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On-line registration of femtosecond time intervals based on polarization properties of femtosecond stimulated photon echo generated on exciton states

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Abstract. This paper reflects the results of the research on the character of the dependence of the non-Faraday rotation of the femtosecond stimulated photon echo polarization plane on the time interval between the second and third exciting pulses, discretely varying from 180 to 900 fs in increments 180 fs. The time interval between the first and second pulses was equal to zero. The echo signal was formed at room temperature on exciton states localized on the surface defects of a thin three-layer textured ZnO/Si(P)/Si(B) film in the presence of a homogeneous magnetic field of 0.25 mT applied longitudinally to the optical excitation axis. The qualitative coincidence of the investigated dependence with the theoretical prediction of the investigated effect for gaseous medium is shown.

Stimulated photon echo (SPE) was excited at room temperature by three laser pulses on exciton states localized on nanoscale surface defects of a three-layer ZnO/Si(B)/Si(P) thin film (each layer had a thickness of 100 nm). The experiment was carried out both without a magnetic field, and in the presence of a longitudinal homogeneous magnetic field with an induction of 0.25 mT. The dependence of the intensity of the SFE signal on the angle of rotation of the prism relative to the plane of polarization of the exciting laser pulses was recorded. The parameters of the exciting pulses were as follows: τi - 60 fs; λvi = 790 - 830 nm; Evi> 30 μJ; Pv - 1 TW / cm2. The time interval between the first and second pulses was equal to zero, and between the second and third it changed discretely.

The difference in the polarization plane of a femtosecond SPE excited on exciton states localized on the surface defects of a thin three-layer textured ZnO/Si(P)/Si(B) film depending on the presence of a magnetic field is given in the following work [1]. The difference in the value of the angle of rotation of the plane of polarization for time intervals between 2 and 3 pulses, equal to 720 and 900 fs, is given in the work [2]. In this paper we present the results

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of a study of the non-Faraday rotation of the plane of polarization of a femtosecond photon echo from the time interval between the second and third exciting pulses from 180 to 900 fs in steps of 180 fs.

The decrease in the angle of rotation of the PE polarization plane with the growth of the time interval τ23 qualitatively confirms the coincidence of the results obtained with the theoretical prediction [3] of the tangential dependence of this effect for gaseous medium on the value of the time interval τ23. The decrease in the angle of rotation of the PE polarization plane with the growth of the time interval τ23 qualitatively confirms the coincidence of the results obtained with the theoretical prediction [3] of the tangential dependence of this effect for gaseous media on the value of the time interval τ23. The difference between the results of this experiment and the theoretical predictions is due, first of all, to the influence on the process of formation of the SPE on the presence of the phonon wing exciton state in the resonant spectral line, which is absent on the gas spectral line. Therefore, the form of the tangentoid is distorted in comparison with the experiment in the gas, but the self-tangential character of the investigated dependence is preserved. The points obtained refer to the negative branch of the tangentoid. By detecting the angle of the non-Faraday rotation of the polarization plane of a femtosecond photon echo, it is possible to register on-line femtosecond time intervals in the range of values starting with a doubled duration of the laser pulses that excite the echo signal, to within several times smaller magnitude than today's existing on-line registration capabilities of the smallest time interval.

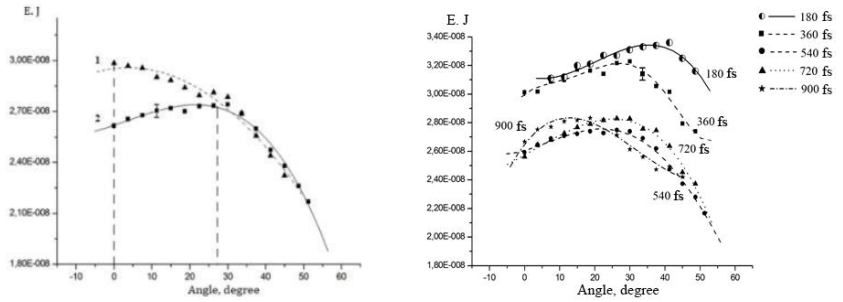

Fig. 1. The dependence of the intensity of a linearly polarized femtosecond SPE signal, on the angle of rotation of the prism relative to the plane of polarization of the exciting laser pulses for a time interval of τ_{23} equal to 720 fs: 1 - without a magnetic field; 2 - in the presence of a longitudinal homogeneous magnetic field of 0.25 mT (left). Dependence of the intensity of a linearly polarized femto-second SPE signal on the angle of rotation of the prism relative to the plane of polarization of exciting laser pulses for a time interval of τ23, discretely varying from 180 to 900 fs after 180 fs. The maximums of the curves for the five discrete values of τ23 were observed at the following prism angles φ: 1) τ_{23} = 900 fs; φ = 10 deg; 2) τ_{23} = 720 fs; φ = 27 deg; 3) τ_{23} = 540 fs; φ = 31 degrees; 4) τ_{23} = 360 fs; φ = 33 degrees; 5) τ_{23} = 180 fs; φ = 34 deg (right).

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