CHIRAL IMAGING OF COLLAGEN

Hsuan Lee¹, Mikko J. Huttunen², Kuo-Jen Hsu¹, Mari Partanen², Guan-Yu Zhuo¹, Martti Kauranen², and Shi-Wei Chu¹,³

¹Department of Physics, National Taiwan University, No. 1, Sec. 4, Roosevelt Rd., Taipei, Taiwan ROC
²Department of Physics, Tampere University of Technology, P.O. Box 692, Tampere, Finland
³Molecular Imaging Center, National Taiwan University

Email: swchu@phys.ntu.edu.tw

KEY WORDS: Circular Polarization, Optical Section, Chirality, Nonlinear Microscopy, Ligament, Second Harmonic Generation, Circular Dichroism

Chirality is one of the most important structural properties of molecules, and can be extensively found in various biological molecules. Collagens, which are the most abundant proteins in vertebrates, are intrinsically chiral due to their right-handed triple-helix structures. The structural changes of collagen due to misfoldings of the triple helices are associated with severe diseases, so it is important to study those variations of collagens in tissues [1]. The conventional optical method for chiral detection of molecules is circular dichroism (CD) spectroscopy, in which the absorption differences between right- and left-circularly polarized lights (RCP/LCP) are measured [2]. However, CD is a weak effect and therefore resulting in poor signal contrast and does not provide spatial discrimination in axial direction. Alternatively, second-harmonic-generation circular-dichroism (SHG-CD) detects SHG signal difference between RCP and LCP with the advantages of higher signal contrast [3]. Additionally, SHG as a nonlinear process also provides intrinsic optical sectioning capability.

In this report, we have studied morphology of thick biological tissue by introducing SHG-CD as a new microscopic contrast agent. Compared with conventional chiral measurement, our method provides three-dimensional sub-micrometer spatial resolution, microsecond acquisition time per pixel, and 100% signal contrast. We perform this chiral imaging to study morphology of collagen fibers in pig ligaments, as shown in Fig. 1. Our method is expected to expand chiral studies inside complicated biological tissues.