

Infrared Imaging Sensor

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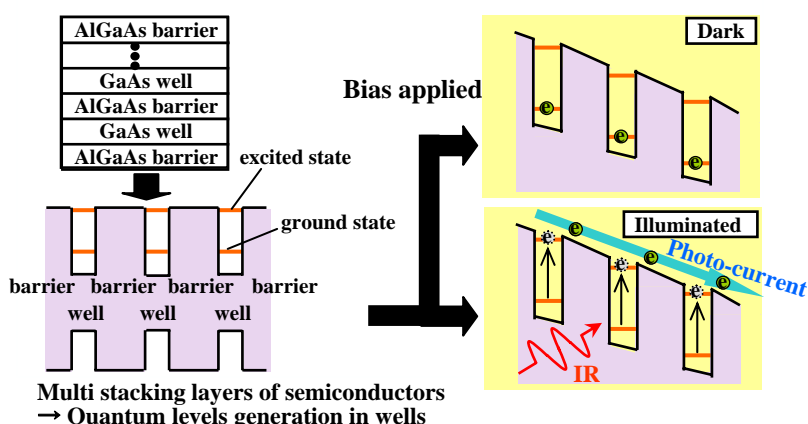
Abstract

Infrared imaging is attractive as a key technology for the sensor networking security system, that intends to support secure and comfortable society. Infrared ray, invisible light whose wavelength belongs among 1-100 micron, is emitted from various objects owing to their temperature. Infrared imaging sensor can detect infrared radiation from faraway objects and visualize their surface temperature distribution in real time. By utilizing such features, infrared imaging sensor is applied to medical use (inspection on human body's temperature) or security use such as the continuous surveillance on infrastructures in day and night. Recently, its application would be extended another fields, for example, night car-driving support.

Technology

Quantum well infrared photodetector (QWIP) is constructed by few nanometers alternatively stacking layers of III-V compound semiconductors whose band-gaps are different from each other. Such multi-quantum well (MQW) structures create dispersed quantum sublevels in their conduction band, and infrared beams are absorbed due to the energy difference between quantum sublevels. Thus, infrared detection wavelength of QWIP is controlled by adjusting the energy height of barrier layers and thickness of well layers. As the photo-excitation by normal incidence to MQW layers is weak because the quantization mechanism works only along the stacking direction in this structure, the optical couplers, which convert the normal incidence to the scattered infrared beams by using random reflection, are attached on QWIP and enhance the infrared absorption. Our designed optical coupler is consisted from peculiar ellipsoidal curves which can be easily fabricated by one-step etching and its optical coupling efficiency is larger than the former optical couplers based on the random reflector.

Infrared imaging sensor is fabricated by hybridization of QWIP-array chip made from 50 stacks AlGaAs/GaAs layers and Si read-out integrated circuit (ROIC) which outputs video signals by multiplexing of many pixels, where QWIP element and ROIC unit cell are individually connected with In bump electrode. Our developed QWIP has the response peak wavelength of $8.5 \mu\text{m}$ and the world highest class performance on thermal resolution of 0.05K, that is possible to distinguish very small temperature difference of human skins.



Device mechanism of QWIP



Infrared image taken by QWIP