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Abstract

Nanowires are structures with a diameter of 10-100 nm and a length 10-100 times larger. In the case of semiconductor nanowires, this shape anisotropy can be employed in optoelectronic devices such as lasers, sensors or transistors. The fabrication of radial or axial heterostructures in nanowires increases the range of potential applications of these nanostructures.

In this thesis zinc telluride nanowires are investigated. Such structures can be used in optoelectronics in the yellow range of the electromagnetic spectrum, which currently lacks reliable light sources.

The aim of this work was to study a number of phenomena related to the emission of light from nanowires. The motivation of these studies was to determine the application potential of ZnTe nanowires in optoelectronic devices. In order to achieve high efficiency of light emission from nanowires, it is important to investigate non-radiative processes that limit this efficiency. As a part of this work, the mechanisms of these processes were examined. It has been found that at 5 K the dominant process is the tunneling of electrons from the nanowire core to the surface states. As the temperature increases, a second process is activated-exciton interaction with longitudinal optical phonons. Moreover, multi-body processes were examined in a single nanowire, excited with a strong laser beam. These studies allowed to determine separately the lifetime of carriers and excitons.

Another goal of this work was to study nanowires with respect to their potential applications as converters of infrared into visible light. This was possible as a result of generation of light with a doubled frequency, the so-called second harmonic generation. With increasing excitation laser wavelength, a huge increase in the intensity of the second harmonic was observed. For doubled laser energy tuned to the energy of the exciton in the nanowire, the intensity of the second harmonic was 10000 times larger than for a 100 nm detuning. Moreover, the effect of the nanowire shape anisotropy on the efficiency of the second harmonic generation was observed and quantified.

The photoluminescence properties of axial heterostructures, i.e., the CdTe and CdMn-Te quantum dots grown in a nanowire were also examined. The Zeeman splitting anisotropy of excitonic transitions was applied in order to investigate the ground state of a hole in a quantum dot. It has been found that ground state is a heavy hole state with a small light hole admixture. The calculations allowed to evaluate the degree of heavy-light hole mixing in the

ground state. These results are important for applications of these nanostructures in quantum information processing and telecommunications.

The results obtained in these work determined the direction in which research should be continued in order to increase the efficiency of light from nanowires. In particular, it is important to reduce the tunneling rate of electrons from the core to surface states, for example by nanowire shell growth engineering. Another future research direction is to determine the impact of the nanowire shape on the extraction of photoluminescence.

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