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

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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 $D_{Talbot} = T^2 c / L^2$ [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 $(iTPA(B_2+B_3) + iTPA(B_2-B_3) + iTPA(-B_2+B_3) + iTPA(-B_2-B_3)) / 2$ (The dispersion in the bracket shows the path the signal passes through); the difference of the TPA signal difference (DDi): $(iTPA(B_2+B_3) - iTPA(B_2-B_3) + iTPA(-B_2+B_3) - iTPA(-B_2-B_3))$. 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 $0.5D_{Talbot}$ and $0.1D_{Talbot}$ 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.](image.png)

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