LaserEllips™ – *Polarization measurement of phase retardation*

Introduction

Most surfaces of optical components display isotropic polarizability. However, non-normal incidence may break the symmetry, resulting in polarization-dependent reflection and absorption. Special care is necessary when a beam transport system must deliver a well-defined polarization. As an example, consider the several 90 degrees reflections occurring in the beam guide of a laser cutting robot. To preserve the desired circular polarization, special designs of zero-phase reflectors must be employed. The verification of desired phase tolerance makes the development of polarization-measuring devices necessary.

Operation Principle

The overall design concept is shown in Figure 1. It consists of a laser source illuminating the sample under test, a rotating polarizer and detector.

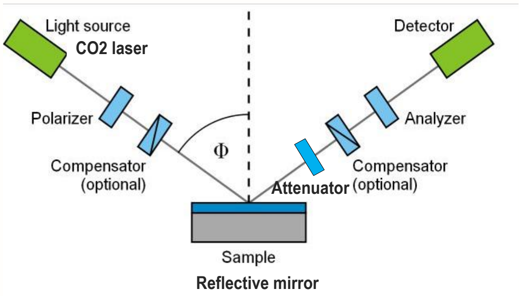

Figure 1. Principle of laser ellipsometry

The beam reflected from sample is transmitted through a polarizer. The measured power ratio $r_o = P_{min}/P_{max}$ and the power maximum occurring at a polarizer orientation a_o are recorded using a software. The phase retardance is related to the power ratio and polarizer orientation by the equations below. The phase retardance can be calculated from the measurement data using least square optimization.

$$r = \tan(0.5 \sin^{-1}(\sin(2\alpha) \sin(\delta)))$$

$$a = 0.5 \tan^{-1}(\tan(2\alpha) \cos(\delta))$$

The key specifications of the laser ellipsometry are listed below. To the best of our knowledge, there has yet to be any commercial products in the market fulfilling similar laser optics measurement purposes:

Laser power	10 W
Wavelength	1.064/10.6um
Power stability	<3%
Alignment	Visible beam
Resolution	<3 degrees
Sample	0 and 90 degrees phase retarder
Measurement SOP	Refer to the manual

Table 1. Key specifications of LaserEllips™

We illustrate the determination of polarization angles using the following measurement data. The periodic trace measures a linearly polarized laser beam since the power goes down to zero. For example, when the time of maximum power signal overlaps with the occurrence of the encoder signal peak in the bottom box, the orientation of the laser polarization electric field is known to coincide with the polarimeters' orientation.

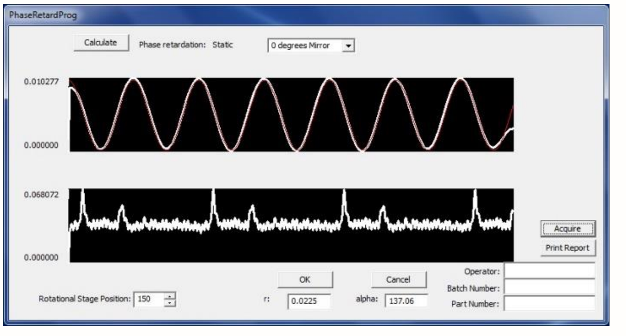

Figure 2. Layout of laser ellipsometry GUI

Applications

Within the visible regime, laser ellipsometry is commonly used for measurements of thickness and refractive index. The development of a phase retardance measurement system resulted in compact, accurate polarization instrumentation for near-infrared and mid-infrared laser beams. Applications with high-power industrial beams include the testing and adjustment of either ideal linearity or circularity of the polarization. Further applications include component testing and in general, infrared ellipsometry.

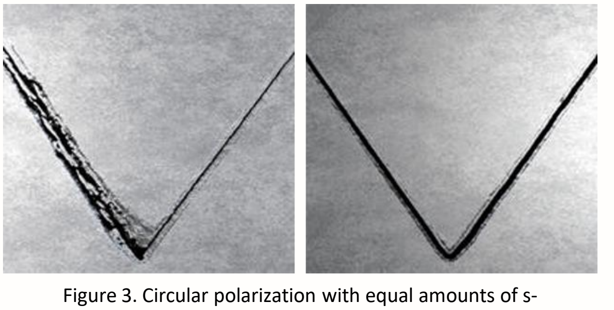

Figure 3. Circular polarization with equal amounts of s-polarization and p-polarization. The material is removed uniformly regardless of cutting direction.

Conclusion

As a global enterprise, leading photonics innovation since 2002, WOE has built up customization engineering capability for polarization optics characterization, precision instrumentation, data processing and software development.

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