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Coherent intersubband polarization switching in a semiconductor quantum well using terahertz pulses

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Intersubband transitions in semiconductor quantum wells with their large dipole moments and their polarization decay within a few hundreds of femtoseconds [1] to a few picoseconds are interesting for optical switching with picosecond switching times. Up to now coherent control of an intersubband polarization has only been demonstrated in multiple quantum wells in the mid-infrared spectral region where the infrared transmission change between a doped sample and a similar undoped one was measured [2]. Here we demonstrate coherent switching of an excited intersubband polarization in a single GaAs/AlGaAs quantum well in the far-infrared spectral region in a more direct way [3]. To this end a bias modulation is applied to fill and empty the doped quantum well via the Stark effect and simultaneously monitor changes in the THz transmission. A first THz pulse centered around the 2 THz intersubband transition energy excites a coherent, macroscopic polarization between the n=1 and n=2 conduction band states. A temporally delayed control pulse is used to either switch the polarization off or to refresh it, depending on the relative time delay between pump and control pulse. The polarization switching is directly monitored in the time domain by measuring the free induction decay of the induced polarization with standard electro-optic sampling. Model calculations based on the optical Bloch equations agree well with the experiment. [1] R. A. Kaindl et al., Phys. Rev. Lett. 80, 3575 (1998). [2] F. Eickemeyer et al., Appl. Phys. Lett. 79, 165 (2001). [3] M. Wagner et al., Appl. Phys. Lett. 99, 131109 (2011).

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