Quantification of induced local stress birefringence due to elastic inhomogeneity with surface plasmon microscopy towards label free detection of dermatoheliosis

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Abstract

In this paper, we study the relationship of induced local stress birefringence with the spatial frequency response of focused surface plasmon of thin film samples as a result of inhomogeneous elasticity. The change in eccentricity of the absorption pattern at the back focal plane of the microscope is a label free quantifier of local induced stress birefringence in the sample.

Introduction

Anisotropic thin film probed [1] by focused surface plasmon (FSP) (probe size: 180nm) revealed elliptical absorption pattern at the exit pupil plane of the focusing lens as shown in Fig. 1. In the present case, thin film samples were subjected to stress resulting in inhomogeneous elasticity and its effect on birefringence was studied from the response of the FSP towards evaluation of mechanobiological activity under certain conditions, such as UV irradiation on human dermal fibroblast (HDF) cells.

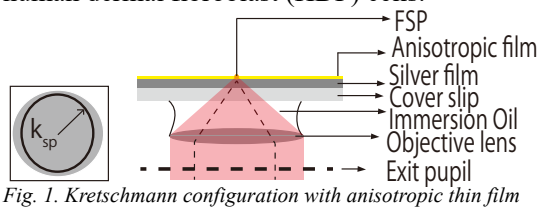

Fig. 1. Kretschmann configuration with anisotropic thin film

Effect of local stress birefringence at exit pupil

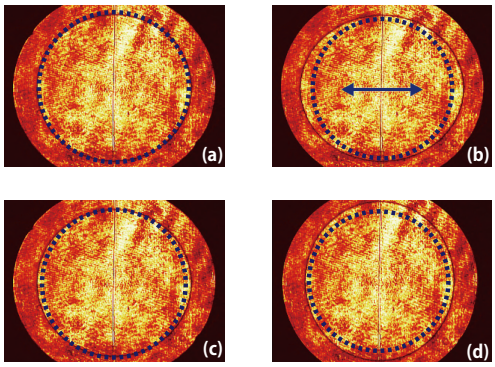

Fig. 2. Exit pupil when cellophane film was (a) not stretched, (b) stretched, (c) subjected to temperature of 60ºC and (d) exposed to UV irradiation for 24 hours. The dotted pattern is for reference to the eye for the change in eccentricity (e).

As a first step of feasibility study of this instrumentation technique, FSP response against induced elastic inhomogeneities was investigated by using cellophane thin films. Figure 2 shows the change of eccentricity (*e*: the ratio of the spatial propagation constant along the fast to that of slow axis) of the absorption patterns at the exit pupil in various environments as a result of change in induced local stress birefringence. When the cellophane was stretched along its fast axis as shown in Fig. 2(b), 20% increase in eccentricity was observed and it was further noted that the change in eccentricity was proportional to the magnitude of stress. Also, temperature changes and prolonged UV irradiation resulted in increase of eccentricity by 1.8% and 10%, respectively.

Conclusion

We confirmed the correlation between the induced birefringence of the sample due to elastic inhomogeneity with the change in eccentricity of the absorption pattern at the exit pupil plane of the microscope as shown in Fig. 2. As the next step, we would like to analyze HDF cells adhesion on the extracellular matrix under UV irradiation towards label free detection of dermatoheliosis [2].

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References

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