Expanding the range of chromatic dispersion monitoring with two-photon absorption in semiconductors

W. H. Guo and J. F. Donegan
Semiconductor Photonics Group, School of Physics, and Centre for Telecommunication Value-Chain Driven Research (CTVR), Trinity College, Dublin 2, Ireland

L. P. Barry
School of Electronic Engineering, Dublin City University, Dublin 9, Ireland

Chromatic dispersion monitoring based on two-photon absorption (TPA) in semiconductors is very attractive because it does not need any high speed electronic devices [1-2]. However, at present the dispersion monitoring range is limited to half of the Talbot dispersion which is defined as $D_{\text{Talbot}} = T^2c/\lambda^2$ [2], T is the period of the signal pulse sequence. In this work we propose a scheme to expand this monitoring range.

As shown in the inset of Fig. 1, the signal pulse sequence with dispersion B_1 passes through two possible routes with dispersion B_2 and $-B_2$ and then goes through another two possible dispersions B_3 and $-B_3$ and is incident onto a TPA detector. So before the signal enters the TPA detector, the signal can experience four possible dispersion combinations, $\pm B_2 \pm B_3$. We define two signals: the difference of the TPA signal (called Di in the following) which is $(i_{\text{TPA}}(B_2+B_3)+i_{\text{TPA}}(B_2-B_3)-i_{\text{TPA}}(-B_2+B_3)-i_{\text{TPA}}(-B_2-B_3))/2$ (The dispersion in the bracket shows the path the signal passes through); the difference of the TPA signal difference (DDi): $(i_{\text{TPA}}(B_2+B_3)-i_{\text{TPA}}(B_2-B_3))-(i_{\text{TPA}}(-B_2+B_3)-i_{\text{TPA}}(-B_2-B_3))$. We use simulations to show that the dispersion B_1 can be monitored with an expanded range by a combination of Di and DDi. In the simulation, B_2 and B_3 are set as $0.5D_{\text{Talbot}}$ and $0.1D_{\text{Talbot}}$ respectively; a RZ (33%) PRBS signal at 40 Gb/s is assumed; a microcavity TPA detector is used which has a bandwidth of 6.5 nm and a cavity lifetime around 0.2 ps. The microcavity enhances the TPA by a factor of 1820. The following parameters are also assumed in the simulation: the TPA coefficient 20 cm/GW, the cavity active layer thickness 0.46 μm, the collection efficiency 10%, the spot diameter 3 μm, and the average signal power 1 mW.

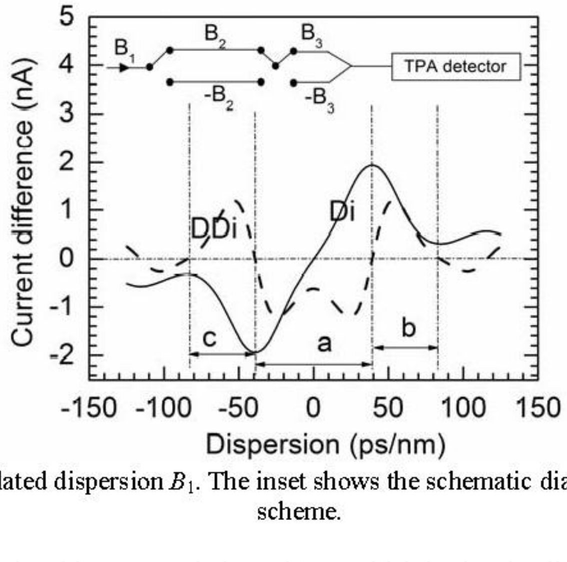

Fig. 1 Di and DDi vs. accumulated dispersion B_1. The inset shows the schematic diagram of the proposed monitoring scheme.

As shown in Fig. 1, the Di signal is monotonic in region *a*, which is also the dispersion monitoring region realized in [1]. In the expanded region *a*+*b*+*c*, Di is not monotonic any more. However, we can find that in region *a*, DDi is negative, but in region *b* and *c*, DDi is positive. So the sign of DDi can be used to judge if the dispersion is in region *a* or in region *b*+*c*. So combining Di and the sign of DDi we can uniquely determine the dispersion of the signal pulse sequence in a doubled region compared with the scheme used in [1], i.e. the dispersion can be monitored up to the Talbot dispersion.

References

1. T. Inui, K. R. Tamura, K. Mori, and T. Morioka, "Bit rate flexible chirp measurement technique using two-photon absorption," Electron. Lett. **38**, 1459-1460 (2002).
2. S. Wielandy, M. Fishteyn, and B. Zhu, "Optical performance monitoring using nonlinear detection," J. Lightwave Technol. **22**, 784-793 (2004).