

Imaging Stokes Polarimetry with Circularly Polarized Light for Label-Free Biotissues Diagnostics

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Due to the high sensitivity of the polarized light to the structural variations in the sample, the spatially resolved sensing with polarized light has a great potential to be used as a label-free technique for screening malformations in biological tissues. Our studies show that circularly polarized light scattered within the tissues is highly sensitive to cancer cells that allow identification of the cancerous lesions on early-stage. The multiple measurements on formalin-fixed, paraffin-embedded blocks of early-stage breast cancer samples (ductal carcinoma in situ) and developed stage (invasive ductal carcinoma) have been performed with the laboratory-built double-axis system. The illumination channel contains the supercontinuum fiber laser (Leukos Ltd., France) and a high-speed acousto-optic tunable filter (Leukos Ltd., France), enabling selecting the specific probing wavelength within the range of 400–650 nm. Circularly polarized light of the selected wavelength is then focused onto the sample at a 55° angle. The reflected light is collected in the detection channel at a 30° angle at a variable distance away from the point of incidence and analyzed by the Stokes polarimeter system (Thorlabs Ltd., USA). High precision spatial scanning of the samples is performed with the XY translation stage (Thorlabs Ltd., USA), providing a resolution of 5 μm.

We show that the polarization characteristics (Q, U, V components of the Stokes vector and the degree of polarization) of the back-reflected radiation provide information close to that obtained from the standard histological examination. The degree of polarization was found to be the most sensitive parameter indicating the malignant changes in the considered samples. Automated classification of the obtained data and determination of the cancer zones in the specimens has been performed with the k-means algorithm of cluster analysis. A good correlation of the automatically recognized zones with the histopathological image obtained by a qualified pathologist is observed.