Abstract(ENG)

Optical detectors for the mid-infrared have been broadly investigated in recent years in terms of architecture and novel active materials to improve their efficiency. These devices are used in, among others, military, various industries, medicine as well as commercially. One of the most prominent applications is optical gas detection, which is the very basis of state-of-the-art early warning systems, environmental protection, or medical diagnostics. The most important element of this dissertation was the optical spectroscopy of various active regions used in infrared detectors, such as type-II InAs/GaSb and InAs/InAsSb superlattices and resonant tunnelling diodes. Detailed experimental methodology of Fourier spectrometry was presented, as well as the numerical methods used for the identification of the measured optical features, as well as the physical theory behind them. Identification of the optical transitions in InAs/GaSb superlattices on GaAs substrates was performed and this was enhanced by experimental verification of the numerical models used to describe the influence of the interface layers on the optical characteristics. The theoretical effect of the interchanging nature of the valence states was also experimentally verified. Furthermore, the influence of interface engineering on the optical characteristics of InAs/GaSb superlattices on GaSb substrates was presented. Numerical calculations of the confined states were performed, which resulted in the identification of the optical features observed in the spectra, and the influence of the growth procedures on the energy of optical transitions was explained. The high precision of the experimental methodology allowed for the adjustment of the numerical model to fully describe the physical phenomena behind the interface engineering. In the next part, the optical features observed in InAs/InAsSb superlattices were identified. Experimental measurements allowed for the evaluation of the valence band offset parameter that describes the band discontinuity from the adjusted numerical model. In addition, the mechanism behind the carrier relaxation processes were identified using time-resolved transient absorption spectroscopy. In the last part of this work, the optical features in resonant tunnelling diodes were identified. The explanation of the high degree of linear optical polarisation observed for one of the transitions was presented, since the signal was related to the triangular quantum well partially filled with two-dimensional hole gas in the widely used GaInAsSb/GaSb material system.