Abstract

The day-by-day increase of data traffic over the optical network demands transmission of higher bit-rate (> 10 Gb/s) signals with shorter optical pulses. The present signal processing is done in the electronic domain and requires an opto-electronic (O-E-O) conversion. These electronic devices will fail to operate at high bit-rate. Therefore, all-optical signal processing devices are required which do not need any O-E-O conversion. Here we numerically study such all-optical device applications of semiconductor optical amplifier (SOA) and vertical cavity semiconductor saturable absorber (VCSSA).

Propagation of short pulses leads to saturation of the SOA gain due to both interband and intraband phenomena. We first study the effect of including and excluding intraband effects in the model with respect to short pulse amplification in SOA. For short pulses, the saturation energy of the amplifier becomes pulsewidth dependent but no relation between the two has been reported. By proper fitting of the numerical results, we obtain an expression for the same.

The small gain recovery time (200 ps -1 ns) of SOA leads to patterning effect (PE) in the output signal. For the extraction of the maximum PE introduced by the device, we propose a new and efficient input signal. Utilizing this signal we study the PE introduced by the SOA as an amplifier. We show the effectiveness of a tunable bandpass filter (BPF) with Gaussian transfer function in reducing PE. We also study the effect of various input signal parameters on the PE of the amplified signal and prescribe a relation between PE and pulsewidth. The optimum filter parameters corresponding to these input parameters are numerically estimated.

Using our proposed input signal we have studied the SOA and BPF based all-optical wavelength conversion numerically for its optimum operation, i.e. to obtain wavelength converted signal with minimum PE and an acceptable extinction ratio.

Next we have numerically investigated for the optimum operation condition of different all-optical logic gates based on a single SOA followed by a tunable BPF. Finally, we have studied *optical bistability* in VCSSA and optimized its logic operation by taking into consideration the heating effect in the device.

Keywords: Semiconductor optical amplifier, Vertical cavity semiconductor saturable absorber, All-optical signal processing, Amplifier, Wavelength conversion, Logic gates, Patterning effect, Optical bistability, Optical bandpass filter.