Nonlinear Photonic Crystal for Optical Switching and Logic Functionality

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Abstract:

Nonlinear photonic crystals (NPCs) made from materials of high Kerr nonlinearity offer a promising way to build ultrafast and low-power optical switching devices. When photonic crystals are built from materials with Kerr effect, the bandgap or defect state frequency can be controlled effectively by external pump light with a remarkable shift, leading to optical switching effect [1]. In this talk we present our recent works on exploiting ultrafast optical switching and logic functionality by using polystyreneNPC, which is a polymer material with a very large Kerr nonlinearity and extremely fast optical response speed (down to several femtoseconds). First we will showthat ultrafast optical switching with a response time down to 10 fs can be achievedby polystyrene NPCwhen the pump light is high-intensity ultrafast laser pulse with a duration of several femtoseconds [2]. Second we will presentthe concept of hybrid polymer-silicon NPC [3,4] and discuss a versatile technique based on nano-imprint lithography to fabricate high-quality silicon-polystyrene compound nonlinear photonic crystal slabs [5]. The hybrid photonic crystal structures can incorporate both advantages of ultrafast and low power nonlinear optical effects. The versatile method can be expanded to make general semiconductor-polymer hybrid optical nanostructures, and thus it may pave the way for reliable and efficient fabrication of ultrafast and ultralow power all-optical tunable integrated photonic devices and circuits. Finally we will discuss optical logic gate based on the scheme of two switchable optical cavities in NPC [6].

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