Abstract Field based polarization measurement is essential to understand and quantify the optical response of any target sample. The method discussed here is digital holography microscopy that enables us to quantify spatially the Jones Matrix of a transparent anisotropic sample. Our method provides precise information about the polarization properties in a single shot, therefore, well suited for a dynamic biological specimen.

Introduction

Principle

The Jones Matrix formalism says that an input light field with $E_{ix}$ and $E_{iy}$ and the output field upon emerging from an object are related as

$$\begin{bmatrix} E_{ix} \\ E_{iy} \end{bmatrix} = \begin{bmatrix} J_{xx} & J_{xy} \\ J_{yx} & J_{yy} \end{bmatrix} \begin{bmatrix} E_{ix} \\ E_{iy} \end{bmatrix}$$

Where $J_{ij} = [U_{ij}] e^{i\Phi_{ij}}$ is the Jones matrix element and $\Phi$ is a phase with $i,j = x,y$.

For 45° degree polarized input light output field can be written as

$$\begin{bmatrix} E_{45x} \\ E_{45y} \end{bmatrix} = \begin{bmatrix} J_{xx} & J_{xy} \\ J_{yx} & J_{yy} \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = JE_{45}$$

(1)

Similarly for -45° degree polarized input light output field can be written as

$$\begin{bmatrix} E_{-45x} \\ E_{-45y} \end{bmatrix} = \begin{bmatrix} J_{xx} & J_{xy} \\ J_{yx} & J_{yy} \end{bmatrix} \begin{bmatrix} 1 \\ -1 \end{bmatrix} = JE_{-45}$$

(2)

These two output fields are then interfered with the two reference beams having different carrier frequency $R_x$ and $R_y$. Then the recorded multiplexed interference pattern can be written mathematically as

$$I = |JE_{45} + JE_{-45} + R_x + R_y|^2$$

The recorded interferogram is then analyzed using Fourier fringe analysis to achieve the complete Jones matrix information. Multiplex interference pattern and its Fourier transform are shown in Fig.1 (a) and (b) respectively.

Experimental Setup

![Fig.2. Experimental Setup : Single Shot Jones Matrix Microscopy](Image)

Experimental Results

(a) Recovered Jones Matrix for 0°
(b) Recovered Jones Matrix for 45°

Fig.3 (a) and (b) show the Jones Matrix of a Polarizer oriented at 0° and 45° respectively

Conclusion

![Single Shot Jones Matrix Microscopy](Image)

Biological, anisotropic or birefringence sample

Single Shot

References