Image acquisition of the test-object by the CVL-10 copper-vapor amplifier and optical bunch

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Abstract. Images of the test object surface were obtained using a laser projection microscope and an optical bunch. Images of the surface of the test object at its different location in the experiment (the test object is located at the end of the optical bunch; the test object is located in a double focus lens; the test object is located after the optical bunch and optical system of two lenses) were obtained on the screen of a laser projection microscope.

1. Introduction
The registration of laser-induced processes on the surface of various materials using a laser monitor (brightness amplifier of copper vapor CVL-10) is presented in many works, for example [1-6]. The problem is that the distance from the processing surface to the input lens of laser monitor is fixed, which is inconvenient in the study of technological processes of laser processing of various materials. The optical harness (OJ) allows to carry out researches of processes of interaction of laser radiation with a surface and in cases of rather arbitrary arrangement, both in space, and on remoteness from the laser monitor.

2. Experimental work
The scheme of the experimental setup is shown in Figure 1.

![Figure 1. Scheme of the experimental installation for monitoring the surface of the test object](image)

As a laser projection microscope (LPM), a brightness amplifier on copper vapors CVL-10 was used with the following characteristics: length of the active element l=0,8 m, diameter d=18 mm, unsaturated gain coefficient α = 0,14 cm⁻¹; emitting at a wavelength λ=510,6 nm.
CVL-10 copper vapor laser radiation focuses on the surface of the optical bundle using a lens with a focal length of 125 mm and an antireflection coating of 400 – 700 nm. The paper used a fiber-optic bundle with the following characteristics: the calculated numerical aperture of 0.5; resolution of 8-15 mm\(^{-1}\). An optical wedge (refractive angle \(\theta = 4^\circ\)) is glued to the end of the optical bundle to reduce the reflection of radiation.

After the optical bundle, an optical system consisting of one lens or two lenses was installed to focus the radiation on the test object. Lens material BK7, focal length 50 mm and 200 mm.

The model of the treated surface was a test object (TO), which is a plate of polished stainless steel, on which the laser engraving applied strokes with a certain amount per millimeter (from 1.75 to 10 strokes per millimeter (Fig.2).

![Figure 2. Image of the test object surface (numbers indicate the number of strokes per millimeter)](image)

### 3. Experimental results

In Figure 3 shows the image of the surface of the test object obtained on the screen of the LSM without the use of coolant. The number of strokes per millimeter is 2.5.

![Figure 3. The image of the test object on the LPM screen.](image)

The image clearly shows the surface of the test object and the frequency of the bands.

In Figure 4 the images of the test object surface obtained on the LPM screen using coolant are presented. The test object was located at the end of the optical bundle.

![Figure 4. The image of the test object on the screen LPM: a) 2.5 strokes per millimeter; b) 5 strokes per millimeter; c) 7.5 strokes per millimeter.](image)

The periodicity of the structures is observed, but the image contrast is low, since part of the radiation involved in the formation of the image when passing through the optical bundle is lost.
Figure 5 presents the image of the surface of the test object located in the double focus of the lens with a focal length of 50 mm is presented.

![Image of the test object on the LPM screen located at a distance of 100 mm from the lens.](image)

**Figure 5.** The image of the test object on the LPM screen located at a distance of 100 mm from the lens.

The image of the surface has low contrast. Part of the radiation involved in the construction of the image is lost when passing through the coolant and the optical system. In Figure 6 the images of the test object surface located at a distance of 50 mm from the second lens are presented (Fig.1). The image is obtained on the screen, which is located behind the test object at a distance of 30 cm.

![Images of the test object surface were obtained in reflected light from the spherical surface of the lens. Contrast and sharpness of the image is observed.](image)

**Figure 6.** The image of the test object on the screen: a) 2.5 strokes per millimeter; b) 1.75 strokes per millimeter.

Images of the test object surface were obtained in reflected light from the spherical surface of the lens. Contrast and sharpness of the image is observed.

4. **Conclusion**

Images of the test object surface were obtained using a laser projection microscope and an optical bundle. The use of an optical harness can significantly improve the capabilities of the laser monitor and observe laser technological operations (laser cutting, welding, etc.) at an arbitrary distance from point of impact. In the micro-processing of local areas of 3D-products of complex profile, the use of laser projection monitor together with an optical bundle can give fundamental advantages in the aspect of controllability of the process directly during its implementation and achieve the required/record processing accuracy.

**References**

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