Abstract

For a long time in the industry of electronics, the goal of increasing the efficiency of a device was as important as decreasing its size. The ultimate limit of miniaturization in the semiconductor technology is a single atom device. However, for any potential application of a given system, it is necessary to have a fundamental understanding of its various parameters and phenomena occurring therein.

Zero-dimensional semiconductor nanostructures doped with single magnetic ions, which are the subject of this thesis, are the simplest experimental system that enables optical investigations of a single atom in the solid state. In this work I discuss three examples of magnetic dopants, that can be embedded in single quantum dots, while two of them (Vanadium and Nickel) were never explored thus far. The investigated samples were manufactured by the Molecular Beam Epitaxy method and were optically characterized in spectroscopic and magnetospectroscopic measurements.

For the case of CdTe quantum dots with single Vanadium dopants a theoretical model is presented, that explains experimentally observed phenomena. Furthermore, the determination of Vanadium dopant spin equal to $\pm\frac{1}{2}$ shows that this system could be a solid state realization of a qubit.

The investigation of CdTe quantum dots doped with single Nickel ions showed their tendency to temporal variations of their charge state. Solving this issue required the development of a method of manufacturing electrical contacts for the studied samples. The application of an external electric field to the quantum dots allowed not only for the stabilization of their charge state but also opened up new possibilities for experimental studies.

In particular, the electrical contacting of epitaxially grown samples was utilized in order to further investigate an already partially explored system of CdSe quantum dots doped with single Iron ions. One of the most important outcomes was the first known observation of X^{2-} and XX^{-} states in these quantum dots.