Effect of Single Ultrashort Magnetic Pulse On Energy Subbands Dynamics In Bilayer Nanowire

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In 2013 it was demonstarated by Vicario et al. [1] that strong magnetic pulses of amplitude $B_M = 0.5\,\mathrm{T}$ can be generated on a time scale shorter than 1 ps. That gives a possibility for investigation of dynamical effects of magnetic hybridization of electron's wave functions in bilayer nanostructures. This kind of nanostructures, usually made of GaAs or InGaAs materials, are often fabricated by means of MBE method as two-dimensional wide ($> 30\,\mathrm{nm}$) quantum wells (QW). Within such QW two vertically stacked transport layers are created near its top and bottom edges due to conduction band bending by two ionized δ-doped Si layers localized below and above the well.[2,3] The effect of an in-plane static magnetic field action on Bloch states describing the electrons confined in such nanostructure is formation of pseudogaps in energy spectrum $E(k)$.[4] These pseudogaps are experimentally observed as drops in conductance for increasing Fermi energy. Quite recently it was theoretically predicted that a picosecond magnetic pulse can set a single electron confined in bilayer nanowire in motion. This dynamical effect, being the result of temporary interlayer magnetic hybridization, can be observed only when spatial symmetry of vertical confinement is broken.[5] In present work these preliminary considerations are extended to many-electron system. The outcomes of time-dependent DFT calculations show that the time changeable magnetic field tilts temporary the electrons' energy subbands what induces a charge flow along the wire. The amplitude of such magnetoinduced current oscillations may achieve about $0.5\mu A$ in a 250-nm-wide nanowire what certainly makes its experimental detection feasible. It depends however on the Fermi energy, the time length and strength of magnetic pulse as well as on disproportion in charge density distribution between two involved transport layers what is analyzed in detail.

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