World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:15, No:03, 2021

Engineering the Topological Insulator Structures for Terahertz Detectors

Authors : M. Marchewka

Abstract : The article is devoted to the possible optical transitions in double quantum wells system based on HgTe/HgCd(Mn)Te heterostructures. Such structures can find applications as detectors and sources of radiation in the terahertz range. The Double Quantum Wells (DQW) systems consist of two QWs separated by the transparent for electrons barrier. Such systems look promising from the point of view of the additional degrees of freedom. In the case of the topological insulator in about 6.4nm wide HgTe QW or strained 3D HgTe films at the interfaces, the topologically protected surface states appear at the interfaces/surfaces. Electrons in those edge states move along the interfaces/surfaces without backscattering due to time-reversal symmetry. Combination of the topological properties, which was already verified by the experimental way, together with the very well know properties of the DQWs, can be very interesting from the applications point of view, especially in the THz area. It is important that at the present stage, the technology makes it possible to create high-quality structures of this type, and intensive experimental and theoretical studies of their properties are already underway. The idea presented in this paper is based on the eight-band KP model, including the additional terms related to the structural inversion asymmetry, interfaces inversion asymmetry, the influence of the magnetically content, and the uniaxial strain describe the full pictures of the possible real structure. All of this term, together with the external electric field, can be sources of breaking symmetry in investigated materials. Using the 8 band KP model, we investigated the electronic shape structure with and without magnetic field from the application point of view as a THz detector in a small magnetic field (below 2T). We believe that such structures are the way to get the tunable topological insulators and the multilayer topological insulator. Using the one-dimensional electrons at the topologically protected interface states as fast and collision-free signal carriers as charge and signal carriers, the detection of the optical signal should be fast, which is very important in the high-resolution detection of signals in the THz range. The proposed engineering of the investigated structures is now one of the important steps on the way to get the proper structures with predicted properties.

Keywords : topological insulator, THz spectroscopy, KP model, II-VI compounds
Conference Title : ICIPT 2021 : International Conference on Infrared Physics and Technologies
Conference Location : Rome, Italy
Conference Dates : March 04-05, 2021