Design and Characterization of Al/GaSe/MgO/Ag Hybrid Devices

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Abstract

A new hybrid type device is designed and characterized. The design is actualized in the scope of the theoretically derived band diagrams of Schottky Al/GaSe, the p-n junction n-GaSe/p-MgO and the Schottky Ag/MgO interfaced together. Geometrically two Schottky diodes one of p-type majority and another is of n-type majority are brought together. The total area is ~200 μ m^2, while the height is ~50 μm. The resulting structure is characterized by means of optical spectroscopy, current voltage characteristic curves, capacitance, and resistance and inductance spectra in addition to the microwave power absorption spectra in the frequency range that extends to 3.0 GHz under no biasing conditions. Optically, the energy band gap of the 0.8 μm thick GaSe devices is determined as 1.6 eV. As the MgO energy band gap is 7.8 eV, with the help of the midgap rap rule the valance band splitting is determined to be 3.19 eV. On the other hand, the current voltage characterization of the device is observed to be governed by the electric field assisted thermionic emission for low field values during reverse biasing process and up to 1200 V/cm. The tunneling of charged particles is through a wide barrier of ~670 nm during the forward biasing operation and relatively narrow barrier of 116 nm during the reverse basing operation. The barrier height is ~0.81 eV. In addition, the capacitance frequency dependence spectral analysis in the frequency region of 0-2000 MHz reflects a resonance anti resonance physical phenomena at ~1.0 GHz. The inductive region width during the resonance-anti-resonance operation is 134.67 MHz. Moreover, when the hybrid device is inserted between the electrodes of the device the amplitude of the ac signal power shows

a sharp decrease with increasing frequency down to 1.5 GHz follow by strong growth with growing frequency. Such behavior indicates the applicability of the device as a band stop filter that can absorb signals with notch frequency of 1.5 GHz. The feather of the Al/GaSe/MgO/Ag device are promising as they appear to be suitable as for use as processor clock controller, microwave band stop filter, and as an effective electronic element in the optoelectronic communication systems including the visible light communication, Wi-Fi and WLAN communications.