

E-band Fourier domain mode locked laser and its application in optical coherence tomography

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The Fourier domain mode locked (FDML) laser finds applications in fiber Bragg grating (FBG) interrogation and optical coherence tomography (OCT) systems [1]. The center wavelength of FDML laser is important in many applications. The C-band (1530–1565 nm) FDML laser is often used in FBG interrogation systems because of the availability of components at low cost. Swept sources with central wavelengths at 1300, 1060, or 800 nm are also used in OCT systems owing to the low water absorption loss at these wavelengths. FDML lasers at the E-band however have not yet been demonstrated. The E-band refers to the optical band between 1360 and 1460 nm. The E-band offers a superior near-infrared biological imaging window because it has a lower scattering coefficient [2]. Optical fiber loss at the E-band is also low.

In this work, we demonstrate for the first time an E-band FDML laser and its application in a swept-source OCT system. The E-band FDML laser has a large sweep range by engineering the zero dispersion point of the long fiber delay to locate inside the E band, which is achieved by combining non-zero dispersion shifting fibers and single-mode fibers. Fig. 1(a) shows that the center wavelength of the FDML laser is 1440 nm and the sweep range is 90 nm. The sweep-rate is 50.748 kHz corresponding to a time period of 19.7 μ s as shown in Fig. 1(b). The E-band FDML laser is then used as the swept source of an OCT system. Fig. 1(c) shows that the axial resolution is 14.7 μ m in air by calculating the point spread function of the interference signal. The imaging depth is 360 μ m. The swept source OCT system is then used to image human skin in vivo as shown in Fig. 1(d). Fig. 1(d) shows that the boundary between the stratum granulosum and the stratum corneum layer can be clearly distinguished and the thickness of the stratum corneum layer is about 200 μ m.

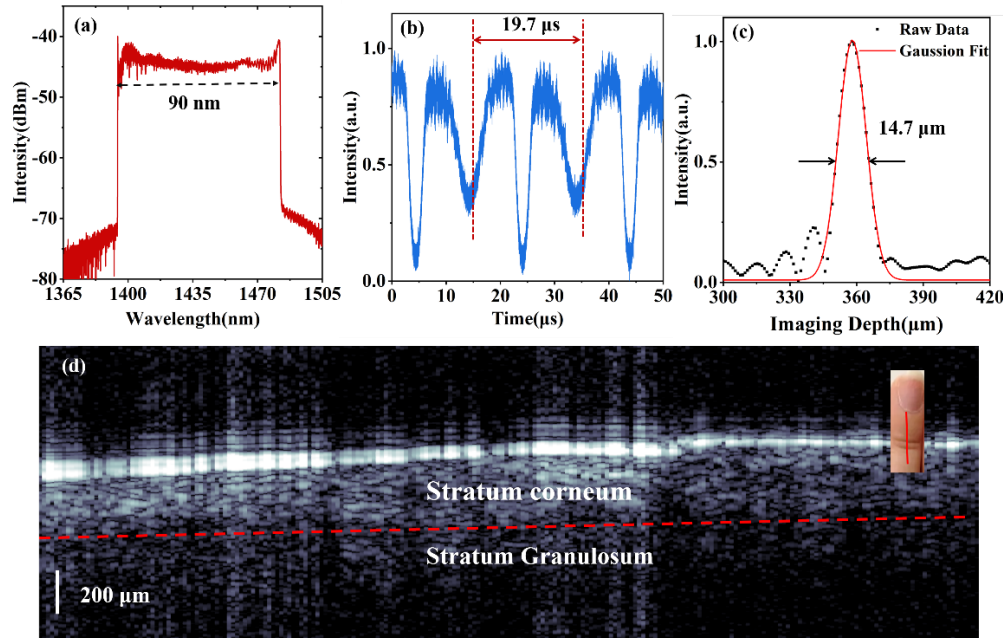


Fig. 1 The (a) optical spectrum and (b) temporal waveform of the E-band FDML laser. (c) Axial resolution of the swept source OCT system. (d) The OCT image of a human finger in vivo. Inset: a picture of the finger being imaged.

References

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2. Z. Feng, T. Tang, T. Wu, X. Yu, Y. Zhang, M. Wang, J. Zheng, Y. Ying, S. Chen, and J. Zhou, "Perfecting and extending the near infrared imaging window," *Light Sci. Appl.* **10**, 1-18 (2021).

Abstract:

We demonstrate for the first time an E-band Fourier domain mode locked laser with a 50 kHz sweep rate and a 90 nm sweep range, and its application in swept-source optical coherence tomography. **(35 words)**