two turns to loosen the arm and rotate the arm out of the way (see Figure 30).
- While holding the pressure head, loosen the setscrew using a 0.050" hex driver enough to be able to slide the pressure head down off the pressure applicator (Figure 31).

CAUTION:
Take care not to drop the pressure head on the crystal.

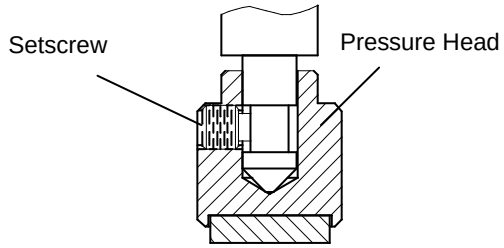


Figure 31 • Pressure Pad

- Remove the damaged pressure pad and if necessary clean the bottom of the pressure head with solvent (see Figure 32).
- Press in the new pressure pad. Note that it has a self adhesive backing.
- Reinstall the pressure head.
- Tighten the setscrew until it stops. Then unscrew it ¼ of a turn to allow free rotation of the pressure head.

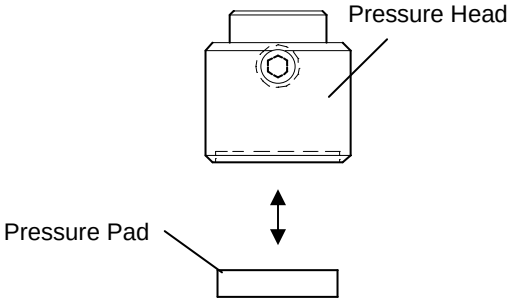


Figure 32 • Pressure Pad

OPTIONAL PARTS

Force Sensor with Digital Read-Out (USB2 compatible, 110V)	GAT-V1-FSD
Force Sensor with Digital Read-Out (USB2 compatible, 220/240V)	GAT-V2-FSD
Angular Scale Viewer for Large Samples	GAT-V-VMR
Polarizer (includes polarizer and mount)	PWD-GATR-XXX
Polarizer Mounting for the PWD Polarizer	PWC-GATR-XXX

REPLACEMENT PARTS

Mounted Ge ATR Crystal	GATR-ATR-J1
Set of Pressure Pads (5)	GATR-PAD



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