Optical Imaging Applications of Multimodal Microscope System

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1. Optical imaging techniques in Multimodal Microscope System
We developed multimodal optical microscope system for wide range of applications including biological imaging, medical imaging and industrial imaging. Our custom-built microscope system is composed of five different optical imaging techniques; Bright-Field Microscopy (BFM), Confocal Laser Scanning Microscopy (CLSM), Multi-Photon Absorption Microscopy (MPAM), Second Harmonic Generation Imaging (SHGI) and Fluorescence Lifetime Imaging Microscopy (FLIM). At the fixed Region of Interest (ROI) of a target specimen, each of these optical imaging techniques, which we call optical modalities, are function to convert several optical information to different characteristics of the sample; Rough appearance from BFM, optically sectioned image and three-dimensionally reconstructed tomography from CLSM [1], deep-tissue morphologic information from MPAM [2], molecular and structural non-centrosymmetricity from SHIM [3], environmental information including Ca2+ and NAD(P)H concentrations from FLIM [4].

2. Various applications of Multimodal Microscope System
The most important feature of our multimodal optical microscope system is that the modalities composing the microscope has a sole ROI since they share some portion of relay optics and optical pathways. It means that the system can give morphologic, three-dimensional, structural and environmental information at the same ROI of the specimen. This feature makes our system be used to image and analyze various samples from various field of optical applications. In this paper, we will show some images taken by our newly developed microscope; 1) BFM and CLSM reflection image for inspecting the accuracy of a laser processing device, 2) BFM and CLSM fluorescence images for analyzing atherosclerotic lesion of mouse coronary artery in vivo, 3) CLSM, SHGI and MPAM images for analyzing atherosclerotic lesion of rabbit coronary artery ex vivo and 4) CLSM, MPAM and FLIM images for analyzing destruction mechanism of artificial lipid bilayer membrane exposed to antimicrobial peptides.