QUANTITATIVE IMAGING OF ANISOTROPIC MATERIALS BY VECTORIAL PTYCHOGRAPHY

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Ptychography is an imaging approach based on the acquisition of series of diffraction intensity patterns recorded by illuminating an object at several overlapping positions with a finite size probe. The optical properties of the scanned object are reconstructed numerically by means of an iterative algorithm [1]. In optical microscopy, this method offers many major advantages such as an extended field of view and an access to the object phase map. Initially developed with a scalar formalism [1], ptychography could however not take into account light polarization properties and therefore not address birefringent materials. This limitation excludes a large range of materials, e.g., minerals, organics (plastics under constraint, cells).
We have recently developed a "vectorial" ptychography, which accounts for the vectorial nature of the illumination field and the anisotropic properties of the object [2], allowing to retrieve the Jones matrix at each point of the object [3,4]. We have recently demonstrated the improvement of the accuracy of the method by reconstructing the probes wavefront and polarization states simultaneously with the object [5]. From the reconstructed Jones matrices we are able to provide quantitative maps of a wide range of optical properties of specimens, including transmittance, optical path length, retardance, diattenuation, and fast axis orientation [4]. We will present the vectorial formalism, its practical implementation and show experimental results demonstrated on biomineral specimens, as shown in Fig. 1.

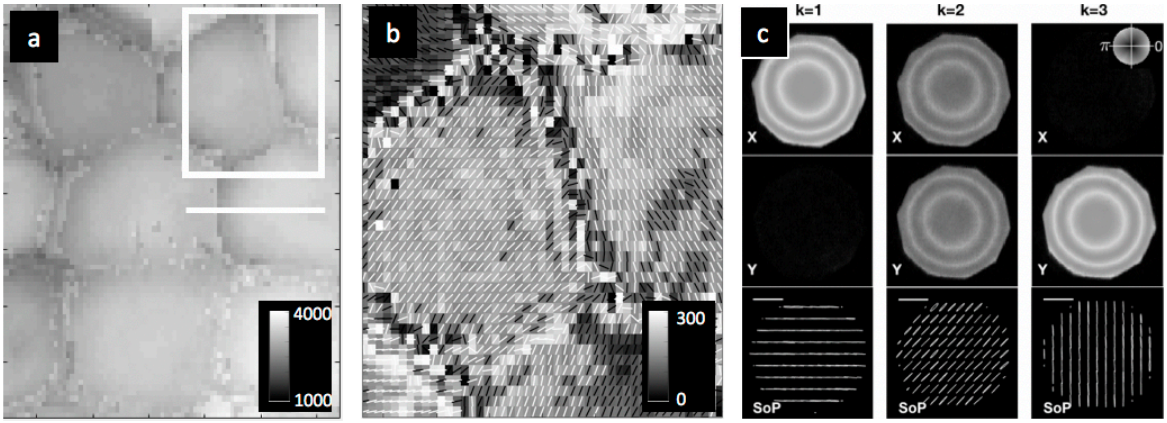

Fig 1. A biomineral specimen (oyster shell) investigated by vectorial ptychography. Reconstructions of (a) optical path length (nm), (b) retardance (nm) and fast axis orientation (sticks) of a close-up (white area of (a)) of the object, and (c) the three corresponding reconstructed illumination probes (from left to right). Scale bars are 25 µm.

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