Relationship between second-harmonic generation circular dichroism (SHG-CD) and molecular orientation angle in biological tissues

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ABSTRACT

Biomolecules having non-superimposable images present chirality, which is an indispensable factor that dominates specific biological functions in an organism. Thus, studying microscopic and macroscopic orientation of molecules is essential to understand how they respond to external stimuli. In this work, we use polarization-resolved second-harmonic generation (P-SHG) microscopy to image three standard biological tissues, including muscle fibers, collagen fibers and starch granules, and study the relationship between SHG-circular dichroism (SHG-CD) and molecular orientation angle [1, 2]. With these relationships, three-dimensional (3D) molecular orientation of biological tissues can be rapidly extracted with high precision; that is, two cross polarized images for the interactions between right and left circular polarizations are able to determine the orientation information in 3D. This method outperforms the approach of image stacking that might be time consuming and suffered from the problems of sample drift and fluctuation when imaging *in vivo* for a long time. Furthermore, the P-SHG microscopy allows for the extraction of absolute value of the chiral component of second-order nonlinear susceptibility, which could be severed as a contrast mechanism to distinguish between various biological tissues.

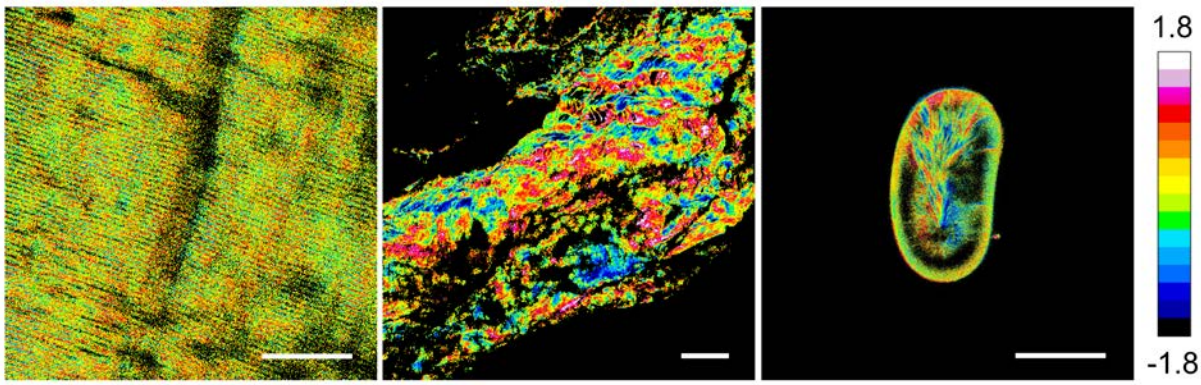

FIGURE 1: Form left to right are SHG-CD images of muscle fibers, collagen fibers and starch granules. Scale bar: 20 μm. Most of the places of muscle fibers showing nearly zero SHG-CD values indicate that the molecules laid parallel to the sample plane (zero molecular tilt angle).

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