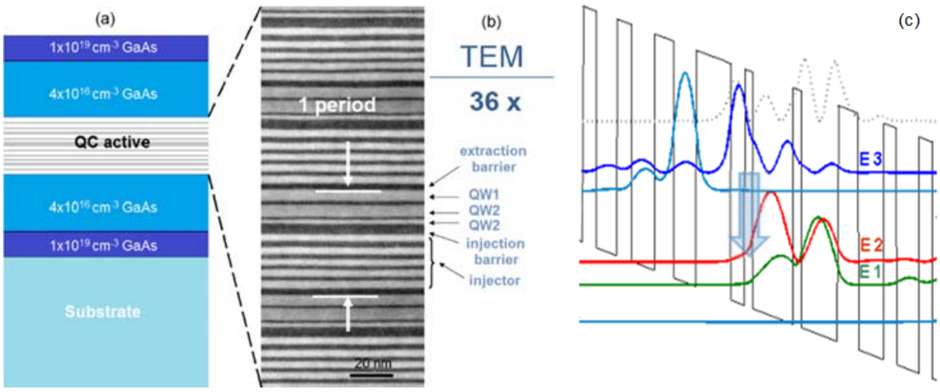
Optoelectronic devices are now everywhere. They work, e.g., as light sources and receivers. Such a pair is for example used to remotely control TV's; there is a light emitting diode in the control unit and a photodetector in a TV set. Both are the small optoelectronic devices that use the radiation to communicate each other. Nowadays devices are getting smaller and smaller, not only in order to save space and become cheaper, but also because they can have quite new features when become very small. These new features arise due to quantum nature of the matter which manifests itself when the size of the system goes to nanometer scale. Such devices require special tools for their analysis and design. They allow to simulate devices, their features and characteristics. Usually, these are the computer programs, called simulators, that analyze the theoretical model of the device. The model consists of the set of equations derived from more general laws of physics which - in case of nano-optoelectronic devices - include the laws of quantum mechanics. The set of equations included in device's model is usually very complex, and so must be solved numerically. This is what quantum-mechanical simulators do. In the project, a new simulator of nano-optoelectonic devices will be developed. It will be attempted to better describe the interactions between the matter and the radiation (light) that take place in such devices. An example of such nano-optoelectronic devices is a new type of semiconductor laser, the so called quantum cascade laser. The figure illustrates quantum states in the laser calculated with the help of quantum optoelectronic simulator. The wavelength of the light emitted by this laser is described by the energy difference between states E3 and E2. This difference depends on the width of the layers in laser's structure. The use of the simulator allows to design the structure, i.e., tune layers width such that the emitted light has the desired wavelength.



The structure of GaAs/AlGaAs quantum cascade laser (a) and microscopic image of a few periods of its active region (b). The darker/brighter layers are made of AlGaAs/GaAs materials. The results of simulations of such structure are shown in (c).