Wavelength tuneable pulse monitoring using a Two-Photon-Absorption microcavity

K. Bondarczuk, P.J.Maguire, and L.P.Barry
Research Institute for Networks and Communications Engineering, Dublin City University, Dublin 9, Ireland

J. O'Dowd, W.H. Guo, M.Lynch, A.L.Bradley and J.F.Donegan
Semiconductor Optronics Group, University of Dublin ,Trinity College, Dublin 2, IRELAND

H.Folliot
Laboratoire de Physique des Solides, INSA, Rennes, FRANCE

Two Photon Absorption (TPA) is a non-linear optical-to-electrical conversion process that can be significantly enhanced by placing the active region within a resonance microcavity [1]. Such a structure exhibits a resonance wavelength-selective characteristic dependent on the cavity design. This makes a microcavity detector a good candidate for applications in WDM systems, as the wavelength selective characteristic of the cavity can replace the need for additional optical filters. Furthermore the possibility of tuning the resonance wavelength by tilting the cavity such that the incident angle of the light is varied, gives a possibility of using the non-linear TPA response in a single device for monitoring or sampling of wavelength channels in a WDM system [2]. Fig 1 (a) presents the TPA photocurrent generated within the resonance microcavity as a function of incident wavelength for a 10 GHz optical pulse train. From the plot the cavity resonance width measured at the 3dB point is 7nm. Fig. 1 (b) presents the cavity resonance wavelength as a function of incident angle. The cavity resonance wavelength for normal incident light is 1563 nm and can be tuned downwards by 60nm when the cavity is tilted by 60°. As the sampling pulse source used had a small tuning range and could not access the peak resonance wavelengths of the device at normal incidence, the cavity was tilted by 20° during the experiment, resulting in off-incidence resonance wavelength of 1557 nm.

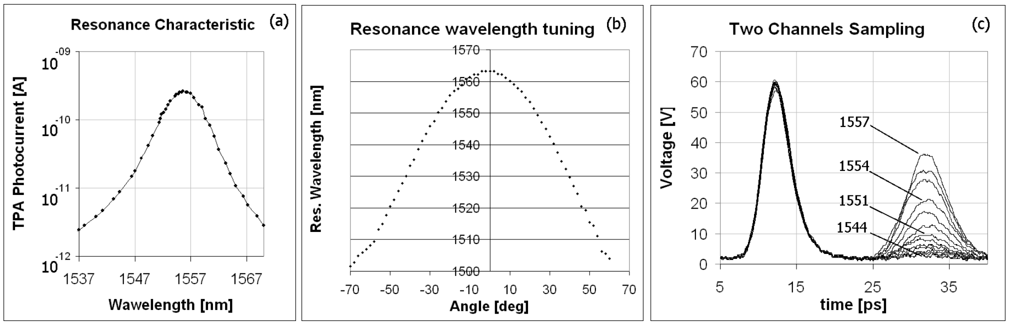

Fig. 1 (a) TPA cavity resonance characteristic; (b) Resonance wavelength tuning by cavity tilting; (c) Two channels optical sampling – first channel at resonance, second channel wavelength varied.

The microcavity was then employed in an optical sampling experiment [2] of a 10 GHz optical pulse train. To demonstrate the device wavelength selectivity an additional channel was introduced operating at various wavelengths around the experimental off-incidence cavity resonance. Two wavelength tuneable 2ps 10 GHz pulse sources were employed to generate two optical channels. The second channel was passed through 300m Single Mode Fiber to introduce chromatic dispersion pulse broadening allowing us to clearly distinguish between the two channels. Both signals were combined with a high peak power 800 fs sampling pulse source operating at a slightly detuned sub-harmonic frequency of 10.000001 MHz (allows sampling pulse to be scanned across the signal under test), with the combined signal incident on the TPA microcavity. The resulting 1kHz sampling signal was displayed on a low bandwidth, high impedance oscilloscope. Fig. 1 (c) presents the sampling traces of both signals separated in time, when the second wavelength channel is varied from 1557nm to 1544 nm. An 11 dB decrease of the sampling signal from the second channel was observed when it was tuned by 13 nm away from resonance of the microcavity.

The experiment confirmed the potential use of the microcavity structure for monitoring a single channel in multi-wavelength systems. The cavity can be designed for different applications depending on desired resonance width or cavity life time allowing the contrast ratio to be further improved. Due to the possibility of tuning the resonance wavelength by cavity tilting, a single device can be used to monitor a number of WDM channels without the need for additional optical filters.

1 H.Folliot *et al.* " Two-photon absorption photocurrent enhancement in bulk AlGaAs semiconductor microcavities", Appl. Phys. Lett **80**, 1328-1330 (2002)
2. P. J. Maguire *et al.*"Optical Signal Processing via Two-Photon Absorption in a Semiconductor Microcavity for the Next Generation of High-Speed Optical Communications Network", J.Lightw. Tech. **24**, 2683-2692 (2006)