ISSN 0735-2727, Radioelectronics and Communications Systems, 2008, Vol. 51, No. 5, pp. 280–283. © Allerton Press, Inc., 2008.
Original Russian Text © D.M. Yodgorova, 2008, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2008, Vol. 51, No. 5, pp. 65–71.

Specialities of Optical FET with Tin-Doped Junction Channel

D. M. Yodgorova
Physical-Technical Institute NPO "Fizika-Solntse" Academy of Sciences of Uzbekistan, Tashkent

Received in final form April 4, 2007

Abstract—This paper deals with researches of phototransistor based on gallium arsenide with tin-doped channel. It is experimentally shown, that in contrast to usual phototransistors with tellurium-doped channels, gate photocurrents are constant, i.e. independent on blocking voltage, and these currents grow with light intensity increase. At that time total photo sensitivity is smoothly controlled by working voltage and it achieves high values, current sensitivity achieves 8.26×10^2 A/W, voltage sensitivity achieves 1.3×10^8 V/W.

DOI: 10.3103/S0735272708050087

Field effect transistors (FET) with controlling junction find an application for optical and microelectronics devices. There are developed very high frequency both low-powered and high-powered FETs, begining to substitute bipolar transistors according to many parameters. An application for their construction materials with high movability, in particular, gallium arsenide heterostructures allows to expand their functionality. New technology application and perfection of FET construction give an opportunity to use it as an amplifier of electrical and light signals and also for magnetic sensitive elements. Last time different optic FETs and magnetotransistors appear [1, 2]. An information about photo sensitivity of FET with controlling homo *p-n*-junction based on gallium arsenide appears in papers [3, 4]. Here optical FET was illuminated by integrated light (light intensity changes from 400 to 8500 lux) with maximum wavelength 0.55 μm. High photo sensitivity (400 A/W) was obtained due to channel can be illuminated directly and its width (0.5–0.7 μm) was selected less than light penetration depth from proper domain and also due to high output resistance. Photocurrents and photovoltages was maximal in saturation region in current characteristic. Photocurrent dependently on blocking voltage also achieved maximal value (at 1 V) and then it was three and more times decreased, when voltage values (2.5 V) tended to cut-off voltage (3 V). High sensitivity region position at narrow working voltages interval (1–1.5 V) can be related to growing character of tellurium impurities in channel width [5].

In this paper we present researches results of photosensitivity specialties of optic FET with *p-n* junction, whose channel is tin–doped.

Investigated structures were created according to criteria, stated in certificate of recognition [6] with intermediate epitaxial *p*-layer between channel and p^+GaAs gate. Correspondingly,

$$h_{\text{int}} = h_{\text{ch}}(N_{\text{ch}} / N_{\text{int}})^{0.5},$$

where N_{ch}, N_{int} are carrier concentration in channel and intermediate *p*-layer, h_{int}, h_{ch} are thickness of intermediate layer and channel correspondingly. In particular, epitaxial channel of *n*GaAs, tin-doped up to concentration of 3×10^{16} cm^{-3} is grown by means of liquid epitaxy on the top of intermediate epitxial *p*GaAs layer with concentration of 3×10^{17} cm^{-3} and with thickness of ~0.1 μm, which is grown on heavily p^+GaAs (2×10^{19} cm^{-3}) substrate. Epitaxial layer—channel thickness is 0.32 μm and its width is 700 μm. Distance between source and drain contacts (channel length) is 50 μm. Light sensitivity area of channel is 3.5×10^{-2} mm^2. Tin selection as a dopant was determinate by two factors. At first tin in epitaxial layer compensates internal stresses and it reduces amount of gallium inclusions, captured by grown epitaxial layer, while tellurium promotes their growth [7]. Gallium inclusion presence leads to back current growth due to tunnel effect appearance [8]. At second, while tellurium carrier concentration in epitaxial layer grows along its thickness [5], whereas tin provides diminution carriers concentration, that increase efficiency of FET channel cut-off.