A Novel Approach towards Two-Photon Absorption based Detectors

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We have demonstrated that the inherent inefficiency of the TPA process in semicondutors can be overcome by incorporating the semiconducor in a microcavity structure. Proof of concept devices with a 0.27μm $Ga_{0.7}Al_{0.3}As$ active region and two Bragg reflectors with the cavity resonance of 890 nm were fabricated. We measured the TPA photocurrent of these devices and have demonstrated a factor of 12000 enhancement over a non-microcavity device at 890 nm, as shown in figure 1. Our active length of 0.27μm is as efficient as 5.4mm without a microcavity, overcoming the very long detector lengths limiting the use of TPA in practical autocorrelators, optical switches and sampling devices for real telecommunication systems. The effect of the cavity is to enhance the intra-cavity optical intensity, which leads to an increase in the non-linear response of the active region. We studied, theoretically and experimentally, the impact of the cavity on the temporal response and the sensitivity of the device, which are critical considerations for commercial applications. This cavity design has a 3 pico-second response time and the autocorrelation trace is comparable with the BBO crystal response for an input 1.6 ps pulse, figure 2. Devices designed for 1550nm have also been realised and our measurements indicate these two-photon absorption based detectors are potential candidates for optical autocorrelation of short optical pulses, and for optical switching and sampling in optical time division multiplexed (OTDM) communications systems.

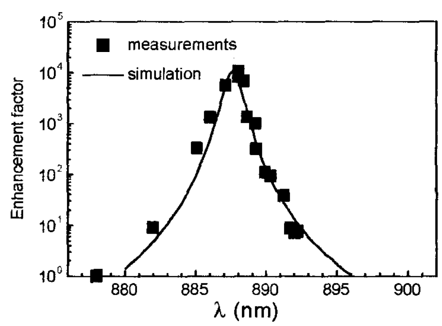

Fig.1. Photocurrent enhancement vs. wavelength across the cavity resonance.

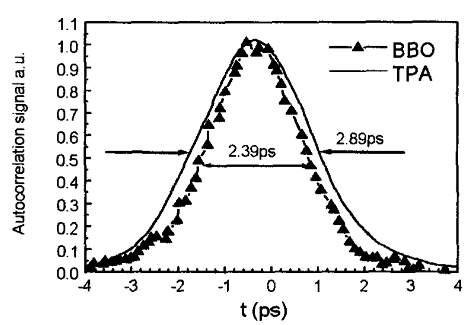

Fig.2. Autocorrelation signal using BBO crystal (triangles) and the TPA microcavity device (straight line)