2. System Description

2.1 Principle

A randomly polarized beam becomes linearly polarized after passing through a polarizer and it then becomes elliptically polarized after passing a quarter-wave plate. If this beam is projected onto the surface of a film sample under test, the polarization status of the beam is altered when the incident beam is reflected from the sample. Some specific parameters of the film under test can be derived from the detection of the variation in light polarization status.

2.2 System Structure

The system consists of three main parts: light source, receiver and main unit, as seen in Figure 1.

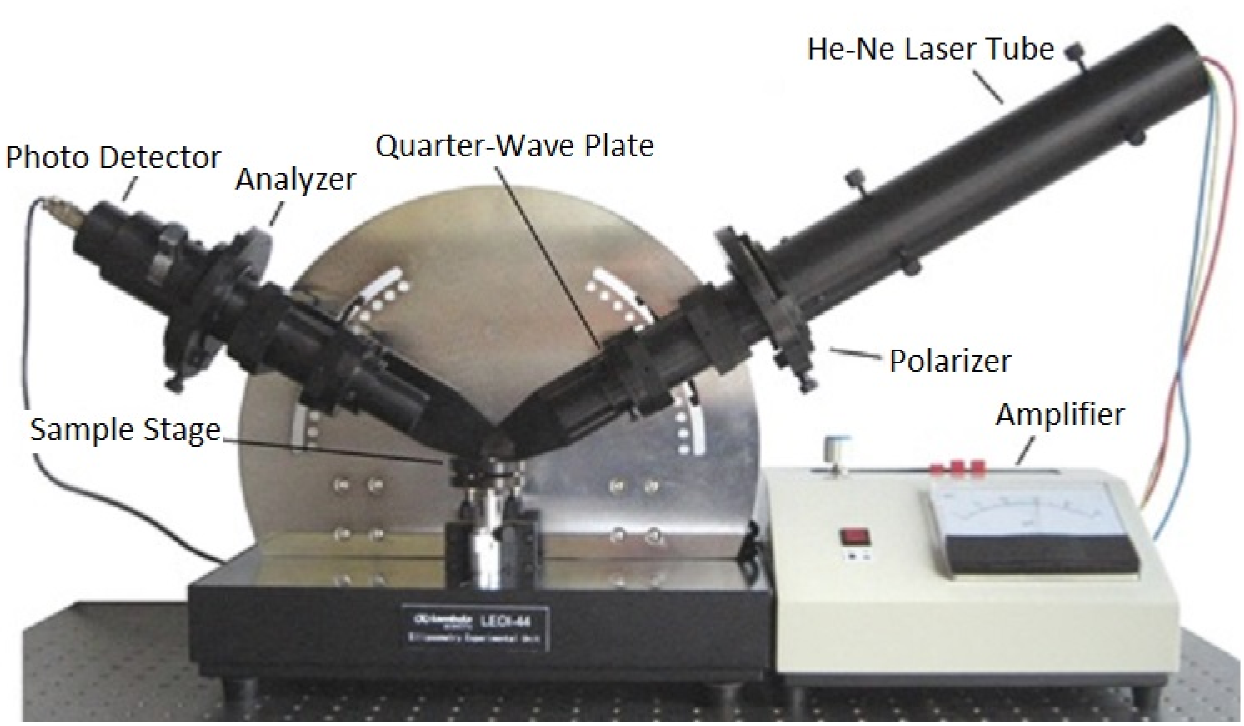

Figure 1 Illustration of system structure

(1) Light source: it is a He-Ne laser at 632.8 nm. The inside tube itself outputs a polarized beam. By placing a quarter-wave plate at proper angle, it becomes circularly polarized output. It features high intensity and excellent coherence.

(2) Main unit: consists of polarizer, quarter-wave plate, entrance tube, sample stage (height change through micrometer), exit tube, analyser, and detector. The detector transforms

optical signal to electrical signal. The signal is amplified and displayed by an analog meter.

(3) On the exit arm, there is a selection knob labelled with "Detector" and "Eyeballing" for detection or observation, respectively.

(4) To adjust the angle of the entrance arm or the exit arm, hold the arm and then pull out the corresponding white metal screw on the lock block at the back side of the vertical scale plate. Rotate to the desired angle and release the screw. Angle can be finely adjusted by using the two black screws on the two sides of the lock block.

3. System Setup (Please read Notes in Sec. 6 prior to setting-up**)**

1. Place system on a solid table. Remove surface dust using a soft brush or a silk cloth.

2. Remove the black protection covers of the entrance arm and the laser head, and mount the laser head onto the entrance arm. Connect the three wires from the laser tube to the three sockets on the back panel of the laser power supply, respectively. **Warning**: the red wire (with red plug) must be connected to the positive (white) socket, the blue wire (with black plug) connected to the negative (black) socket, and the yellow wire (with yellow plug) connected to the ground (yellow) socket.

3. Connect the photo detector with the amplifier using the 3-core cable. Plug the power cord of the amplifier.

4. Confirm all switches of current scale selection are released. Turn on the amplifier (also the laser).

5. Align optical path following these procedure:

(1) Place the test sample on the stage, illuminate the laser onto the sample.

(2) Adjust the height of the stage to let the reflected laser beam enter the diaphragm (i.e. the receiving aperture) so that the brightest spot is observed on the viewing window of the exit arm (set the selection knob to "Eyeballing").

(3) If no laser spot observed on the viewing window, carefully adjust the two tilt adjustment screws of the sample stage, at the same time adjust the height of the stage

to keep the reflected laser beam entering the receiving aperture. Till laser spot observed on the viewing window.

(4) Now, lock the sample stage firmly.

4. System Calibration

The system has been pre-calibrated at factory to meet the designed specifications. To check if the system is still in normal status, lay down both entrance and exit arms horizontally, turn on laser, observe the light spot on the viewing window, light extinction should occur when the polarizer is set at 45^{o} and the analyser is set at 135^{o}. If not, the system needs to be recalibrated. To recalibrate the system, the following steps can be taken:

(1) Lay down both entrance and exit arms, place the "Zero" line of the vernier to 90^{o} position of the main scale (on the back side of the scale plate). Check whether the laser beam passes through the aperture center. If not, adjust the six adjustment screws on the laser tube holder until the brightest spot is observed on the observation window.

In case the laser beam doesn't exit from the entrance arm or cannot enter the receiving aperture of the exit arm, take the following steps to resolve this problem:

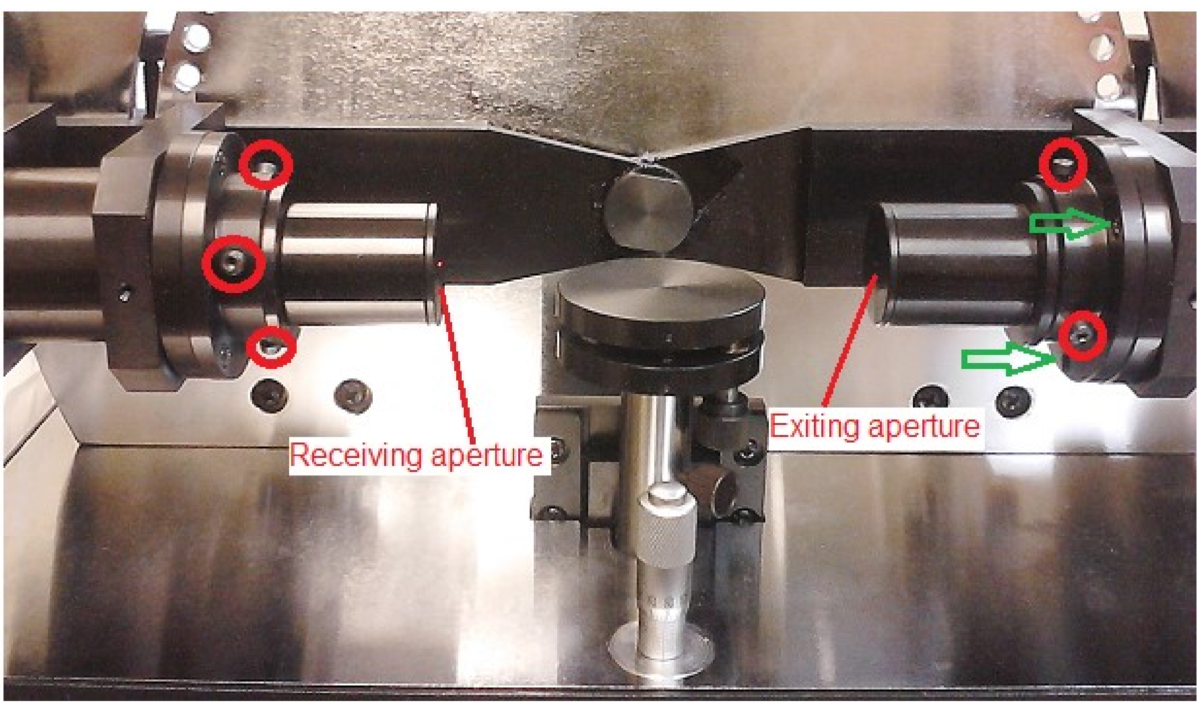

Figure 2 Photo of exit and receiving apertures

a) Refer to Figure 2, lay down both the entrance arm and the exit arm to let them in one line in horizontal direction (Note: check if the "Zero" line of the vernier is at 90^{o} position on the back side of the scale plate).

b) If the beam doesn't exit from the exiting aperture, firstly try to adjust the 6 adjustable screws on the laser tube.

c) If still can't get laser out, remove the flange of the exiting aperture by unscrewing the 3 Fillips screws (pointed with green arrows in Fig. 2), then adjust the 6 adjustable screws of the laser tube to bring the laser beam approximately in the centre of the entrance arm (may use a white paper to view).

d) If the laser beam doesn't enter the receiving aperture on the exit arm, remove the flange of the receiving aperture and then check if the beam spot presents on the viewing window. If not, finely adjust the 6 adjustable screws of the laser tube and at the same time keep the laser beam approximately in the centre of the exit arm, till beam spot presents on the viewing window.

e) Mount back the two flanges of exiting aperture and the receiving aperture, if no laser outputs from the exiting aperture, release the 3 screws (red circled in Fig. 2) using a 2.5 mm inner hexagon spanner wrench and carefully move around the released aperture tube head to let the laser beam exit from the aperture, then fix the 3 screws. Similarly, adjust the receiving aperture if the laser beam cannot enter the receiving aperture.

(2) Take down the flange of the exiting aperture (see step (1) – c)) to expose the quarter-wave plate (note: before doing that, make a mark on the flange edge near one of the three Fillips screws to remember its orientation, so it can be recovered to the same orientation when mounting back). Make a mark to remember the orientation of the wave plate and then remove the wave plate by releasing the two pressing screws. Place both the entrance and exit arms to 70^{o} position. Put a flat mirror on the stage, and adjust the stage to let the reflected beam enter the receiving aperture. Set the polarizer to 0^{o} and the analyser to 90^{o}, check if light extinction occurs. If not, rotate both the polarizer and the analyser back and forth carefully until the minimum optical signal is recorded on the detector. Write down the angle readings of the polarizer and analyser, which are the original system errors of the angle readings. They need to be subtracted in angle measurement in experiment.

(3) Lay down both the entrance and exit arms horizontally, put back the quarter-wave plate at its original orientation. Check if extinction occurs when the polarizer is at 45^o and the analyser at 135^o (note the original system error). If not, finely rotate the quarter-wave plate to achieve the minimum light signal with the polarizer at 45^o and the analyser at 135^o (still note the original system error) and fasten the wave plate. Finally, mount the flange of the exiting aperture back. Make sure the laser can output from the aperture, if not, finely adjust the exiting aperture following step (1) – e).