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Charge carrier dynamics in Mn-doped Methylammonium Lead Bromide.

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One of the most challenging tasks for LED applications is emitting 100% polarized light from the device. Typically, this is achieved by introducing an additional layer of polarization filter which leads to losing half of the light intensity. To overcome this issue, one has to find a system with a high degree of photoluminescence (PL) polarization. A promising approach here is using magnetic metal doping in combination with a highly efficient semiconductor. Metal-halide perovskites have attracted the attention of many scientific groups around the world as one of the most promising candidates for solar cell applications and light-emitting diode (LED) technology. In our work, we will present how doping of methylammonium lead bromide (CH3NH3PbBr3) with the transition metals Ni, Co, and Mn induces dramatic changes in the magneto-optical properties and carrier dynamics due to interactions between the magnetic moments of the dopants and Coulomb interactions of the excitons.

We have chosen to use transient absorption (TA) spectroscopy at cryogenic temperatures to investigate changes in the optical properties induced by magnetic metal doping in CH3NH3PbBr3 since it gives spectral information about the energies of electronic states and dynamic properties of the photoexcited carriers. We find a change in the main ground state bleach (GSB) peak position in doped CH3NH3PbBr3, which depends on the transition metal used. The main GSB peak of pure CH3NH3PbBr3 at 4 K is at 2.32 eV. Doping CH3NH3PbBr3 with Mn leads to a shift of the main peak to lower energies by 0.04 eV. The modifications of the TA spectra are associated with changes in the bandgap energy, which is the result of doping-induced lattice expansion or compression.

We investigate spin dynamics and charge carriers' dynamics in doped and undoped samples using CTA and transient Kerr effect. We found that in the 50% Mn-doped sample spin lifetime is approximately 100 ps which is approximately 3 times longer than the lifetime in the undoped sample. We attribute these changes in spin life to the interaction of the polarized excitons with Mn spins. Spin lifetimes in doped and undoped materials were confirmed both by CTA measurements and by the transient Kerr effect.

Topics

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