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标题: THz quantum-confined Stark effect in semiconductor quantum dots

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摘要: We demonstrate an instantaneous all-optical manipulation of optical absorption at the ground state of InGaAs/GaAs quantum dots (QDs) via a quantum-confined Stark effect (QCSE) induced by the electric field of incident THz pulses with peak electric fields reaching 200 kV/cm in the free space. As a result, a THz signal with the full bandwidth of 3 THz can be directly encoded onto an optical signal probing the ground state absorption in QDs, resulting in the encoded temporal features as fast as 460 fs. The optical absorption modulation at highest THz fields reaches about 30% of the total optical absorption in QDs at the ground state. The dependency of electro-absorption modulation depth on the peak THz field is found to be strongly nonlinear, as expected from the QCSE. From this dependency we conclude that the dominant contribution to the observed electro-absorption modulation in our sample is made by the overall optical absorption quenching via a reduction of the overlap integral and hence the probability of inter-band transition, rather than by the Stark shift of the QD absorption peak away from the spectrum of the optical probe. As expected from the three-dimensional geometry of a QD, the THz QCSE was found to be independent of the polarization of the THz field. The instantaneous nature of THz QCSE in QDs enables femtosecond all-optical switching at very high repetition rates. This allowed us to demonstrate the potential for applications in THz-range wireless communication systems with the data rate of at least 0.5 Tbit/s.

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