Title	光和周波顕微鏡を用いた生物試料の非線形顕微分光による研究
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Citation	
Issue Date	2016-03
Type	Thesis or Dissertation
Text version	ETD
URL	http://hdl.handle.net/10119/13525
Rights	
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Abstract

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The sum frequency generation (SFG) microscopy uses the second order nonlinear effect excited by two laser beams with visible and infrared wavelength. This effect is sensitive to the symmetry of material’s structure because it occurs only at non-centrosymmetric parts in the sample. Hence this microscope is expected to be useful in the observation of biomaterials because most biomolecules have chiral or non-centrosymmetric structure. However, until now SFG microcopies have not been completely successful in observation of several samples so far. Therefore, it is necessary to try to observe on as many different samples.

In this study, I used the two type biological samples, fish scale and cracked rice. These samples contain biomolecules such as collagen and starch. The collagen is included in fish scales, and the starch is included in cracked rice. The collagen and starch can generate relatively strong SFG signals.

The first discuss is about the fish scales. In this study, a scale of *Pagrus major* was used as the samples. Fish scales contain collagen. The collagen is a protein based on glycine, prolin, and hydroxyproline, and their chains are combine to form a triple-helical structure. Collagen is the main ingredient in the animal skin, bones, tendons, cartilage, and teeth. Because of such characteristics, the collagen is studied in the fields of anti-aging, food, cosmetics, healthy supplement, living body or medical materials such as an artificial cornea and vascular grafts. SFG spectra and SFG images have been observed on the fish scales. Compering to the collagen of Achilles tendon of a cow(*Bos Taurus*). The peak near 2950 cm^{-1} in the fish scale SFG spectrum was assigned to the fish collagen. The two collagen spectra showed different line shapes and widths owing to a difference in the background nonlinearity. In the SFG image of the fish scale cross section, stronger signal was observed from the sea side than from the body side.

The second discussion is about the cracked rice. I observed SFG images of the rice kernels and the correlation between the cracking of rice and the molecular structure of amylopectin in them. The samples were the normal and the cracked japonica nonglutinous rice Koshihikari and Nipponnbare, which were cultivated at Shiga Prefecture Agricultural Technology Promotion Center. I attempted SFG spectroscopy in the C-H stretching vibration region for normal and cracked rice kernels. The rice kernels are including so much starch. The starch is composed of two components of homopolymers: amylose, a linear polimer of 1000 links glucose molecules, and amylopectin, a high branching polymer of 10,000-100,000 linked glucose molecules. The amylopectin molecule has complicated branch linkages and its molecular weight is much larger than that of amylose. Thus, the molecule allows for a lot of functional properties according to the variety of its structure. In Nipponbare, the width of the SFG spectrum C-H vibration peak at 2915$cm^{-1}$of the cracked rice kernals was broader than that of the normal ones, while for Koshihikari there was no clear difference. The width of the 2015cm^{-1} peak is suggested to originate from the variety of the higher-order structure of saccharide chains in amylopectin.

Key Words

nonlinear optics, sum frequency generation spectroscopy and microscopy, cracked rice, fish scale, starch, amylopectin collagen