The dissertation is devoted to atomically thin layers of semiconducting transition metal dichalcogenides. The author explores mechanisms of excitonic processes and interactions and explores technologies that may enable the large-scale use of these materials in optoelectronics in the future.

The first explored research area is the magnetic polarizability of a two-dimensional electron gas in the MoSe2 monolayer. Strong many-body effects were observed. When compared with the theoretical predictions of ab-initio methods, experimental results allow estimation of the single-particle Lande g-factor of the electron band: $g0=2.5 \pm 0.4$.

Another of the fundamental problems of two-dimensional systems tackled in this work is the understanding of the exciton formation and relaxation processes. A model of neutral and charged exciton formation and interaction was developed based on the experimental results obtained using the excitation correlation spectroscopy technique.

The excitation correlation spectroscopy technique was also used for the time-resolved characterization of MoSe2 monolayers produced with molecular beam epitaxy. Time-resolved studies revealed an exceptionally fast decay of the exciton states. Non-radiative recombination channels were identified, both at cryogenic temperatures and thermally activated at higher temperatures.

The last of the undertaken research tasks was aimed at developing a technology for producing compact, electrically controlled devices containing monolayers of various transition metal dichalcogenide monolayers. Small modules based on a miniature light-emitting diode placed under a layer of optically active material were produced. The technical limitations of this approach were analyzed, and the performance of device prototypes containing monolayers of various transition metal dichalcogenides was investigated. It has been shown that such devices can operate at cryogenic temperatures and serve as electrically controlled single photon sources.