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Polarization Imaging for Identifying the Microscopical Orientation of Biological Structures

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Biological structures such as wood fibers or tissue cells often have a characteristic alignment of their molecular architecture. Therefore cells, tissues, organelles can show birefringence and dichroism with the passage of light, which can be detected and measured accurately by performing polarized light imaging. This technique allows to highlight both micro- and nano-structures of the materials, characterizing the anisotropy of the optical properties due precisely to the specific molecular order. Hence, absorption, reflection, refraction and dispersion measures of polarized light by structured materials is a powerful tool for analyzing the morphological order of the organization.

In the present work we have created images of biological structures with micro- and nano-structures by illuminating the samples with linear polarization light. The wavelength has been chosen from time to time to increase the contrast of the recorded images. The samples were illuminated orthogonally but observed at different angles in order to highlight the different behavior of the diffused light according to the viewing angle. The images were mathematically treated to determine the depolarization anisotropy of the light diffused towards the observer. Jones matrix analysis and Stoke's vector representation of light [1] through the Mueller matrix [2] have been implemented to characterize the final polarization state and increase the contrast.

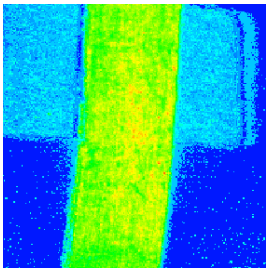

Figure 1. Polarisation imaging of wood.

The polarisation imaging of wood is shown in the previous figure. Two orthogonal samples are contemporarily imaged using the same polarised light in the violet chromatic band (405 nm). The samples have orthogonal fibre orientation as well, which is well pointed out in the image [3] where the chromatic difference evidences the two orientations. Such powerful technique can be applied to other biological tissues like human skin, internal organs, connective tissues to discriminate different constituent materials or the health level of the tissue (e.g. highlight the difference between healthy tissues and tumor masses).

References

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