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Integrated Tunable Quantum Dot Laser for Optical Coherence Tomography in the 1.7µm Wavelength Region

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We have designed and fabricated a monolithically integrated continuously tunable laser source for frequency domain optical coherence tomography (FD-OCT) in the 1.6 to 1.8µm wavelength region. The InP-based laser consists of two 8mm long quantum dot (QD) semiconductor optical amplifiers and two electro-optically (EO) tunable filters in a 43.5 mm long ring laser cavity. An 8mm long output amplifier is used to boost the output signal. A picture of the mask is given in Fig. 1a.

In this laser the QD-amplifiers are chosen to generate and amplify light in the desired 1.6 to 1.8µm wavelength region. The desired central wavelength of the gain spectrum of these QD-amplifiers can be adjusted by controlling the size of the QDs during the growth process [1]. Furthermore due to the inhomogeneous broadening the bandwidth of the gain spectrum will be more than 100nm which is necessary to tune the laser over at least 100 nm [2]. The two intra-cavity EO tunable filters are used to tune the lasing wavelength of the ring laser. The first, a high resolution (HR) filter, is an arrayed waveguide grating (AWG) filter with a 0.5 nm full-width-half-maximum (FWHM) and a 10nm free spectral range (FSR) (at 1700nm). The second, a low resolution (LR) filter, is an MMI-tree filter with a 25 nm FWHM and a 210 nm FSR. The HR-filter is used as a narrow wavelength filter to allow a maximum of 3 ring laser cavity modes with a 0.02 nm mode spacing and to suppress other neighbor ring cavity modes. The LR-filter is used to select one pass-band of the HR-filter. Both filters are tunable with EO phase modulators (PHM) in the arms of the filters [3]. The laser has been fabricated in the active-passive integration technology used at COBRA [3].

After calibration of the PHMs in both filters [3] we were able to tune the wavelength of the laser reliably and reproducibly. Both ring amplifiers where biased at 1A and the output amplifier at 700mA. In Fig. 1b the lasing spectra are given for 30 different wavelength settings between 1686 nm and 1744 nm. A full characterization within this wavelength region shows a wavelength accuracy within ±0.15nm (+0.1nm thermal detuning) and a FWHM between 0.05nm (instrument limited) and 0.3nm maximum. The spectral suppression of the laser is more than 25dB except for a 5nm region around 1728nm where the spectral suppression is more than 15dB. The total output power fluctuates between -8dBm and -18dBm.

The effective linewidth of the scanning laser has been measured with a free-space Michelson-interferometer setup containing one fixed mirror and one moving mirror [4]. A 0.11nm effective linewidth has been measured for a 500Hz scan over 60nm in 4000 wavelength steps.

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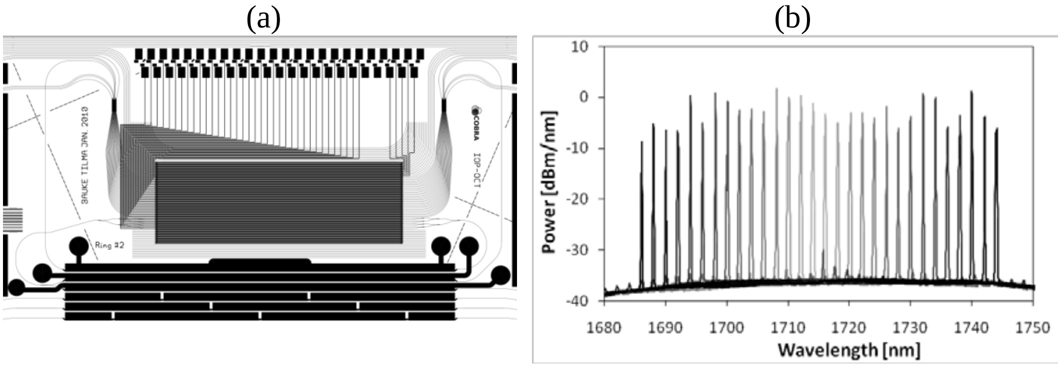

Fig. 1 (a) Mask design tunable laser. size: 10 x 6 mm (b) Laser spectra for 30 different laser tuning settings between 1686 nm and 1744 nm.

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