Maxim V. Trigub: HARDWARE-SOFTWARE SYSTEM BASED ON THE CUBR-LASER FOR HIGH-SPEED PROCESS VISUALIZATION

Abstract

Nowadays studying nanosecond and nanometer ranges becomes rather popular. Moreover, the processes of particular interest are those of interaction of powerful energy fluxes with matter that occur in circumstances with the background light being involved. These are the processes such as laser material processing, gas-discharge film deposition, e-beam surface modification, tissue irradiation by concentrated energy fluxes, self-propagating high-temperature synthesis (SHS) and etc. It is rather hard to observe the process in its progress but still possible using modern high-speed detectors. Usage of such methods is limited by the power of background light. Laser methods such as laser monitor and laser illumination will help to widen the range of processes being studied [1].

The method of laser illumination is as follows. The object under observation is illuminated by the outer radiation source (laser), a reflected signal is passed through a band-pass filter and is then fed to be registered by sensors. The advantage of this method is its simplicity and possibility of ‘compact’ realization due to the use of lasers with small weight and size parameters, such as semiconductor lasers.

The second method is based on the use of systems with image amplifiers [2]. Its principle of operation is as follows. Superluminosity radiation of a laser amplifier is focused on the object by means of an objective lens, reflected signal (image, echoed signal) and radiation of the background light passing through the lens is brought to the active medium at the time instant when inverted population is still present. Due to this only the signal with the wavelength of the generation spectrum of an operated laser is amplified. Thus, at the output of a brightness amplifier we will get an object image amplified in brightness.

In paper [3] it has been shown that an object can be observed with a laser monitor even at temperatures exceeding 25000 K. To illustrate this possibility the following experiment was carried out. The metal gauze was chosen as an object, it was located behind the flame of a d.c. arc which was ignited using welder BlueWeld Prestige 164. The object was visualized with a laser monitor at different currents. The results are shown. Therefore, the presence of background light (according to estimates, the temperature being more than 10000 K) does not influence the quality of an image, which is evident from images and has also been proved using calculations, i.e. we have deter-mined the brightness of each point [5].

In order to study the possibility of using the proposed method of monitoring for the investigation of processes that occur in biological object at the time of energy flux impact, we carried out a set of experiments on visualization of coagulation process, and the peel of an apple 1 mm thick was taken as an object. As a coagulator we used the device AHVCH-400. The coagulation was produced by the electric arc from the electrode at a contactless impact. Under coagulation bright luminous plasma of the discharge shields the impact zone, and the process observation becomes impossible. As a

brightness amplifier for the laser monitor a small-size CuBr-laser was used. Pulse duration of superradiance was 40 ns. As a registrator CCD-camera FastCam HiSpec 1 was used with a framing rate up to 100 thousands frames per second. During the experiment the framing rate was 1800 frames per second, the exposition time was 2 µs.

For imaging we use free software – VirtualDub [4] for work with videos and ImageJ [5] for imaging in our experiments.

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Keywords: Imaging, active optical system, laser monitor, CuBr-laser.

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