

# Comparison of Obtain of Phase Photo-Response Images in Case of Scanning of Semiconductor Heterostructures in $p$ - $n$ Junction Perpendicular Plane

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**Abstract**—It is carried out comparative analysis of the methods of research of photo-electric response on example of scanning of semiconductor structure of laser diode on a basis of AlGaInP in direction, which is perpendicular to  $p$ - $n$  junction plane. We discovered and theoretically proved a difference in results obtained by means of phase and differential-phase research methods. It is shown differential-phase research method allows to obtain addition information about optical properties which are not present in results, obtained by phase method.

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## INTRODUCTION

Now development of semiconductor electronics requires application of fast nondestructive methods for research and control of semiconductor structures. There are known a lot of methods based on amount of optical, electric and X-ray measurements [1]. Among them there is a method of scanning laser microscopy LBIC (Light Beam Induced Current) [2], which is based on appear of photo-voltage in case local illumination of space non-uniform layer of semiconductor material.

In this method the information sources are amplitude and phase of photo-flow, which is induced in near-surface layer of researched semiconductor structure in case of its scanning by focused laser beam (which is amplitude modulated in case of phase measurements). In this connection in LBIC method there are amplitude [2] and phase [3] measurements modes. Amplitude mode basically is used for control of the solar elements fabrication quality [4]. But like the other amplitude methods it has an essential drawback, which lies in light generated near-surface charge carriers in case of propagation in the semiconductor body “diffuse” that results in decrease of total current amplitude and hence in decrease of obtained images contrast.

From the other hand, as it was shown in [3], application of photo-current phase as an information source allows to obtain amount of information about semiconductor properties, related to lifetime of minor carriers, their diffusion velocity and the other parameters defining photo-current phase. Moreover phase images of the semiconductor structure are more contrast and they contain more details of the object researched. But for semiconductor materials with small relaxation time of the minor carriers with great diffusion velocity an essential influence on photo-current phase can be obtained in case of great modulation frequency that is not realized always.

For example, for material of GaAs for different semiconductor types relaxation time is from  $10^{-9}$  to  $10^{-7}$  s that corresponds to necessary modulation frequency in a range of hundreds MHz. In this paper in addition to phase method it is proposed to consider differential-phase method for research of LBIC signal phase [5, 6].

The purpose of the paper lies in showing the difference between classic phase measuring mode of LBIC signal and measurement of phase of the same signal, induced applying differential phase method on example of photo-response image of semiconductor heterostructure of the laser diode. Such research is represented interesting, since there are amount of papers [5, 6] showing the application of differential-phase method for research of semiconductor structures is promising, but there are no comparison of its results with traditional phase method.