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INVESTIGATIONS OF OXIDE GLASSES WITH USE OF FARADAY EFFECT METHOD

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Presented work is a continuations of investigations of oxide glasses with use of Faraday effect method. Investigation was performed for lead-bismuth oxide glasses and tellurite glasses from the TeO_2–WO_3–PbO system La_2O_3 modified. The investigations have shown existence very strong Faraday effect in lead-bismuth oxide glasses. In the TeO_2–WO_3–PbO glass system the magnetooptical properties was observed thanks to La_2O_3 addition. For further application of oxide glasses as a optical shutters and optical modulators a dynamic method will be proposed to monitor Faraday effect.

Key worlds: oxide glasses, Faraday effect, magneto-optical devices.

Oxide glasses with lead and bismuth oxides, due to the big mass and polarizability of ions Pb2+ and Bi3+, posses interesting properties in infrared optics and nonlinear optics. These glasses are characterized by great value of the nonlinear refractive index what it suggest the possibility of observation great value of the Verdet constant [1].

TeO_2 based glasses are of great interested for use in optical communication system. The refractive index of tellurite glass from TeO_2–WO_3–PbO system reach the value up to 2,30 [2]. Relatively high refractive index is a consequence of high polarizability of tellurium ions. Their highest refractive indices among oxide glass in the visible and near IR region causes that TeO_2 based glass systems are the most promising materials in optoelectronical devices [3].

Properties of oxide glasses in the range of magneto- optics phenomena are very interesting for optoelectronics. Faraday rotation has a practical application in optical isolators. An optical isolator is a device that allows light to go through in one direction but severely attenuates reflected light propagating in the opposite direction. Optical isolators have important applications in telecommunications preventing reflected signals on fiber optic cables from producing unwanted signals. Isolators are important when lasers are used because reflected light can cause havoc with the operation of the laser itself [4].

The Faraday effect depends on to turn the plane of polarization of linearly polarized light in isotropic transparent materials under the magnetic field. An extensive description of this effect may be found in [5].

The experimental of the method probing the Faraday effect was carried out in magnetic field with induction B=0,06 T. The measurements of steering angle were executed in the range from 480 to 700 nm. From the value of the rotation of the polarization plane the value of Verdet constant was estimated. Maximum error of measurement rich the value 4%. The block diagram of measuring system to investigation of Faraday effect are given in [6].

Detailed investigation of magnetooptic properties was made for the oxide glasses PbO(25%mol)–$BiO_{1,5}$(50%mol)–$GaO_{1,5}$(25%mol), PbO(25%mol)–$BiO_{1,5}$(30%mol)–GeO_2(45%mol), TeO_2(60%mol)–WO_3(30%mol)–PbO(10%mol) and TeO_2(57%mol)–WO_3(30%mol)–PbO(10%mol)–La_2O_3(3%mol). Lead-bismuth glasses was synthesis carried out in platinum crucibles in an electric furnace at the temperature about 1 100°C. The melts was poured out into a cast iron form and then relief annealed. Tellurite glasses have been obtained by melting 100 g batches in a gold crucibles in an electric furnace at the temperature 850ºC in air atmosphere. The melts were poured out into a steel form. The glasses prepared in such manner was thermoannealed at 350ºC for 12 hours. Samples used for studies were mechanically treated by grinding and polishing.

The received results of investigations on figure 1 was presented.

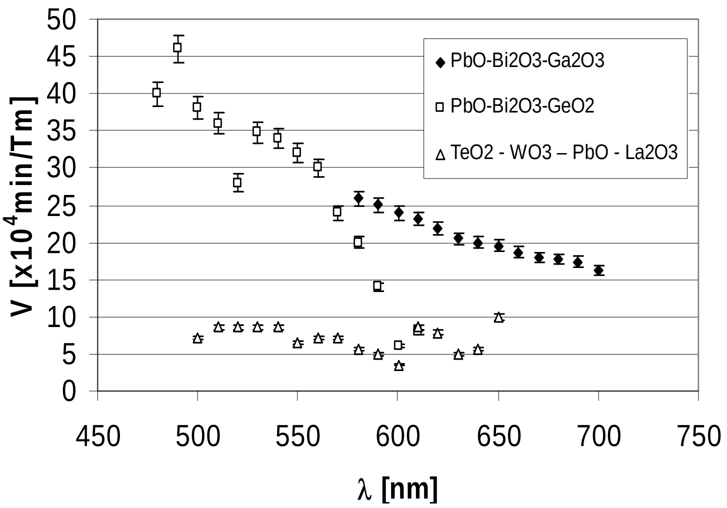

Fig. 1. The dependence Verdet constant from wavelength in constant magnetic field about induction 0,06 T for investigated oxide glasses

The investigations have shown existence very strong Faraday effect in lead-bismuth oxide glasses The maximum value of turn angle the plane of polarization was received for wavelength λ=490 nm for PbO–Bi_2O_3–GeO_2 glass system. Calculating for this value Verdet constant carries out $46{,}00\cdot10^4$ min/Tm.

For the PbO–Bi_2O_3–Ga_2O_3 glass system the maximum value of turn angle the plane of polarization was received for wavelength λ=580 nm. Calculating for this value Verdet constant carries out $25{,}83\cdot10^4$ min/Tm.

For the tellurite glass TeO_2–WO_3–PbO the dependence of turn angle of the plane of polarization on light wavelength under magnetic field was not observed.

In case of glass TeO_2–WO_3–PbO–La_2O_3 the investigation have shown the dependence of turn angle of plane of polarization and Verdet constant on magnetic field induction for the range of wavelength 490–650 nm. The maximum value of turn angle was received for wavelength λ=650nm. Calculating for this wavelength Verdet constant gives the value of $10\cdot10^4$ min/Tm.

The magnetooptical properties are observed in the TeO_2–WO_3–PbO glass system thanks to La_2O_3 addition, it has been confirmed by a Faraday effect occurrence. The polarization of the glass is not only the result of electron polarization but also includes the contribution of the orientation of charged defects in glass. Those phenomena have influence on calculated Verdet constant.

Thanks to the addition of La ions into the tellurite glass structure, those glass system can be considered as promising material for optoelectronics. However obtained results could be suggested that lead-bismuth oxide glasses are to possibly better materials for magneto-optical devices.

For further application of oxide glasses as a optical shutters and optical modulators a dynamic method will be proposed to monitor Faraday effect.

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ДОСЛІДЖЕННЯ ОКСИДНИХ СТЕКОЛ З ВИКОРИСТАННЯМ МЕТОДУ ЕФЕКТУ ФАРАДЕЯ

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Наведено результати досліджень оксидних стекол з використанням ефекту Фарадея. Дослідження проводили для свинцево-вісмутових та телуридних стекол системи TeO_2–WO_3–PbO, модифікованої La_2O_3. Виявлено сильний ефект Фарадея у свинцево-вісмутових стеклах. Показано, що завдяки додаткам La_2O_3 в стеклах системи TeO_2–WO_3–PbO спостерігаються магнітооптичні властивості.

Ключові слова: оксидні стекла, ефект Фарадея, магнітооптичні пристрої.

ИССЛЕДОВАНИЕ ОКИСЛЁННЫХ СТЕКОЛ С ИСПОЛЬЗОВАНИЕМ МЕТОДА ЭФФЕКТА ФАРАДЕЯ

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Приведены результаты исследований окислённых стекол с использованием эффекта Фарадея. Исследования проводили для свинцово-висмутовых и телуридных стекол системы TeO_2–WO_3–PbO, модифицированных соединением La_2O_3. Обнаружен сильный эффект Фарадея в свинцово-висмутовых стеклах. Показано, что благодаря дополнениям La_2O_3 в стеклах системы TeO_2–WO_3–PbO наблюдаются магнитооптические свойства.

Ключевые слова: окислённые стекла, эффект Фарадея, магнитооптические устройства.

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