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Editorial

Introduction to the special issue on polarization of light in biomedical applications

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Although birefringence was discovered just three years after white light was separated into different colors, polarimetry has lagged behind spectroscopy in characterizing diverse materials, likely due to our naked eyes' limited sensitivity to polarizations. Recent advancements in light sources, polarization optics, detectors, displays, data processing, and feature extraction techniques are rapidly propelling polarimetry as a convenient and potent tool for probing the distinct properties of complex and turbid materials. It is well known now that polarization properties of a material encode rich information on its distinct features, including not only the bulk optical properties related with dispersions and absorptions, but also distribution and microstructural properties of the scattering particles in turbid media such as the size, shape, orientation and alignment, surface morphology and internal structure, etc. All these features can be used for differentiating different materials, sensing ambient environment around scatterers, or monitoring dynamic processes in complex systems.

Since biological tissues are usually optically turbid and contain complex structures, biomedical polarimetry has become a vibrant research area with significant progress achieved in recent years.

The use of polarized light in biomedical applications is attracting significant interest across academia, clinical settings, and industry. The development and clinical implementation of polarization-based optical imaging and diagnostic modalities are providing more opportunities to healthcare professionals and significantly extending the diagnostic toolkit.

In this special issue of Journal of Innovative Optical Health Sciences, six articles are selected to represent the recent developments related to Polarized Light in Biomedical Applications, including fundamental, clinical, and pre-clinical studies, as well as attempts of new explorations related to the use of polarized light in life sciences and for healthcare needs.

One of the most promising areas of biomedical polarimetry is clinical histopathology, where doctors examine high resolution images of stained tissue slices to identify abnormal features related to different diseases. By taking transmission Mueller matrix images of the thin pathological samples, more comprehensive information becomes available for revealing the characteristic feature of tissues. Liu *et al.* used pixel data of Mueller matrix elements and supervised machine learning to distinguish conjunctiva, sclera, and scars in surgical ocular tissues.[1] Huang *et al.* used Mueller matrix elements and polarimetry basis parameters (PBP) derived from Mueller matrix as well as their statistical parameters as the input pixel data. Using supervised machine learning, polarimetry feature parameters (PFP) were derived to differentiate serous ovarian tumor and revealed correlations between polarimetry and clinicopathological features.[2] Yao *et al.* further combined the advantages of polarimetry and image processing techniques by deriving PFPs at pixel level and then extracting texture features from the PFP images to assess quantitatively liver fibrosis.[3]

As a label-free and non-invasive technique, backscattering polarization imaging is a potentially powerful tool for probing superficial tissues *in vivo*, such as living skin or inner cavity of organs. Two examples are presented in this special issue. Canabal-Carbia *et al.* studied the backscattering Mueller matrix images and used indices of polarimetric purity (IPPs) to characterize depolarization properties of turbid thick tissues.[4] Khuong *et al.* combined backscattering polarization imaging with colposcopy for quantitative fiber orientation analysis and visualization within the cervix *in vivo*,[5] which demonstrated the potential power of using Mueller endoscopy for intraoperative assessment or monitoring.

We also included an article to represent progress in a related field. Song *et al.* reported a compact and robust illumination source that emits dual-color linearly polarized light, which was used in the present work for three-photon microscopy but can serve as a new light source for polarimetry.[6]

In our role as guest editors, we are grateful for the platform the journal has offered. We genuinely hope that the chosen articles will illuminate this expansive subject and accelerate progress in this dynamic domain. At the same time, we want to extend our heartfelt thanks to all the authors and reviewers who have contributed.

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