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Title:Spin-polarized electric currents in diluted magnetic semiconductor heterostructures induced by terahertz and microwave radiation

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Abstract:We report on the study of spin-polarized electric currents in diluted magnetic semiconductor (DMS) quantum wells subjected to an in-plane external magnetic field and illuminated by microwave or terahertz radiation. The effect is studied in (Cd,Mn)Te/(Cd,Mg)Te quantum-wells (QWs) and (In,Ga)As/InAlAs:Mn QWs belonging to the well-known II-VI and III-V DMS material systems, as well as in heterovalent AlSb/InAs/(Zn,Mn)Te QWs, which represent a promising combination of II-VI and III-V semiconductors. Experimental data and developed theory demonstrate that the photocurrent originates from a spin-dependent scattering of free carriers by static defects or phonons in the Drude absorption of radiation and subsequent relaxation of carriers. We show that in DMS structures, the efficiency of the current generation is drastically enhanced compared to nonmagnetic semiconductors. The enhancement is caused by the exchange interaction of carrier spins with localized spins of magnetic ions resulting, on the one hand, in the giant Zeeman spin splitting, and, on the other hand, in the spin-dependent carrier scattering by localized Mn²⁺ ions polarized by an external magnetic field.

Number of references:56

Inspec controlled terms:aluminium compounds - cadmium compounds - carrier relaxation time - electric current - exchange interactions (electron) - gallium arsenide - III-V semiconductors - II-VI semiconductors - indium compounds - magnesium compounds - manganese - manganese compounds - microwave spectra - phonons - photoconductivity - point defect scattering - semiconductor quantum wells - semimagnetic semiconductors - spin polarised transport - terahertz wave spectra - Zeeman effect

Uncontrolled terms:spin-polarized electric currents - diluted magnetic semiconductor

heterostructures - terahertz radiation - microwave radiation - in-plane external magnetic field - II-VI diluted magnetic semiconductor material systems - III-V diluted magnetic semiconductor material systems - heterovalent quantum wells - II-VI semiconductors - III-V semiconductors - photocurrent - spin-dependent scattering - static defects - phonons - Drude absorption - carrier relaxation - nonmagnetic semiconductors - exchange interaction - carrier spins - localized spins - magnetic ions - Zeeman spin splitting - spin-dependent carrier scattering - localized Mn²⁺ ions polarization - (CdMn)Te-(CdMg)Te - (InGa)As-InAlAs:Mn - AlSb-InAs-(ZnMn)Te

Inspec classification codes:A7360L Electrical properties of II-VI and III-V semiconductors (thin films/low-dimensional structures) - A7155G Impurity and defect levels in II-VI and III-V semiconductors - A7240 Photoconduction and photovoltaic effects; photodielectric effects - A7210F Carrier scattering by point defects, dislocations, surfaces, and other imperfections - A6322 Phonons in low-dimensional structures and small particles - A6320D Phonon states and bands, normal modes, and phonon dispersion - A7170G Exchange interactions (condensed matter) - A7530E Exchange and superexchange interactions in magnetically ordered materials - A7170E Spin-orbit coupling, Zeeman, Stark and strain splitting (condensed matter) - A7820L Magneto-optical effects (condensed matter) - A7865K Optical properties of II-VI and III-V semiconductors (thin films/low-dimensional structures) - A7550P Magnetic semiconductors - A7220J Charge carriers: generation, recombination, lifetime, and trapping (semiconductors/insulators) - A7225 Spin polarized transport - A7870G Microwave and radiofrequency interactions with condensed matter - A7320D Electron states in low-dimensional structures - B2530C Semiconductor superlattices, quantum wells and related structures - B4210 Photoconducting materials and properties - B2520D II-VI and III-V semiconductors

Chemical indexing:CdMnTe-CdMgTe/int CdMgTe/int CdMnTe/int Cd/int Mg/int Mn/int Te/int CdMgTe/ss CdMnTe/ss Cd/ss Mg/ss Mn/ss Te/ss;InGaAs-InAlAs:Mn/int InAlAs:Mn/int InAlAs/int InGaAs/int Al/int As/int Ga/int In/int Mn/int InAlAs:Mn/ss InAlAs/ss InGaAs/ss Al/ss As/ss Ga/ss In/ss Mn/ss Mn/el Mn/dop;AlSb-InAs-ZnMnTe/int ZnMnTe/int AlSb/int InAs/int Al/int As/int In/int Mn/int Sb/int Te/int Zn/int ZnMnTe/ss Mn/ss Te/ss Zn/ss AlSb/bin InAs/bin Al/bin As/bin In/bin Sb/bin

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