On the way to colloidal spintronics – Rashba spin-orbit interaction in PbS nanosheets

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Employing the spin degree of freedom of charge carriers offers the possibility to extend the functionality of conventional electronic devices, while colloidal chemistry can be used to synthesize inexpensive and tunable nanomaterials. In order to benefit from both concepts, Rashba spin-orbit interaction has been investigated in colloidal lead sulfide nanosheets by electrical measurements on the circular photo-galvanic effect. Lead sulfide nanosheets possess rock salt crystal structure, which excludes Dresselhaus spin-orbit coupling due to the inversion symmetry of the crystal. We show that the symmetry can be broken by quantum confinement, asymmetric vertical interfaces and a gate electric field leading to Rashba splitting. We probe the influence of these parameters on the circular photo-galvanic current, originating from spin-related splitting of the band structure. Such splitting occurs in momentum space at the M points of the band structure, which results in an unconventional selection mechanism for the excitation of the carriers. The effect, which is supported by simulations of the band structure using density functional theory, can be tuned by the gate electric field and by the thickness of the sheets. Spin-related electrical transport phenomena in colloidal materials open a promising pathway towards future inexpensive spintronic devices.