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Illumination Effects on the Capacitance Spectra and Signal Quality Factor of Al/InSe/C Microwave Sensors

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Amorphous indium selenide thin films have been used in the design of a microwave-sensitive Schottky barrier. The illumination effects on the capacitance spectra, on the signal quality factor, and on the capacitance (C)–voltage (V) characteristics of the Al/InSe/C device are investigated. Particular shifts in the amplitude and in the resonance peaks of the capacitance spectra which were studied in the frequency range of 10.0 kHz to 3.0 GHz are observed. While the photoexcitation of these devices increased the capacity level by ~1.6 times the original magnitude, the dark quality factor, which was 2.2×10^6 at 3.0 GHz, fell to 1.2×10^6 when subjected to luminance of 14.7 klux. Analysis of the C–V curves recorded at signal power ranging from wireless local area network (LAN) levels to the maximum output power of third generation (3G) mobiles reflected high tunability of capacitance upon increasing the voltage or power. The tunability of the biased capacitance was much more pronounced in the light than in the dark. The obtained characteristics of the Al/InSe/C sensors indicate their usability in radio and microwave technology.

Key words: Semiconductor devices, InSe, thin films, optical

INTRODUCTION

Devices made from metal–semiconductor structures play a key role in modern electronics as components in microelectronic integrated circuits. These devices include microwave field-effect transistors, radiofrequency detectors, phototransistors, heterojunctions, bipolar transistors, quantum confinement devices, and space solar cells.[1] In addition to these devices, Schottky diodes are known as superior microwave mixers and microwave detector diodes, because they are majority-carrier devices and can be switched rapidly from forward to reverse bias without minority-carrier storage effects. When Schottky junctions are illuminated with photons whose energy values are greater than the semiconductor energy band gap (E_g), electron–hole pairs are produced in the depletion region of the semiconductor; as a result, these devices show a photovoltaic effect. Examples of these devices are indium-selenide-based thin-film devices. InSe films are reported to exhibit good properties for fabrication of solar cells,[2] voltage rectifiers,[3,4] photodiodes,[5] gas sensors,[6] switching devices,[7] detectors,[8] and Li solid-state batteries.[9]

Yilmaz et al.[10] studied SnO_2/p-InSe/metal Schottky diode structures made of Ag, Au, Al, In, and C metals based on their current–voltage and capacitance–voltage characteristics. The best rectifying contacts were obtained in a SnO_2/p-InSe/Ag Schottky structure based on I–V measurements, while the Au contact showed poor rectification. Other metal contacts (Al, In, and C) showed almost Ohmic nonrectifying behavior for all samples. The ideality factor and barrier height values with the Ag contact were found to be 2.0 and 0.7 eV, respectively.[10] Capacitance spectra and capacitance–voltage characteristics of the SnO_2/InSe/Ag structure were studied in the frequency region of 0.0 MHz to 1.0 MHz and at 10 kHz between −1.5 V and 1.5 V, respectively. On the other hand, SnO_2/In_2Se_3/Au

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