High-resolution optical coherence microscopy using high-power supercontinuum source in wavelength of 1700 nm region

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Optical coherence tomography (OCT) enables us to obtain 3-dimensional tomographic information of the measured object [1]. Since OCT provides non-invasive observation capability of water-rich biological specimens with micrometer-order axial resolution, it has been widely used in biology and medicine. However, the lateral resolution in conventional OCT is not sufficient to observe smaller details, such as cellular structures inside a sample. To improve the lateral resolution, optical coherence microscopy (OCM) is proposed, which is a imaging technique that combines conventional confocal microscopy and low-coherence interferometric detection. In OCM, the use of an objective lens with high numerical aperture (NA) and confocal detection provides ~ 1-order higher lateral resolution compared with conventional OCT [2]. In addition, OCM also improves the image contrast because the combination of the confocal detection and low-coherence interferometric detection provides high rejection capability of signals from out-of-focus, which could become background signals in an image.

For biological investigations, it is important to improve both the spatial resolution and the imaging depth because volumetric observations are often required for thick biological specimens, such as tissues, in order to investigate the biological features. Recently, it has been reported that the spectral window for 1550-1800 nm wavelength is useful to improve the penetration depth in OCT imaging [3-6]. We also developed high power supercontinuum (SC) source in 1700 nm wavelength region and successfully demonstrated high-resolution OCT imaging with improved imaging depth. In this report, we present the OCM using our high power SC source in 1700 nm.

Figure1 shows the schematic of the developed OCM. We employed time-domain OCT system. The center wavelength of the SC source was 1722 nm and the spectral bandwidth was 344nm (FWHM). The axial resolution was ~ 3.8 μm in air (2.8 μm in tissue, when refractive index n = 1.38).The NA of objective lens is 0.65 (Olympus LCPLN50XIR). To confirm the lateral resolution experimentally, we observed 1 μm polystyrene beads embedded in gelatin. From the result, we confirmed that the lateral resolution was < 1.4 μm. To the best of our knowledge, this is the highest spatial resolution among imaging modalities using the light source in wavelength of 1700 nm region. For this OCM setup, its sensitivity was ~ 93 dB. Figure 2 shows OCM image of pig thyroid, which had been fixed by paraformaldehyde. As shown in this figure, we confirmed that the precise structures were clearly visualized by the developed OCM system.

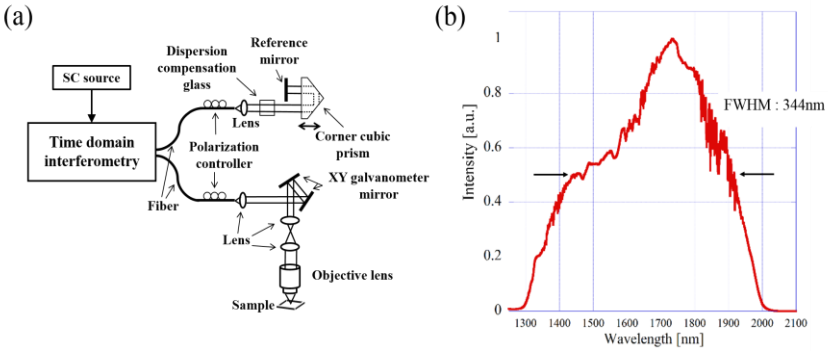

Fig. 1(a) The optical setup for the developed OCM, (b) The spectrum of the SC source

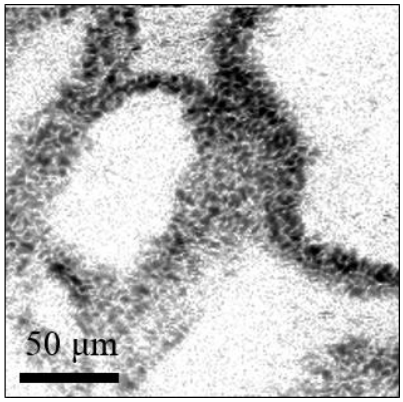

Fig. 2 Obtained OCM en face (x-y plane) image of pig thyroid

References

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