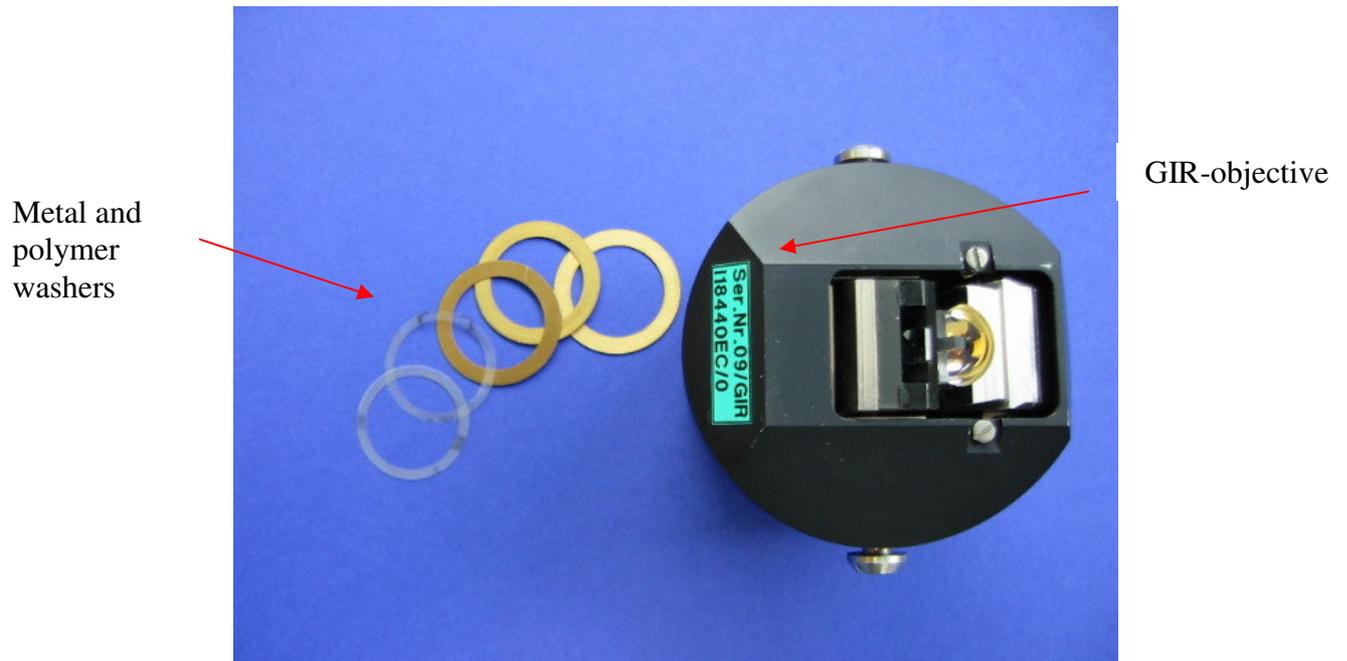


Operating instructions of the GIR-objective 15x

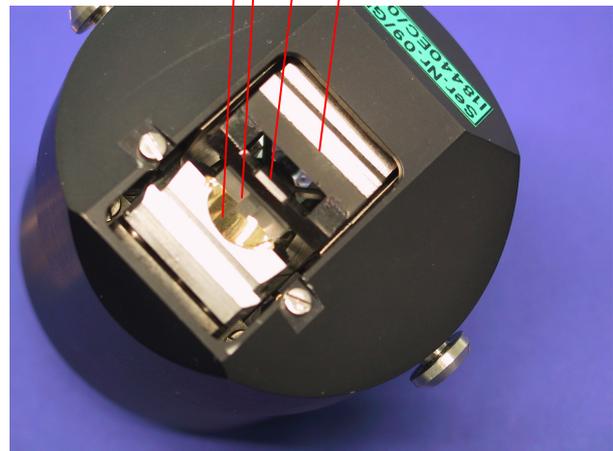
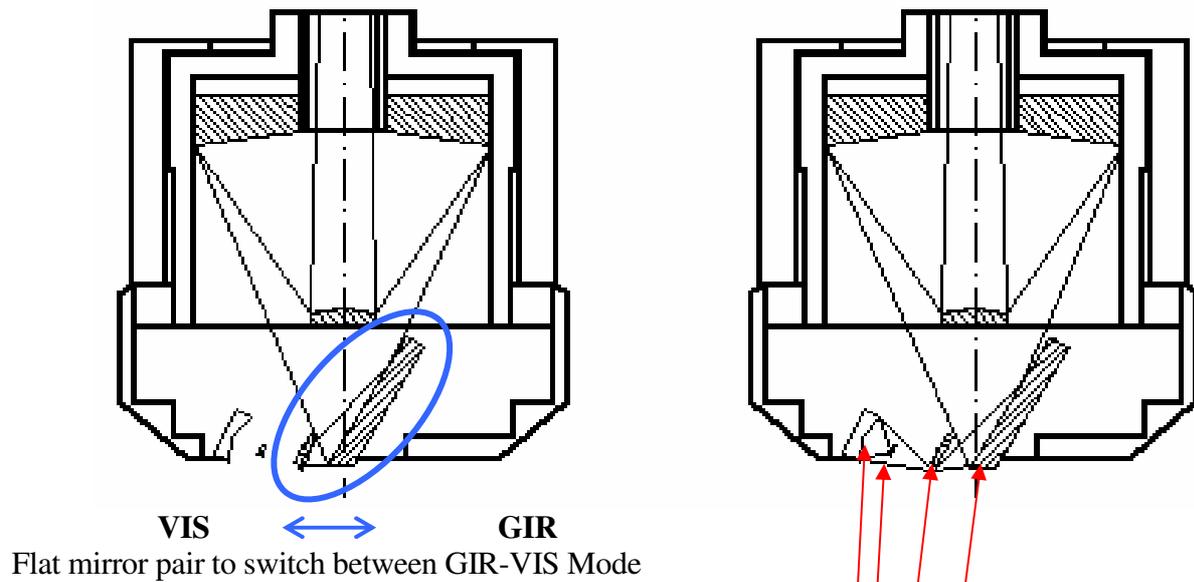
1. Packing list

- 1.1 15x GIR-objective
- 1.2 Metal and polymer washers
- 1.3 Gold mirror



2. Specifications of the GIR-objective:

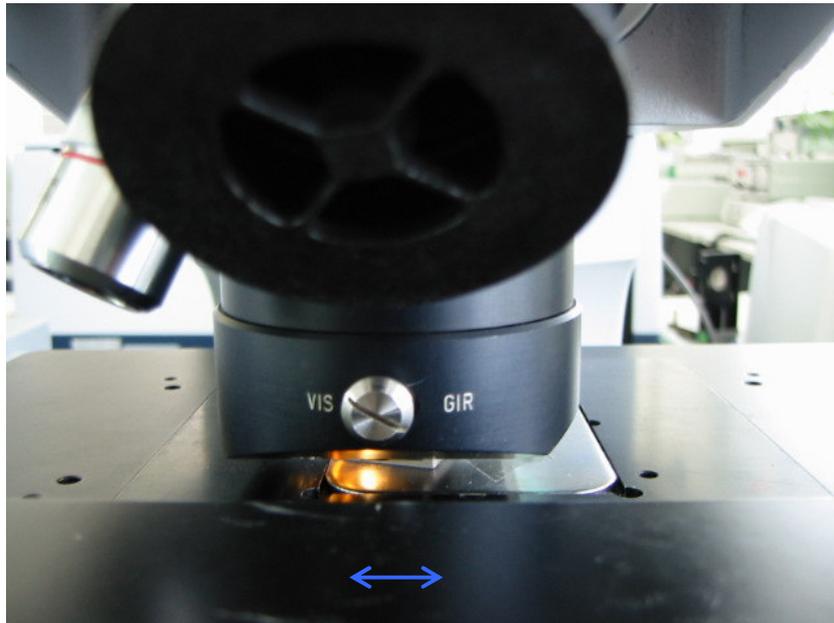
- 2.1.1 15x mirror objective
- 2.1.2 Working distance: 0.8 mm
- 2.1.3 Numerical aperture: 0.4
- 2.1.4 Beampath: see below



3. Installation :

The grazing angle objective has to be mounted opposite to the standard 15x objective. Correct orientation of the objective is important for both polarized light measurements and determination of the sampled area. The label VIS - GIR has to face exactly forward (as shown in the picture below).

To achieve the appropriate orientation at the objective turret metal and polymer washers have to be put in between the turret and the GIR-objective. It is not possible to define an accurate number of washers to achieve the right orientation. The user has to find out the optimal number of washers by trying various numbers of washers. The metal washer is formed from a composite of layers of thinner washers that can be separated to suit the required thickness. In addition to the metal washers there are two pairs of polymers washers: 10 μ m and 100 μ m that could help to optimize the orientation of the objective. Put these polymer washers in between metal washers.



Correct orientation : **Vis**  **GIR**

4. Operating instructions:

4.0 Theory:

The grazing angle objective has two operating modes, one for viewing of the sample , the other for measurement, shown in figure 1. In the viewing mode two parallel plane mirrors displace the focus of a standard 15× Schwarzschild objective. Because the only effect of these plane mirrors is to displace the focal point, the original image quality of the objective is unaffected. In the measurement mode the plane mirrors are moved to the GIR position, and the beam is deflected onto the sample surface at a high incidence angle. After reflecting from the surface the beam strikes a spherical mirror and is refocused on the same sample spot before passing back through the objective to the detector.

The use of this unique geometry has several advantages over other available designs. Because the beam is deviated, rather than masked, to obtain high angles of incidence the objective has very good throughput. Also, twice the absorption is obtained when compared with single reflection objectives, because the beam is reflected twice from the sample surface. The combination of these two factors gives excellent sensitivity. Lastly, because the plane of incidence is well defined it is possible to use polarized light. Light that is polarized perpendicular to the sample surface (p-polarized) has an enhanced absorption when large incidence angles are used, whereas light that is polarized parallel to the sample surface (s-polarized) shows little or no absorption.

Exclusion of the s-polarized light can thus provide a further boost to the sensitivity. Measurements using polarized light can also be used to measure the orientation of molecules on the surface.

4.1 Reference measurement

For the reference measurement a clean and highly reflecting substrate, either a gold mirror or another metal substrate has to be used. If an IR polarizer is applied pay attention not to change its position. The orientation has to be exactly the same with the reference and later with the sample measurement.

- 4.1.1 Switch the mirror pair of the GIR-Objective to the left position in VIS-mode.
- 4.1.2 Adjust the height of the x,y-stage of the microscope until the surface of the mirror is in focus. If the reference mirror is very new (without any scratches or imperfections) it may be difficult to find the focus. In this case it is helpful to move the stage at a corner of the mirror and to adjust the height of the stage using the sharp edge as focus point.
- 4.1.3 Switch the mirror pair of the GIR-Objective to the right in GIR mode.
- 4.1.4 If polarizers are available put them in. In most cases p-polarized light is used.

4.2 Sample measurement

- 4.2.1 For defining the measurement area in visual mode it is recommended to pull out the polarizer without changing the orientation of the light.
- 4.2.2 Put the sample beneath the GIR-Objective and switch the GIR-Objective to VIS mode.

5. Remarks

- 5.1 Sample Format:** the GIR objective is used for thin layers (e.g. impurities, monolayer structures) on highly reflecting substrates as metal and wafers. It cannot be used to study e.g. thin layers on paper because paper is not reflecting neither impurities in polymers.
- 5.2 Controlling of adjustment:** before starting the measurement make sure that the objective still is well aligned. To check the alignment take the gold mirror and focus in VIS-Mode of the GIR-Objective on a smaller insulated impurity spot. Move this spot in the crosshair (center) of the image!! Then switch the GIR-objective into the GIR-mode (measurement mode). As the angle of incidence is now about 83° the visual quality of the image of the spot is worse (it appears diffuse) but it should still be in the center. To express it in other words: there will be two images of the same spot in the measurement mode because light is reflected from the sample twice. The two images will be referred to as the primary image (from the first reflection) and the secondary image (from the second reflection, after the light has been reflected from the spherical mirror). Note that the secondary image is both inverted and mirrored relative to the primary image. For optimal performance, both images should be overlaid and should not be positioned very far from each other.
- 5.3 Polarizer:** For many measurements an IR Polarizer is recommended. To check the orientation of the polarized light an aluminum mirror can be used: the reference measurement has to be done with an gold mirror and for the sample measurement use an aluminum mirror. In p-polarized light there will be a broad band of the Aluminumoxide whereas in s-Polarization the 100% line should not show a strong absorption peak
- 5.4 Working distance:** as the working distance is only 0.8mm there is the risk to hit the mirrors of the GIR objective. Please pay attention.
- 5.5 Purge:** it is advisable to increase the purge for GIR-measurements to avoid water vapour peaks.

5.6 Number of scans: as the signal intensities are very often very small it is recommended to use a high number of scans e.g. 500 or 1000scans.

5.7 Apertures: for smaller measurement areas apertures have to be applied. As the incidence angle is about 83° the shape of the beam is elliptic (see scheme below). Therefore the measurement area is bigger than the size of the apertures. For the reference and the sample measurement the aperture size has to be the same.

IMAGE SIZE, PARALLEL TO INCIDENCE PLANE

