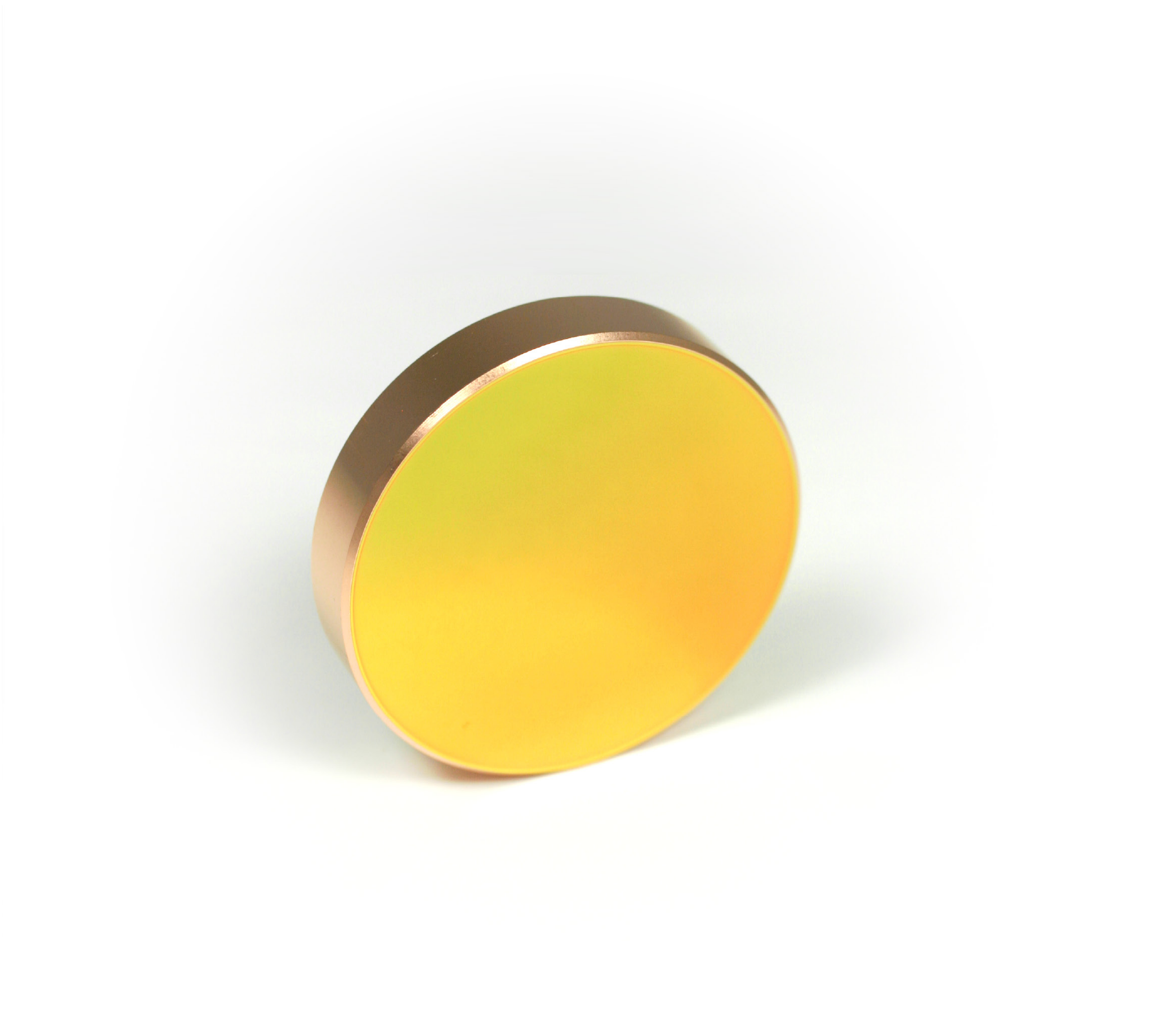
Optics

ATFR MIRRORS

The Absorbing Thin-Film Reflector (ATFR) incorporates a polarization sensitive thinfilm reflective coating on a Cu substrate. This coating is designed for use at 10.6µm and 45° angle of incidence. The coating will reflect S-polarization and absorb P-polarization; therefore, it must be placed in the beam delivery system where the incident beam is S-polarized.



COHERENT

Purpose

In cutting applications where the workpiece is highly reflective, reflections from the workpiece can be transmitted back through the beam delivery system into the laser cavity. This is most likely to occur during the initial stages of the cut. These back reflections can cause laser cavity mode and power instabilities. It is also possible for the returned beam to be amplified in the laser cavity and then focused on one of the beam delivery optics, causing damage to that optic.

Principle of Operation

Use of the ATFR in cutting highly reflective metals, such as copper, brass, or aluminum, is especially important since these materials are highly reflective for 10.6µm laser energy. CO_2 lasers produce a linear polarized laser beam. The beam delivery systems used for cutting applications convert the linear polarization to circular polarization by means of reflective phase retarders (RPR). In this type of beam delivery system, reflected energy from the workpiece is converted back to linear polarization by the RPR. The plane of the reflected linear polarization is 90° to the outgoing linear polarized laser beam. If one of the mirrors in the beam delivery system is oriented so that the outgoing laser beam is S-polarized, then the reflected energy must be P-polarized at this mirror.
The property of the ATFR that makes it an ideal mirror for preventing unwanted reflections from reaching the laser cavity is its absorption of the reflected P-polarized laser beam.

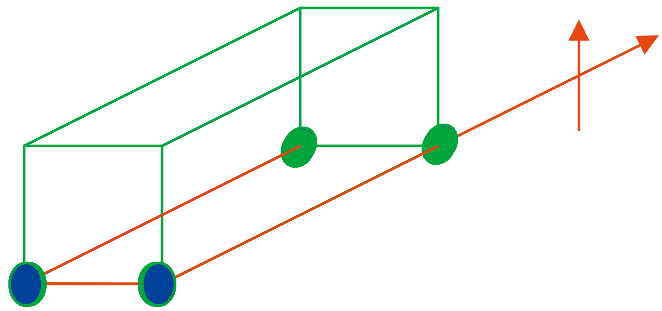
Terms and Definitions

Before discussing how to use the mirror and where to locate it in the beam delivery system, a few terms need to be defined. It is most convenient to discuss polarization in relation to some reference point. For our discussion, we will say that plane polarization is either vertical, horizontal, or oriented at 45° to a vertical plane. When a plane polarized beam strikes a mirror surface, it can be referred to as S-polarized, P-polarized, or plane polarized at 45° to the plane of reflection. Hereafter, we will call this last polarization 45° plane polarized.
Circular polarization does not have a particular plane of orientation. And, when circular polarization strikes a mirror surface, it is referred to as circular polarization.

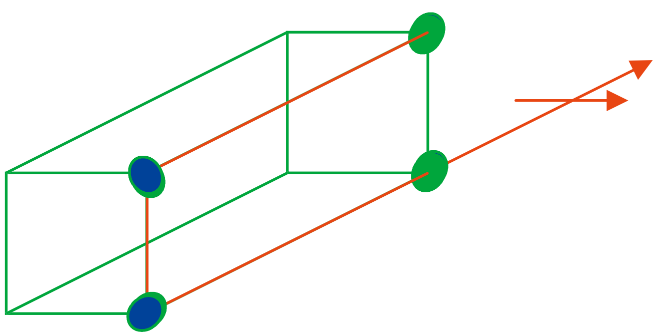
How to Use

The only requirements for using an ATFR mirror are: (1) the outgoing polarization that strikes the mirror must be S-polarization and (2) the beam delivery system contains an RPR that converts the linear outgoing polarization to circular polarization. The RPR must be located downstream from the ATFR going in the direction of the laser beam toward the work surface.
When deciding where to locate the mirror, output polarization for the laser must first be determined–i.e., is it vertical, horizontal, or 45° plane polarized? If unsure what type of polarization the laser produces, the best source of this information would be the laser manufacturer. The following are some examples of laser types and their output polarizations.

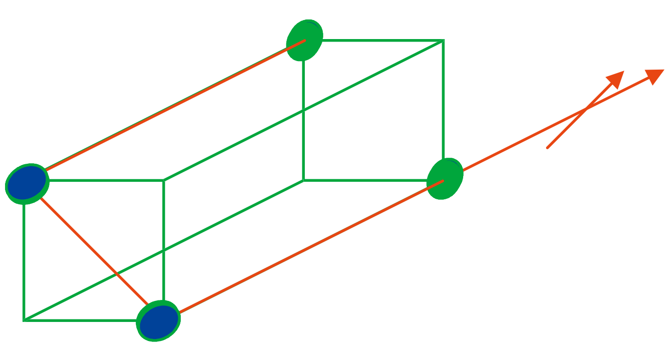
Folded cavity with the folds oriented horizontally produces vertical polarization. These lasers are longitudinal flow lasers.



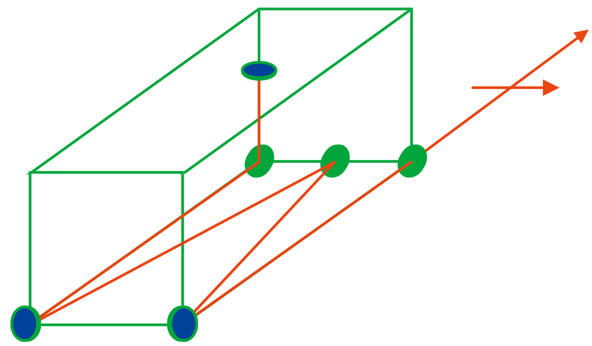
Folded cavity with the folds oriented vertically produces horizontal polarization. These lasers are longitudinal flow lasers.



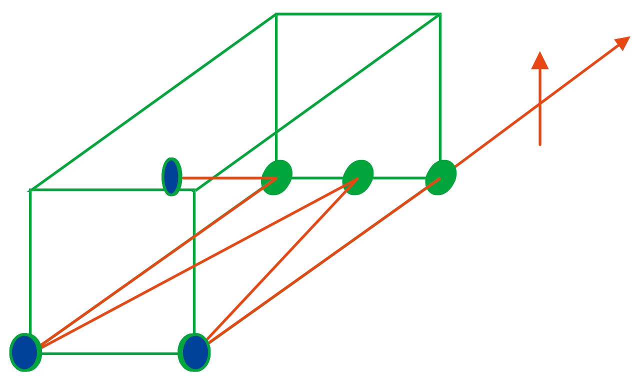
Folded cavity with the folds oriented at 45° to the vertical produces 45° plane polarization. These lasers are longitudinal flow lasers.



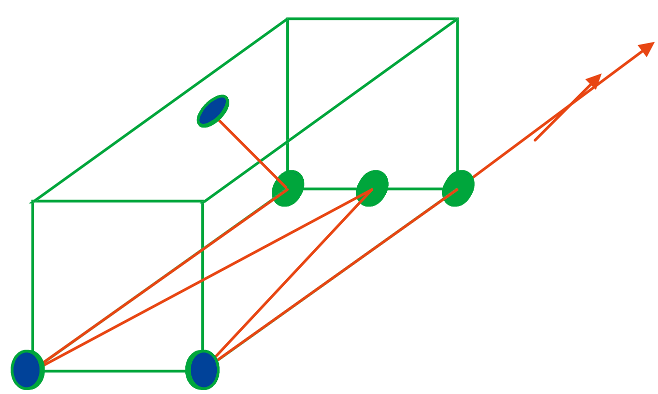
Transverse flow with 90° beam mirror assembly at rear of laser cavity. The 90° assembly is oriented vertically. This laser produces horizontal polarization.



Transverse flow with 90° beam mirror assembly at rear of laser cavity. The 90° assembly is oriented horizontally. This laser produces vertical polarization.

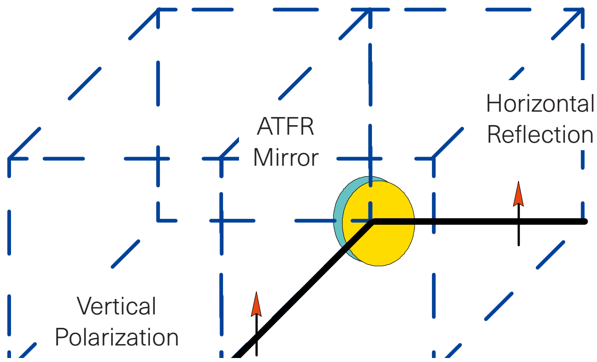


Transverse flow with 90° beam mirror assembly at rear of laser cavity. The 90° assembly is oriented 45° to the vertical plane. This laser produces 45° plane polarization.

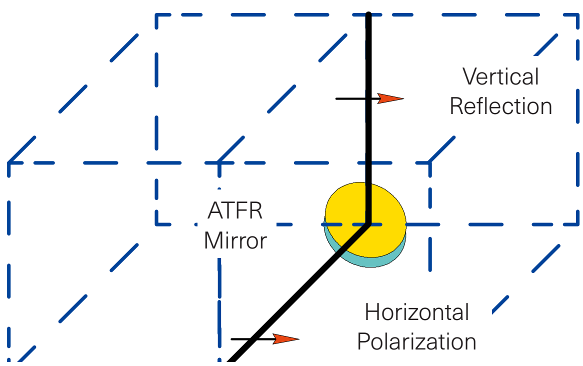


The next step is to locate the RPR mirror. If the system does not use an RPR mirror, then one must be installed before installing the ATFR mirror in the beam delivery system. Note: The RPR mirror must be installed downstream from the ATFR mirror. Quite often, the RPR is located as the last bend mirror before the focusing lens, although it could be located anywhere along the beam delivery path. Again, if you are unsure if and where the RPR mirror is located, then contact the system manufacturer.

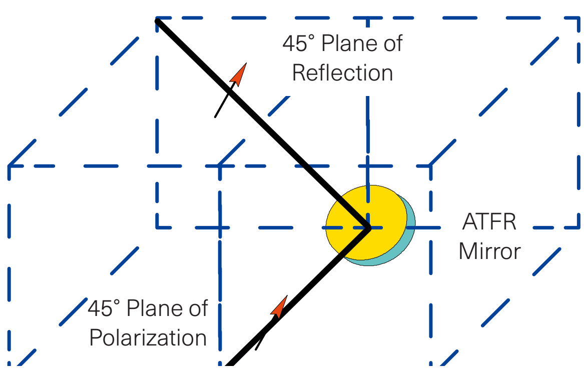
The ATFR must be located between the output coupler of the laser cavity and the RPR located at some point downstream from the laser head. If the laser output polarization is known, a decision can be made on where to place the mirror. Since the ATFR reflects outgoing S-polarization, it must be oriented as shown in the figure below. This figure assumes that the outgoing laser beam is vertically polarized. Note that the mirror reflects the beam in a horizontal plane, which could be left or right.



If the laser produces horizontal polarization, then the ATFR mirror would reflect the beam in a vertical plane, which could be up or down.



Finally, for the more difficult case of 45° plane polarization, the ATFR mirror must be oriented to reflect the beam upwards or downwards at an angle of 45° to the vertical.



Again, the mirror must be positioned to reflect the outgoing S-polarized beam. This is easily accomplished if there is a mirror in the system that is oriented for Spolarization. If there is such a mirror, then the ATFR mirror can be used in place of this mirror, and no other modifications are needed to the beam delivery system.

Figure 1 is an example of a laser system where the first mirror has been replaced with an ATFR mirror. In this example, the laser produces horizontal polarization, so the ATFR is positioned to reflect the beam in a vertical direction. This system could use a 2- or 4- mirror module incorporating an RPR to convert the linear polarization to circular polarization.

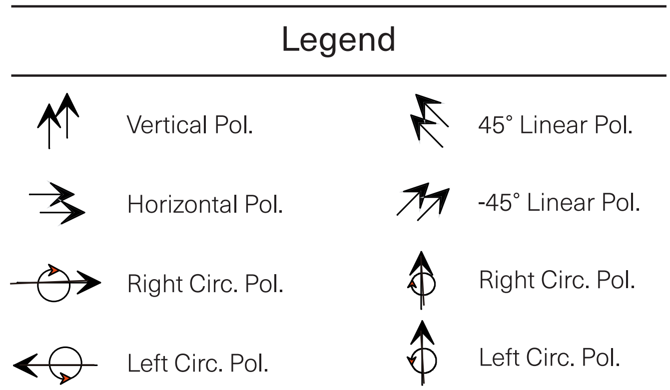
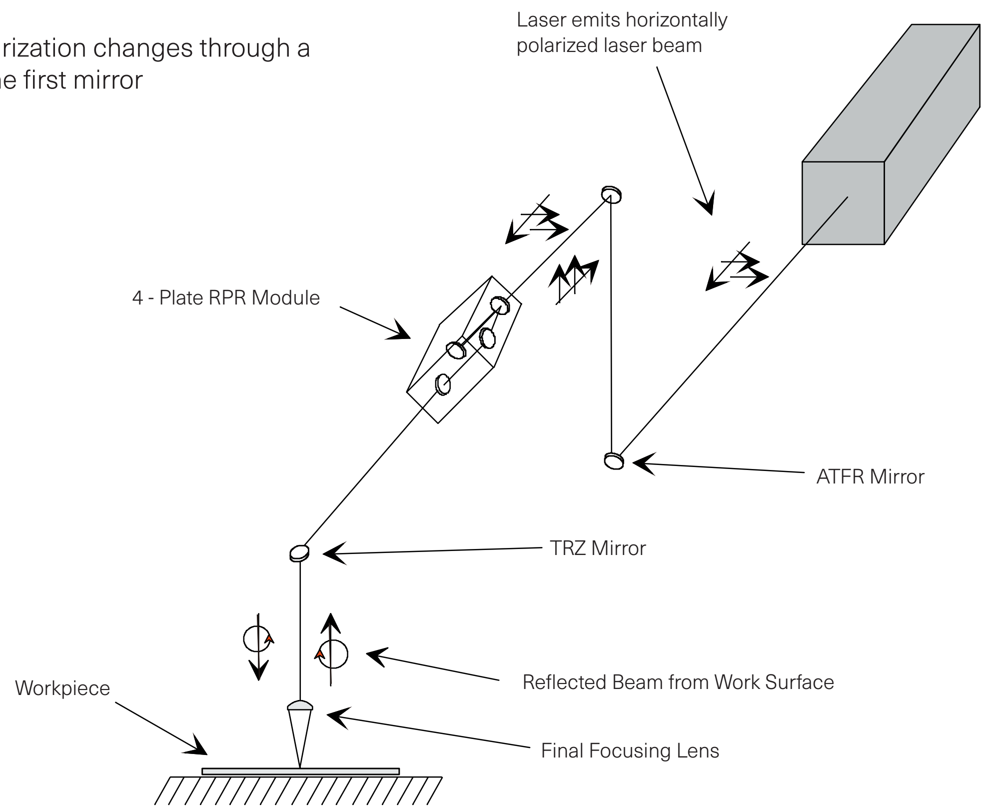
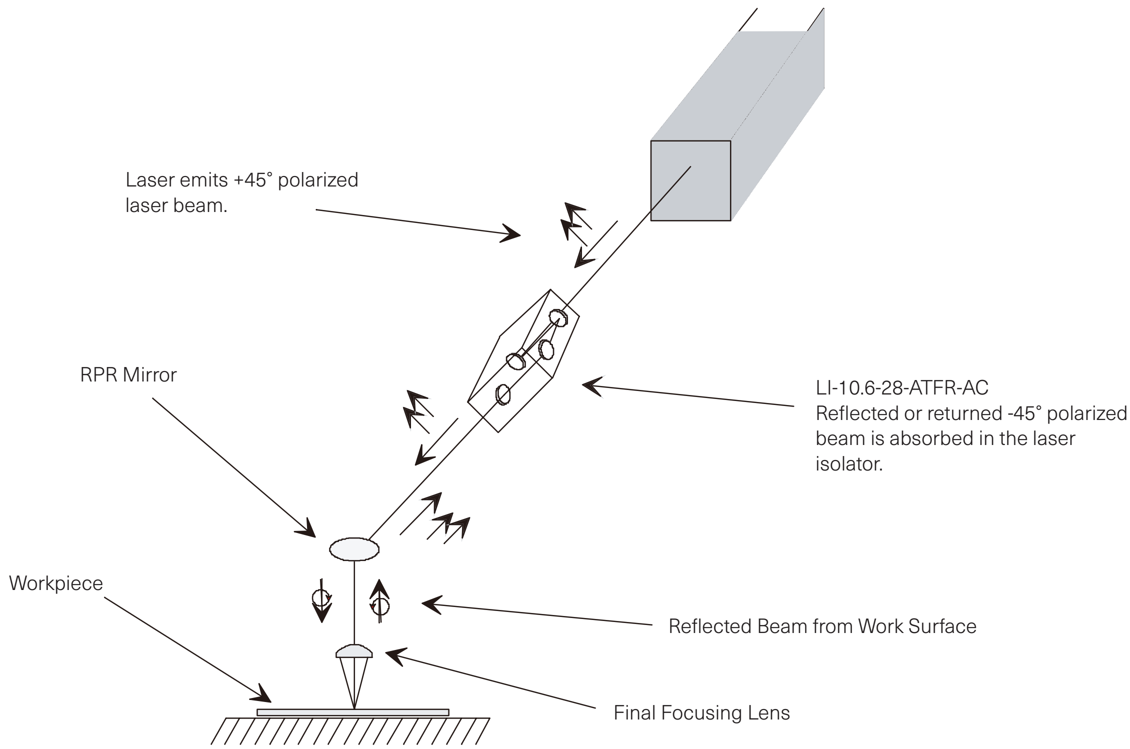


Figure 1.
Application of Laser Isolator - Polarization changes through a system using an ATFR Mirror as the first mirror



Some laser systems do not have mirrors oriented to reflect S-polarization in the beam delivery systems. In some of these systems, adding another mirror is not convenient since it causes the beam to be reflected at an odd angle or in an undesirable direction. In these cases, it may be easiest to add a 4-plate mirror module (laser isolator) that will not change the direction of the laser beam. An example of this scheme is shown in Figure 2. In this example, the laser produces plane polarization, and the 4-mirror module containing the ATFR mirror is mounted at a 45° angle to the vertical. This ensures that the ATFR mirror reflects S-polarization.

Figure 2.
Application of Laser Isolator - Polarization changes through a system using a model LI-10.6-28-ATFR-AC



Some other examples are shown in Figures 3 through 5.
Caution: If the ATFR is not installed correctly, the mirror could be damaged or destroyed. If the ATFR is installed downstream from the RPR, the mirror will absorb 50 percent of the laser power; this may cause the coating to be destroyed. If the ATFR is installed in a location where the ATFR reflects the incoming beam as P-polarization, 100 percent of the beam would be absorbed. If the ATFR is placed in a beam delivery system which has a laser that produces 45° linear polarization and the ATFR reflects the beam left or right or up or down, the ATFR will absorb 50 percent of the beam. If there is a doubt about the correct location for the ATFR, please contact one of our application engineers for assistance.

Figure 3.
Application of Laser Isolator - Polarization changes through a system using an ATFR Mirror as the first mirror

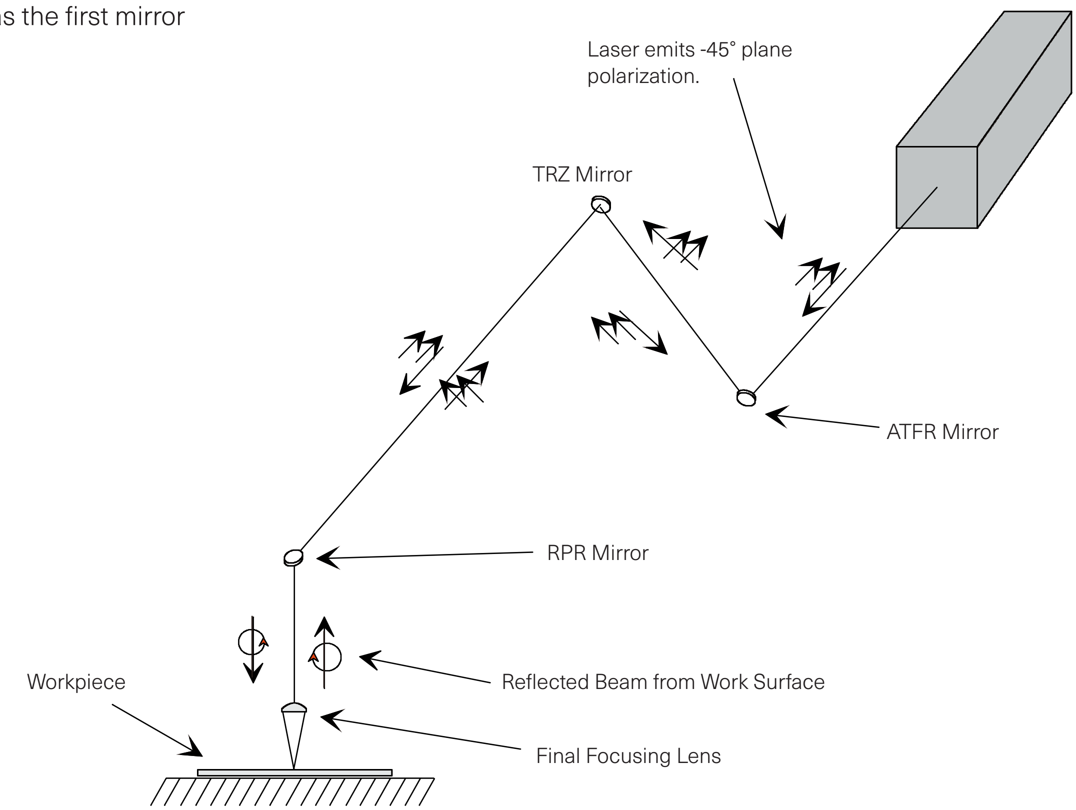


Figure 4.
Polarization changes through a system using a model LI-10.6-28-ATFR-AC

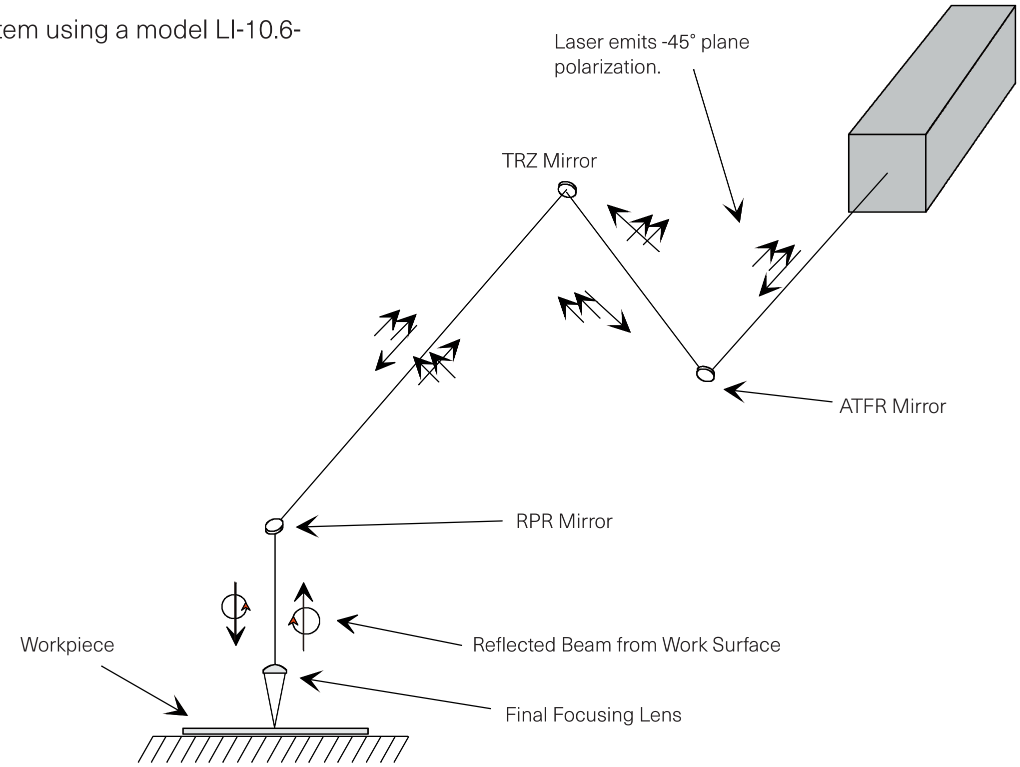
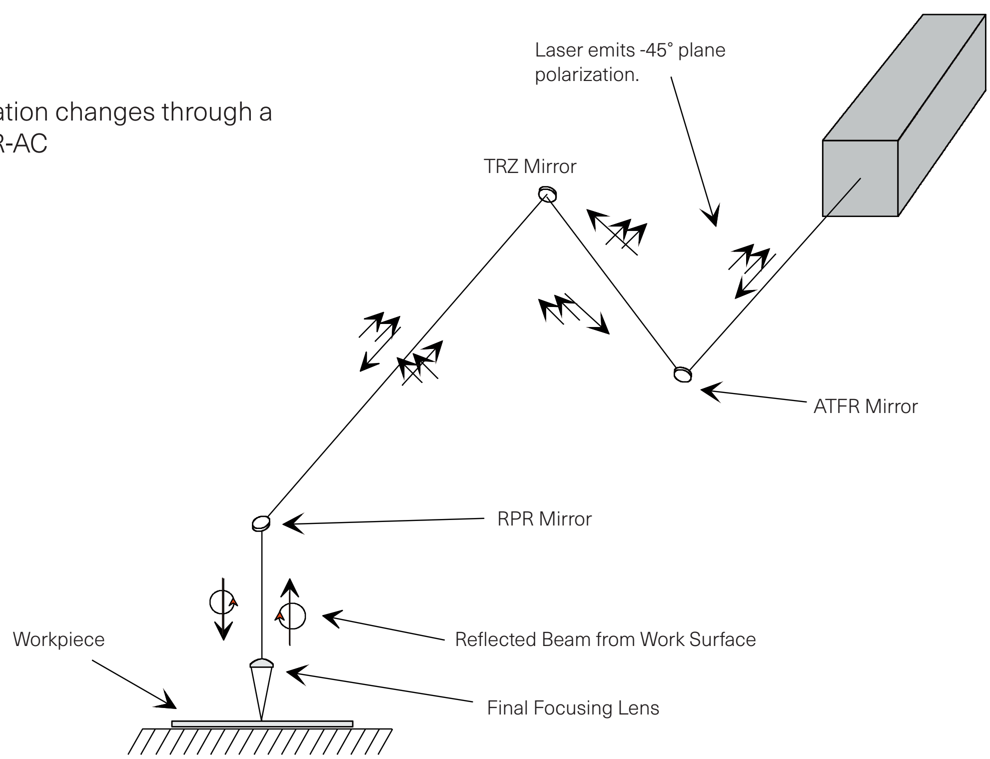


Figure 5.
Application of Laser Isolator - Polarization changes through a system using a model LI-10.6-28-ATFR-AC



© 2022 Coherent Corp.
Legal notices : coherent.com/legal

sales@coherent.com
www.coherent.com