Spectral domain optical coherence tomography using Quasi-supercontinuum source at λ=1700 nm

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Optical coherence tomography (OCT) is an imaging technology to enable us to visualize biological specimens with three-dimensional (3D) high resolution and label-free manner. Recently, our group has reported that the use of 1700-nm spectral band for optical imaging techniques, such as OCT and OCM, allows us to improve the penetration depth [1-3]. The quasi-supercontinuum (Q-SC) source, whose spectrum looks like a supercontinuum (SC), is generated when the wavelength of the soliton pulse shifts rapidly and continuously [4,5]. In Q-SC, the center wavelength, the bandwidth, and the spectral shape can be changed arbitrarily by the use of a programmable function generator to drive the intensity modulator. Here, we present our recent work on 1700-nm Q-SC source for spectral domain (SD)-OCT.

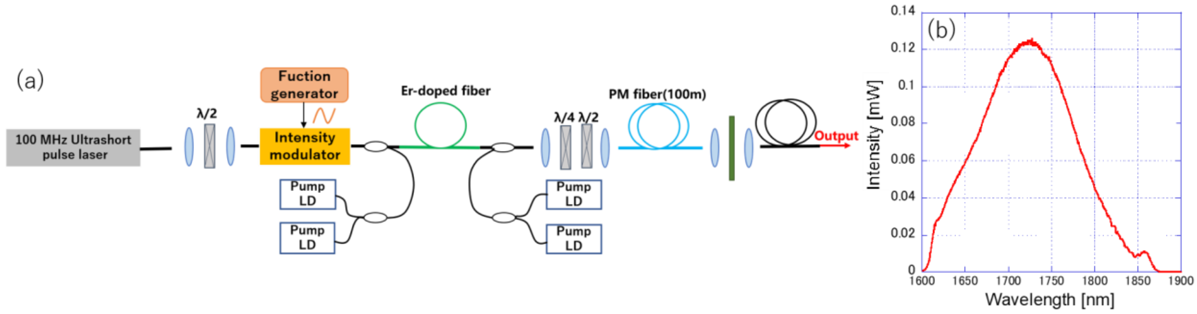

Fig.1. (a) Optical setup for Q-SC laser source and (b) Q-SC output spectrum (the output power was 42mW).

Figure 1(a) shows the optical setup for Q-SC laser, which consists of an ultrashort pulse seed laser, an ultrahigh-speed intensity modulator, an Er-doped fiber amplifier, and a 100 m polarization maintaining (PM) fiber. With ultrafast function modulation, a Gaussian-shape Q-SC output with $\Delta\lambda$ = 105 nm at λ_c = 1712 nm was obtained, as shown in Fig.1(b). Here, we applied the above Q-SC source on SD-OCT system. For OCT signal detection, we used a custom-built spectrometer consisted of a 150 lines/mm blazed diffraction grating and a 47k lines/s InGaAs line scan camera (SU1024LDH-2.2RT-0250/LC, Goodrich). First, to evaluate the performance of SD-OCT using Q-SC, we examined the system sensitivity and axial resolution using a reflective mirror as a sample, as

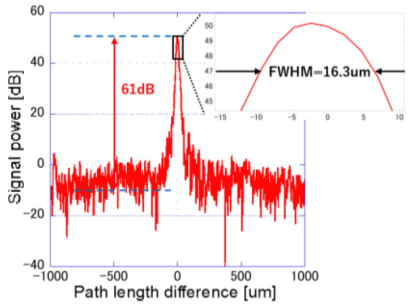

Fig.2. Interference signal of SD-OCT using 1.7um Q-SC source.

shown in Fig.2. The total system sensitivity was 100dB, including 61dB signal power and a 39dB round-trip attenuation. The axial resolution was 16.3 μm in air, corresponding to 11.8 μm in biological tissues. This is close to theoretical value (12.3 μm in air and 8.9 μm in biological tissues). Finally, we observed the cross-sectional structures of tape stack and hamster cheek pouch as shown in Fig.3.

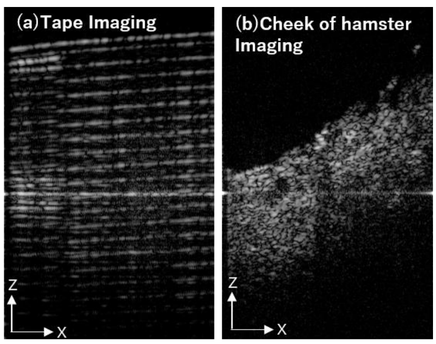

Fig.3. OCT images of (a) tape stack and (b) hamster cheek pouch.

References

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