Researchers demonstrate spin effects in solution-based nanocrystals

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Wet-chemically produced nanocrystals are becoming more and more powerful. They are already used in the background lighting of the latest generation of flat panel displays. In the future they will be used increasingly as active elements, which produce higher color brilliance. They are also used in other fields of application, e.g., for medical diagnosis and treatment. Now a research group around Dr. Christian Klinke from the University of Hamburg has succeeded in substantiating electronic spin effects in such nanoplatelets. In this way, more cost-effective and more powerful transistors and computer chips with lower power consumption are conceivable in the future. The two-dimensional materials are also advantageous since they can be produced inexpensively and on a large scale in a chemical laboratory and are nevertheless of the highest quality, as shown now.

The group around Dr. Christian Klinke focuses on the synthesis and characterization of two-dimensional semiconductor nanocrystals. The nanoplatelets are adjustable in their structure, but also in their optical and electrical properties (by quantum mechanical effects). This makes them interesting for application in solar cells and computer circuits.

In contrast to classical devices which work based on the electron motion, spintronic components function based on the spin orientation of electrons. When light passes through special optical elements, it can become circularly polarized, i. e. the light receives a torque. By the illumination with circular-polarized light, it is possible to align electrical charges with respect to their spin (torque) in semiconductor materials and to convert them into an electrical current without applying a voltage. Investigations on the generated current provide information about spin-dependent properties of the crystal.

The researchers have now succeeded in demonstrating this so-called Rashba effect in two-dimensional lead sulfide nanoplatelets. It is particularly interesting since this effect is normally not observed due to the high crystal symmetry of the nanoplatelets. Only by the influence of an effective electric field the symmetry is broken and a current can be measured. By varying the layer thickness of the nanoplatelets, the character of the light used, and the intensity of the electric fields, the effect could be controlled. This allows the conditions to be adapted specifically to the targeted applications, which enables the external manipulation of the electron spin. The experimental observations were supported with simulations of the electronic structure of the materials by the group of Prof. Carmen Herrmann at the University of Hamburg.

"The findings are particularly valuable as it was demonstrated for the first time that basic effects of electric spin transport are also possible in wet-chemically generated nanomaterials," says Christian Klinke. "This raises hope that also other interesting phenomena can be observed in these materials, which will contribute to improving our understanding of their properties." These new insights, which are described in detail in the journal *Nature Communications*, make a decisive contribution to our knowledge on opto-electronic properties of tailor-made nanostructures. They serve as a foundation for the further investigation of useful two-dimensional systems and their application in the field of regenerative energies, information technology, and catalysis.

Nanotechnology is a key technology of the 21st century. Materials with a size of only a few nanometers (one millionth of a millimeter) have particular optical, magnetic, electrical and photoelectric properties. They can be used in efficient light-emitting diodes, solar cells, novel sensors, photodetectors, flexible transistors, and efficient computer chips as well as in biological and medical fields. The understanding of the opto-electrical properties of nanostructures and their precise control allows the use in semiconductor electronics at the interface to optical and electromagnetic systems, which can lead to novel high-performance and energy-saving processors.

More information: Mohammad Mehdi Ramin Moayed et al, Towards colloidal spintronics through Rashba spin-orbit interaction in lead sulphide nanosheets, *Nature Communications* (2017). DOI: 10.1038/ncomms15721

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