Development of the graphene matrix - polymeric composite for use as an optical modulator based on multi-layered graphene

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Abstract. The article describes the stages of obtaining an absorbing medium based on multilayer graphene in a matrix of carboxymethyl cellulose on an optical substrate. The results of the analysis of the obtained graphene - carboxymethyl cellulose medium are presented. A possible variant of testing the absorbing - saturating properties of the working environment is described.

1 Introduction

Today, passive mode locking [1] is used to obtain ultra short pulses in femtosecond fiber laser systems. Often this mode is provided by SESAM absorbers [2], which have a relatively high cost.

Absorbers on carbon-containing structures can be compared with SESAM modulators in parameters. Their development consists in applying a material layer of a few micrometers thick at the base of the optical element. [3]. In this case, as a working material, multilayer graphene structures can be used.

2 Optical modulator based on multi-layered graphene

The synthesis of the matrix of graphene – polymer composites was carried out in several stages. The first stage was to obtain a graphene - graphite mixture under the influence of high-frequency laser radiation on highly oriented pyrolytic graphite in liquid nitrogen.

As a result, a powder representing a combination of graphite and graphene particles was formed on the laser - substance interaction surface.

During the second stage, particles were separated and a graphene layer was separated in a carboxymethyl cellulose polymer medium by centrifugation under the influence of ultrasound. The result was a suspension of graphene in carboxymethyl cellulose (SAG). In order to test, the resulting suspension was placed on a quartz substrate using the optical strait technique. Conducted Raman spectroscopy showed that the test sample is a multilayer graphene (Figure 1).

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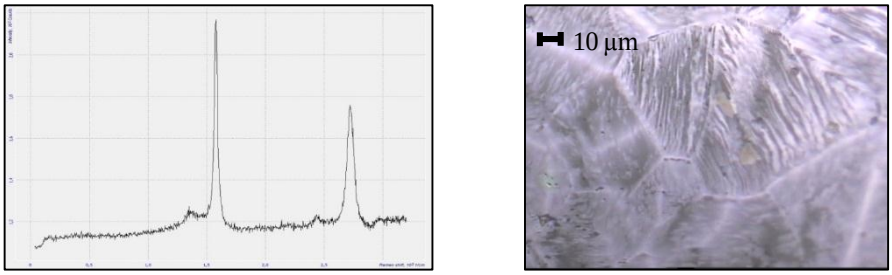

Fig. 1. Test sample SAG: a - Raman peak at 3-5 layers; б - the structure of multilayer graphene.

3 Conclusion

To use the composite as an optical modulator in fiber-optic laser systems, it is necessary to determine the nonlinear characteristics of optical absorption using the z-scanning method. It is supposed to determine the intensity of saturation, the unsaturated part of the absorption, the saturable part of the absorption. If it is necessary to measure the nonlinear absorption parameters of the sample, all radiation passing through the sample is recorded [4]. When the sample moves to the point z = 0 (lens focus 2), the power density of laser radiation on the sample increases due to a decrease in the beam diameter (Figure 2).

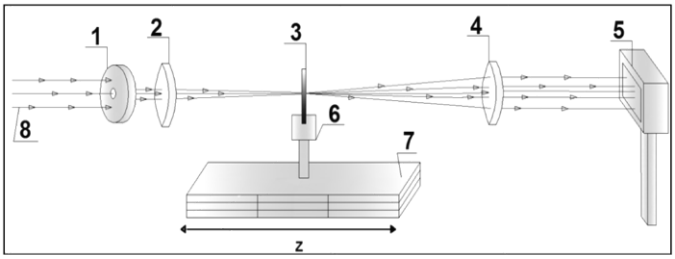

Fig. 2. Schematic diagram of the Z scan method: 1 – aperture; 2,4 – lenses; 3 – test sample; 4 - collecting lens; 5 – power meter;6 – holder; 7 – positioning system.

In this case, nonlinear effects begin to affect, as a result of which, one can observe the bleaching of the sample and an increase in optical transmission [5]. Thus, it is planned to obtain an absorbing medium based on multilayer graphene, designed to operate as an optical radiation modulator in femtosecond fiber laser systems.

References

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