

Ultrafast all-optical switch in polystyrene photonic crystals

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We report here an all-optical switching with a time response of less than 10 fs, which is based on the gap-edge shift of 3D polystyrene photonic crystals under optical pumping. Due to the third order nonlinearity effective refractive index of polystyrene changes with the pumping intensity and the position of corresponding photonic gap-edge is determined by the refractive index. Thus, the variation of pumping intensity leads to a change of transmission wavelength, i.e. previously blocked light beam passes through. There are two major requirements for the opal applied in our AOS system. Its gap edge should be steep and the transmittance difference between pass-band and gap region should be large enough. To achieve these goals the opal is fabricated by an improved vertical deposition method—pressure controlled isothermal heating vertical deposition, where both the pressure and temperature in growth chamber are adjustable, so that the boiling point of solution can be precisely controlled. The switching effect is measured by using a Ti:sapphire laser with a pulse width of 7 fs. The laser beam is divided to two parts: pump and probe beam. To extract the time response of the AOS, we measured the transmittance change of the probe pulse as a function of the time delay between the pump and probe pulses. The time constants of the optical switching can be extracted from the exponential fits of the measured transmittance change. It is found that the time constant in the rising and dropping period is 3fs and 8fs, respectively.