

# NOR and NAND gates using two photon absorption in silicon wire waveguide

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Received: 30 May 2013 / Accepted: 7 August 2013 / Published online: 20 August 2013  
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**Abstract** Ultrafast all-optical NOR gate based on two photon absorption (2PA) process in SOI waveguide is already established. We have designed NAND gate also based on this process with a novel waveguide coupler structure. Power attenuation due to 2PA process and the working of these gates is developed with FDTD simulation. Dominant 2PA process is incorporated in FDTD update equations and it is shown that the influence of high intensity pump pulses on a different frequency continuous probe beam can be utilized to form NOR as well as NAND gates.

**Keywords** SOI waveguide · Two photon absorption · FDTD method · Full vector finite difference method · Pump and probe beam

## 1 Introduction

Silicon-on-insulator waveguides are very attractive for designing all optical signal processing devices and switches due to the mature fabrication technology of silicon. Silicon waveguides can be formed in the nano-scale size, requiring very small energy pulses in the range of pico-joules (Lin et al. 2007) which is very important in the integration of photonic circuits on a chip.

Although silicon has comparatively higher Kerr-type third order nonlinearity than that in silica, it is not so high as to efficiently use power or phase controlled switching using directional couplers (Jensen 1982; Berger et al. 1991; Kumbhakar 2012). But other nonlinear

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