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INVESTIGATION OF OPEN-CHANNEL OPTRONS FOR THE CONTROL OF METAL SURFACES QUALITATIVE PARAMETERS

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Abstract

The paper deals with the techniques and the results of the experimental research as concerns characteristics of open-channel semiconductor optron in fiber-optical systems for the control of metal surfaces qualitative parameters.

Key words: semiconductor, open-channel optrons, metal surface, optocouplers.

Introduction

The main primary elements of optocouplers are semiconductor emitters: light emitting diodes (LEDs), super luminescent diodes (SLDs) and LD; optical radiation receivers s): photo resistors (PR), photodiodes (PD), phototransistors (PT) and AFN-receivers (AF).

The main requirements for emitters: high radiation power, matching spectral characteristics with the characteristics of optical fibers (OM), reliability, small size, reasonable price. In this respect, LEDs are simple, durable, inexpensive, but have a low efficiency of radiation in an OF, limited bandwidth and transmission distance. The power of optical radiation is 0.5 - 5 mW.

The principle of operation of the SLD is similar to a strip LD and differs in that one of the mirrors is removed and the feedback is weakened. Their emission spectrum is xy, and the energy brightness is higher than that of LEDs. The power of the optical radiation (100 - 500 μ W) is much lower than that of the LED, so they are not used in our research.

The main advantages of LD are compactness, durability and high efficiency. Compared with LEDs, they have greater optical power (1-10 mW), a higher limit modulation frequency, a smaller spectral width and better radiation directivity. The disadvantages of LD are lower durability ($3 \cdot 10^4 - 2 \cdot 10^5$ hours) and high price. The width of the emission spectrum at LD 0.2-5 nm, with SLD – 5-8 nm and LED – 30-35 nm [1].

The average angular divergence of the radiation at LD 30° -

5° (in a plane parallel to the pn-junction) and $30^\circ - 60^\circ$ (in a plane perpendicular to the pn-junction) at LED $100^\circ \dots 120^\circ$; for LD $25^\circ - 30^\circ$ (in the plane parallel to the pn-junction) and $30^\circ - 60^\circ$ (in the plane perpendicular to the pn-junction).

The main requirements for semiconductor softwares: high sensitivity, consistency of spectral characteristics with a range of wavelengths of radiation, high speed, linearity of the signal and a large dynamic range of conversion of optical radiation into an electrical signal. These requirements are currently met by semiconductor PR, PD, PT, and AF.

Of all the diversity of ORRs [2], the PR, PD, and PT devices are considered the most accessible and used in optoelectronic instrument engineering. Attention is paid to their parameters and features of use in opto-pairs, the principle of action of which is based on the combined use of radiators and ORR.

Method and discussion

The following study describes the methodology and the results of an experimental study of the characteristics of a semiconductor open channel optocoupler for fiber optic systems. Four types of the optocoupler of the open channel were investigated: “emitter - PD”, “emitter - PT”, “emitter - PR” and “emitter - AF”. A polymer fiber of circular cross section in a protective sheath with a core diameter of $d_c = 0.4$ mm, a diameter of a reflecting shell $d_o = 0.6$ mm and a length of 1 m was used as an optical fiber.

The connection “radiator - connector - optical fiber - con-

necter - ORR” was investigated. To remove its characteristics, experimental stands were assembled (Fig. 1, 3). From the power supply (PS=БП) unit БП₁, through a variable resistor R₁, current is supplied to the emitter of the LED or LD (voltage 2 V). The radiation of LED or LD through the connector P is fed through the OF to the photosensitive surface of the ORR. The milliammeter mA₁ controls the current of the radiator, and the milliammeter mA₂ controls the current of the ORR through the regulating resistor R₂, which is powered by БП₂. An electrostatic voltmeter is used in the circuit with an AF receiver as a measuring device.

The characteristic of an optocoupler pair was taken,

where LEDs AL108A and LD-ILPN-301-1 were used as emitters. A photodiode PD290 served as a ORR (Fig. 1).

For LD ILPN-301-1, the characteristic is steeper, since this LD has a higher radiation power compared to the AL-107A LED. Obviously, for VOS it makes sense to take a radiation source with a steeper characteristic.

The experiment was carried out at room temperature (t = 21° C). The results of the experiment are presented in Fig. 2 as a graphical dependence of the ORR current on the radiation source current. From the experimental results, it can be seen that the characteristic is quite close to linear.

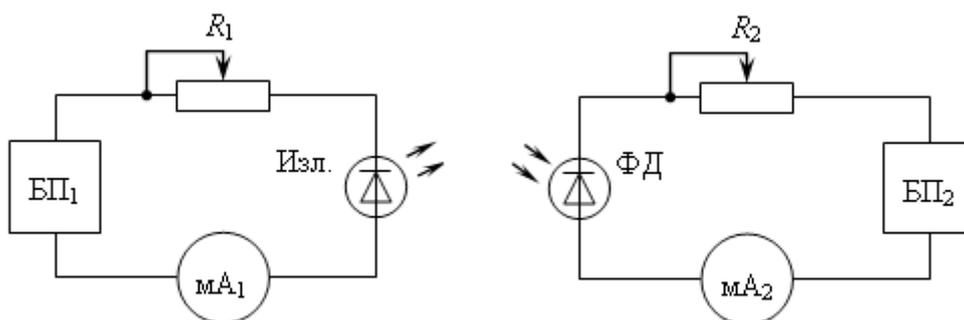


Fig.1. Optocoupler pair IL-PD.

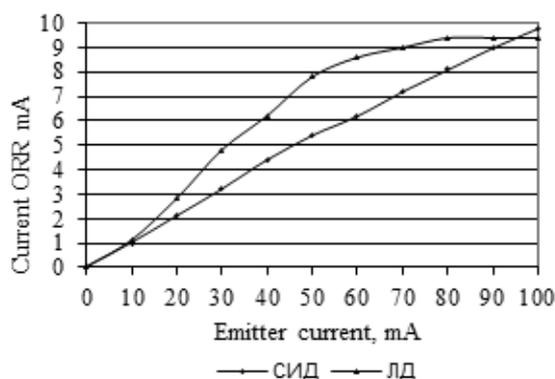


Fig.2. Characteristics of the optocoupler IZL-FD.

The characteristics of an optocoupler pair were taken, where the FT-3G phototransistor was used as the ORR. The scheme of the experimental stand is presented in Fig. 3. The results of the experiment are shown in Fig. 4 in the form of graphs. LD ILPN 301-1 has a high emission yield coefficient compared to the AL-107A LED, and the limiting values of the current passing through the emitters are the same.

The supply voltage of the FT, which is limited by the

maximum permissible value (15 V), determines the steepness of the characteristics of the open channel optocoupler.

Based on the studies performed, an optocoupler pair was selected (Fig. 1), which is convenient to use and is in good agreement with the emitter. Currently, there are available in series blue emitters AL307. Based on this open-type optocoupler, an analyzer was developed to control the characteristics of metal surfaces.

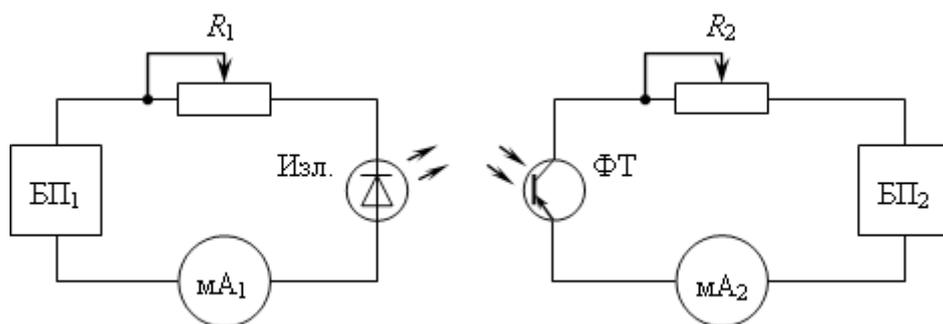


Fig.3. Optocoupler via OV IZL-FT.

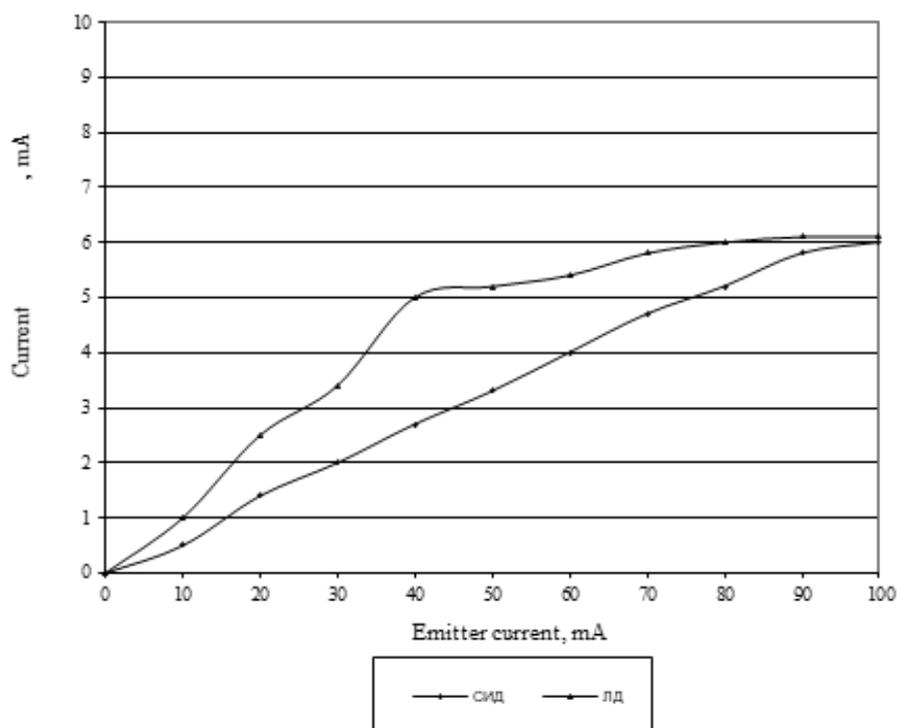


Fig.4. Characteristics of an optocoupler pair of IZL-FT.

In Figure 5 shows the block diagram of the device for analyzing the color of the surface of solid materials, and Fig. 6 - one of the options for the sensor. The color analyzer consists of a sensor and an electronic unit. The sensor is made in the form of a hemisphere 1, in which three pairs of Y-shaped inlet 2-4 and outgoing 5-7 optical fibers are installed.

The electronic unit includes a master oscillator 9, a switch 10, three flip-flops 11-13, three outputs of which are connected to three measuring LEDs 14, 16, 18. The second three outputs - to compensation LEDs 15, 17, 19, three optical receivers radiation 20-22, the output of each receiver of optical radiation is connected to the input of the corresponding

comparison unit 23-25, the output of each of which is connected to the corresponding measuring device 26-28. Further, the electronic unit includes a photoelectric signal-processing unit 29, a storage device 30 and a measuring system, for example, a computer. The device works as follows. The master oscillator 9 generates pulses that are fed to the input of the switch 10. The separating pulses are fed to the input of three identical triggers 11-13, three outputs of which are connected to three measuring LEDs 14, 16, 18, the second three outputs - with compensation LEDs 15, 17, 19-pulses from the flip-flops come to the corresponding LEDs. Each optocoupler is responsible for monitoring a particular parameter.

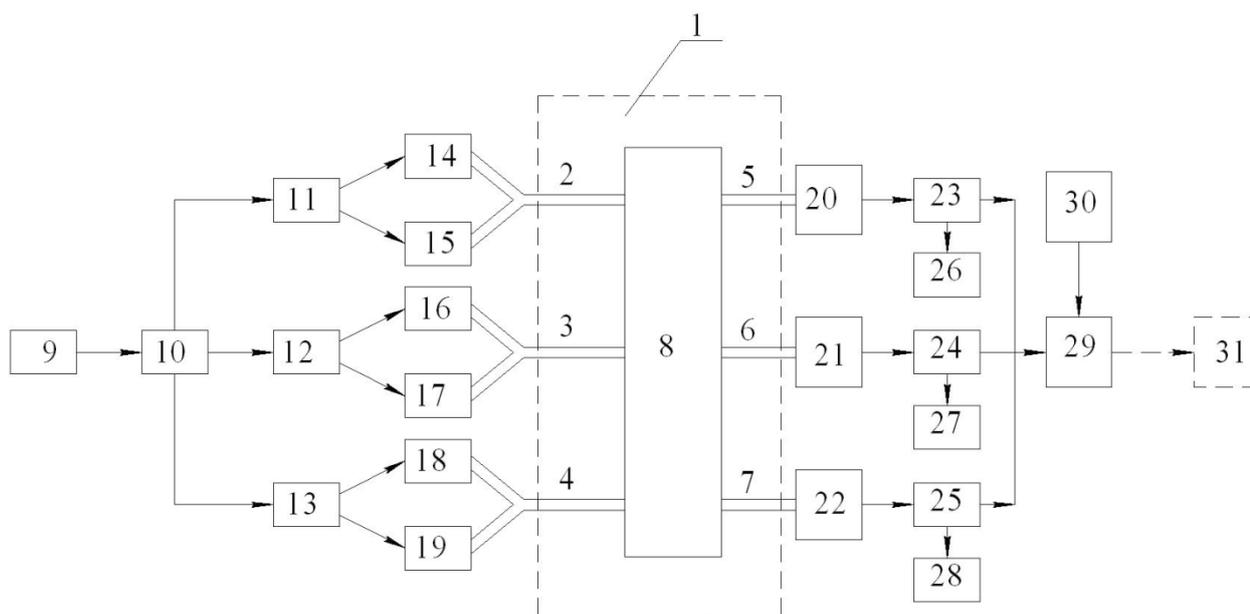


Fig.5. Block diagram of the analyzer device.

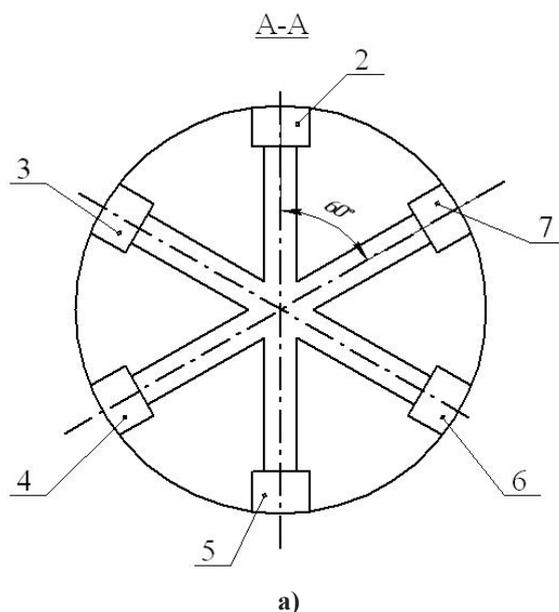
The controlled surface 8, which is enclosed in the hemisphere 1, is irradiated through the supplying optical fibers 2-4 by two light streams (measurement and compensation).

Optoelectronic pairs are enclosed in an annular casing made of soft rubber for the required orientation of the sensor and the optical insulation of the optical channel and are located at an angle, for example, 45°, relative to each other and symmetrically relative to the normal to the test surface at the reflection ORR.

Optical radiation is reflected from the monitored surface and the output optical fibers 5 - 7 are fed to optical radiation receivers 20-22 operating at wavelengths $\lambda_1 = 680 \text{ nm}$, $\lambda_2 = 560 \text{ nm}$, $\lambda_3 = 450 \text{ nm}$ and converting optical signals into elec-

trical ones.

Due to the passage of light through the supply and discharge wholesale-fiber, a narrow beam of radiation is fed and received, which makes it possible to control the parameters. Next, the signal hits its own comparison block 23, 24, 25, the ratio of two signals (measuring and compensation) is taken, and then the shades of three colors are determined by measuring system 26, 27, 28. The measurement process at this stage can be completed. Or three signals can be sent to the photoelectric signal processing unit 29, where they are matched with any of a number of model stored in the storage device 30. Then, both signals and their ratio are fed to the measuring system or to the computer 31.



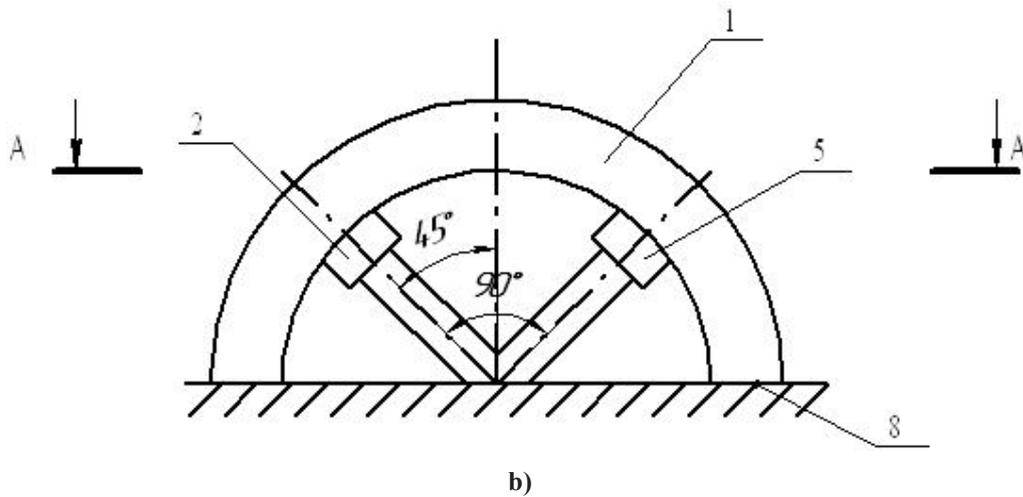


Fig.7. One of the embodiments of the sensor.

Due to the passage of light through the inlet 2-4 and outgoing 5-7 optical fibers, a narrow beam of radiation is fed and received, which enables the control of parameters.

If necessary, the signal from the output of the photoelectric signal-processing unit can be fed into the automatic control system.

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