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ELUCIDATION OF CONDITIONS FOR EXCITATION OF SURFACE POLARITONS IN $Mg_{0.2}Zn_{0.8}O$ CERAMICS USING THE DISTURBED TOTAL INTERNAL REFLECTION METHOD

Conditions for the excitation of surface polaritons in $Mg_{0.2}Zn_{0.8}O$ ceramics have been theoretically analyzed for the first time, and the surface of the disturbed total internal reflection $I(\nu)/I_0(\nu)$ has been plotted, which is a three-dimensional representation of the transmission coefficient in the IR spectral interval. Its dependence on the frequency and incidence angle of radiation is determined. The external reflection IR spectra are measured to calculate the required optical and electrophysical parameters of ceramics using the method of dispersion analysis. The possibility of researching the resonant interaction between optical phonons and plasmons has been demonstrated. The obtained results are in good agreement with the literature data.

K e y w o r d s: (Mg,Zn)O, solid solution, optical properties, infrared spectroscopy, dispersion analysis, reflection coefficient.

1. Introduction

In connection with the intensive development of nano- and optoelectronics in recent decades, the determination of optical and electrophysical properties of optically isotropic and optically anisotropic materials and structures using non-destructive methods remains one of the challenging directions in modern physics of semiconductors and insulators. Those methods include the methods of reflection infrared (IR) spectroscopy and disturbed total internal reflection (DTIR). In the latter case, surface waves can be excited in which the energy propagates along the surface [1, 2]. At the same time, the frequency interval of propagating waves depends on the IR radiation incidence angle.

In our previous works [3, 4], it was shown that the study of conditions for the excitation of surface waves makes it possible to obtain information about elementary excitations of various types (in particular, phonons and plasmons) and their interactions (phonon-phonon, electron-phonon, and electron-electron), and determine the optical and electrophysical parameters of the specimen. In addition, by analyzing the dependence of those parameters on the IR radiation incidence angle, it is possible to detect the inhomogeneity in the thickness of the near-surface

region in the specimen and study thin multilayer structures.

The comprehensive analysis of the properties of surface polaritons (SPs) and the relations of their parameters to the characteristics of near-surface regions in solid media extends the capabilities of studying various physical processes near the surface, which can be used to create solid-state electronic devices. For example, on the basis of surface polaritons, modulators and optical deflectors of IR radiation can be developed [5].

Zinc oxide and solid solutions on its basis demonstrate a number of unique properties, which determine the high application potential of those substances in electronics, medicine, photonics, fabrication of radiation detectors, and so forth. Materials based on ZnO can be used as transparent electrodes, detectors of ultraviolet, X-ray, and gamma radiation, gas sensors, piezoelectric transducers, varistors, LEDs, and catalysts [6]. The addition of magnesium to ZnO increases the band gap, which allows the operating range of lasers, LEDs, and photodetectors to be shifted toward the deeper ultraviolet region. The possibility of changing the optical and electrophysical properties of ternary compounds $Mg_xZn_{1-x}O$ by varying the magnesium content in them extends the limits of their application [7–9].

Depending on the ratio between the Mg and Zn concentrations, ternary compounds $Mg_xZn_{1-x}O$ can possess either a hexagonal crystal structure (wurtzite) or a cubic one. An attractive feature of the study of ternary compounds $Mg_xZn_{1-x}O$ with the Mg^{2+} content ranging from $x = 0$ to $x = 0.2$ is the preservation of the hexagonal lattice and the manifestation of optically anisotropic properties in the IR spectral interval. However, despite broad prospects for the application of $Mg_xZn_{1-x}O$ compounds, there are no studies of their properties using polariton spectroscopy methods.

The aim of this research was to obtain the optical parameters of $Mg_xZn_{1-x}O$ ceramics with the magnesium content $x = 0.2$ using the external IR reflection method in a wide spectral interval and elucidate the excitation conditions for surface polaritons.

2. Analysis of External Reflection IR Spectra of $Mg_x Zn_{1-x}O$

In order to obtain the optical parameters of $Mg_xZn_{1-x}O$ ceramics using the non-destructive IR

spectroscopy method in a wide spectral interval and clarify the possibility of excitation of surface phonon-polaritons in this ceramics using the DTIR method, ceramic specimens with a magnesium content of 20% were produced by sintering ZnO and MgO powders. This composition was chosen in accordance with the maximum solubility of MgO in ZnO (in this case, under proper thermodynamic conditions, the hexagonal phase of the solid solution is predominantly formed [10]).

Specimens of $Mg_{0.2}Zn_{0.8}O$ ceramics were obtained from a mixture of ZnO and MgO powders. The mixture was pelleted at a pressure of 0.5 metric tons per cm^2. Afterward, the pellets were annealed in air at the temperature $T_{ann} = 1100\ °C$ for 3 h and then cooled down together with the furnace. To reduce the roughness of the ceramic surface, the specimens were subjected to the mechanical polishing treatment.

Experimental IR reflection spectra for $Mg_{0.2}Zn_{0.8}O$ ceramics were measured at room temperature using a high-resolution spectrophotometer IRTracer-100 (Shimadzu, Japan) equipped with a specular reflection attachment SRM-8000A. The frequency of excitation light was within a spectral interval of 350–1000 cm^{-1}. The incidence angle was 10°. A golden mirror was used as a standard. The spectra were registered with a resolution of 1 cm^{-1}.

The frequency dependence $\varepsilon(\nu)$ of the dielectric constant within the interval of the interaction between the phonon and plasmon subsystems was described by the following expression which accounts for the damping of transverse and longitudinal optical phonons [3, 11]:

$$\varepsilon(\nu) = \varepsilon_{1j}(\nu) + i\varepsilon_{2j}(\nu) = \varepsilon_\infty + \varepsilon_{fj}(\nu) + \varepsilon_{pj}(\nu) =$$
$$= \varepsilon_\infty \prod_j \frac{\nu_{LO,j}^2 - \nu^2 + i\gamma_{LO,j}\nu}{\nu_{TO,j}^2 - \nu^2 + i\gamma_{TO,j}\nu} - \frac{\nu_p^2\varepsilon_\infty}{\nu(\nu + i\gamma_p)}, \qquad (1)$$

where ν_{LO} and ν_{TO} are the frequencies of transverse and longitudinal, respectively, optical phonons; γ_{TO} and γ_{LO} are the transverse and longitudinal, respectively, optical phonon attenuation coefficients; and γ_p and ν_p are the damping coefficient and the frequency, respectively, of the plasma resonance.

The modeling of IR reflection spectra of $Mg_xZn_{1-x}O$ ceramics was carried out accounting for the contribution of the hexagonal and cubic phases. In the calculations, the values obtained in works [11–14] were used as the basic parameters of

Table 1. **Parameters of the phonon subsystem in Mg$_{0.2}$Zn$_{0.8}$O ceramics**

Optical axis orientation	Parameters of the phonon subsystem					
	ν_{T1} (γ_{T1}) cm^{-1}	ν_{L1} (γ_{L1}) cm^{-1}	ν_{T2} (γ_{T2}) cm^{-1}	ν_{L2} (γ_{L2}) cm^{-1}	ν_{T3} (γ_{T3}) cm^{-1}	ν_{L3} (γ_{L3}) cm^{-1}
$E \perp C$	404.1 (13.8)	509 (20.4)	515.8 (17.7)	588 (85.5)	605.6 (70.7)	620.7 (15.4)
$E \parallel C$	379.8 (12)	504.7 (46.5)	510.3 (26.6)	563.2 (13.3)	579.2 (7.1)	591.6 (12)

the phonon subsystem in Mg$_x$Zn$_{1-x}$O, which were varied afterward when modeling the experimental spectra. Note that the plasmon-phonon interaction most clearly manifests itself in the IR reflection spectra of solid solutions at the concentrations of free charge carriers that satisfy the condition $\nu_{\mathrm{LO}} \leq \nu_p$ [15, 16].

The dielectric permittivity was considered to be a complex-valued quantity, when the anharmonic interaction of the phonon and plasmon subsystems was taken into account in the imaginary form. The consideration of the anharmonicity leads to the appearance of the complex damping coefficient in the expression for $\varepsilon(\nu)$, the real part of which corresponds to the anharmonic damping of phonons $\gamma_{\mathrm{TO}}(\nu)$ and the imaginary part determines the anharmonic frequency shift $\Delta(\nu)$ [1]. The method of dispersion analysis [3, 17] was used to obtain information about the electrical and optical characteristics of ceramics from the IR reflection spectra.

In Fig. 1, the experimental (*1*) and model (*2* and *3*) IR reflection spectra $R(\nu)$ for the Mg$_{0.2}$Zn$_{0.8}$O specimen are shown. Curve *3* demonstrates the calculated external IR reflection spectrum in the interval from 0 to 1000 cm^{-1} in the absence of damping in the phonon subsystem. The calculated parameters of the phonon subsystem are presented in Table 1. As follows from the figure, the spectrum of Mg$_{0.2}$Zn$_{0.8}$O ceramics has three characteristic sections (at 402–508, 515–588, and 607–620 cm^{-1}), where the reflection coefficient is maximum, $R(\nu) = 1.0$, and, accordingly, frequencies at 509, 599, and 686 cm^{-1}, where $R(\nu) = 0$. The reflection spectrum of Mg$_{0.2}$Zn$_{0.8}$O ceramics shows a minimum in an interval of 507–511 cm^{-1}, which corresponds to the LO-phonon in the hexagonal phase of the solid solution.

As was shown in works [3, 14–17], a variation in the concentration of free charge carriers substantially
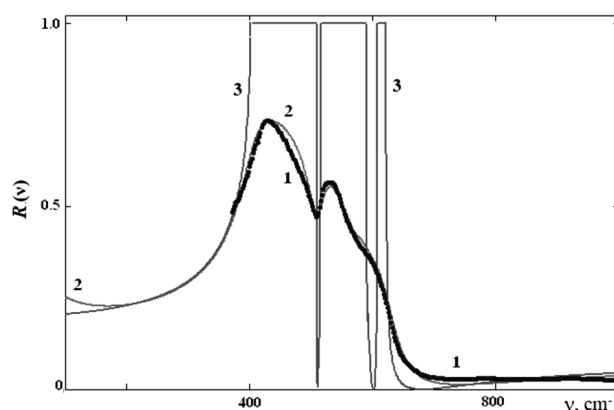

Fig. 1. Experimental IR reflection data for a specimen of Mg$_{0.2}$Zn$_{0.8}$O annealed at a temperature of 1100 °C (*1*) and corresponding theoretical spectra (*2*, *3*)

affects the reflection coefficient value in the high-frequency band of "residual rays" of the zinc and magnesium oxides (600–1500 cm^{-1}), whereas the surface roughness affects the reflection coefficient in a frequency interval of 400–600 cm^{-1}. This difference makes it possible to distinguish the influence of surface roughness on the reflection coefficient from that of the charge carrier concentration directly from the IR reflectance spectra.

A comparison of the experimental spectrum of IR reflection from the surface of Mg$_{0.2}$Zn$_{0.8}$O ceramics (spectrum *1* in Fig. 1) with the calculated one (spectrum *2* in Fig. 1) demonstrates that they are very close to each other. Therefore, the parameter values presented in Table 1 [11] together with the mathematical expressions for the multi-oscillator model [3] make it possible to model Mg$_{0.2}$Zn$_{0.8}$O with a high accuracy.

The parameters of the plasmonic subsystem of Mg$_{0.2}$Zn$_{0.8}$O were obtained using the dispersion analysis method and are equal to $\nu_p = 320$ cm^{-1} and $\gamma_p = 610$ cm^{-1}, which corresponds to the con-
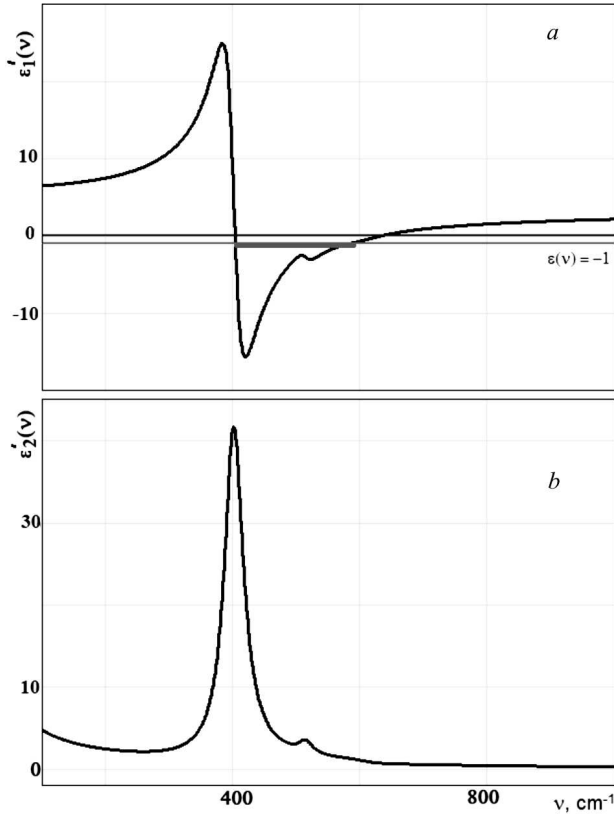
Fig. 2. Frequency dependences of the real, $\varepsilon_1'(\nu)$ (a), andimaginary, $\varepsilon_2''(\nu)$ (b), parts of the dielectric constant for $Mg_{0.2}Zn_{0.8}O$ at the orientation $E \perp C$. The bold section along the abscissa axis in panel a marks the frequency "window" where surface phonon-polaritons can exist at the air-ceramics interface

centration $n_0 = 1.50 \times 10^{18}$ cm^{-3}, the mobility $\mu = 23.8$ cm^2/(V s), and the conductivity $\sigma = 57.5$ Ω^{-1} cm^{-1}.

The frequency dependence of the dielectric permittivity, $\varepsilon(\nu)$, in the interval of the interaction between the phonon and plasmon subsystems was determined using expression (1), which accounts for the damping coefficients for the transverse and longitudinal optical phonons [3].

3. Elucidation of the Capability to Excite Surface Phonon-Polaritons in Mg$_{0,2}$Zn$_{0,8}$O Ceramics Using the DTIR Method

In this part of the work, the theoretical studies of surface polaritons are carried on accounting for the absorption coefficient of $Mg_{0.2}Zn_{0.8}O$ ceramics in the IR spectral interval. Figure 2 illustrates the real and imaginary parts of the dielectric permittivity $\varepsilon(\nu)$ calculated using the parameter values obtained in the framework of the dispersion analysis method applied to the external IR reflection spectrum of the $Mg_{0.2}Zn_{0.8}O$ specimen shown in Fig. 1.

The calculation for $Mg_{0.2}Zn_{0.8}O$ ceramics was carried out in the relevant frequency interval. The bold segment along the abscissa axis marks the frequency "window" where surface phonon-polaritons can exist at the air-$Mg_{0.2}Zn_{0.8}O$ ceramic interface [1, 3]. The calculation involved the interaction of IR radiation with the phonon and plasma subsystems of this ceramics.

As one can see from Fig. 2, in the case of $Mg_{0.2}Zn_{0.8}O$ ceramics, the ranges of anomalous dispersion are contained in the frequency intervals, where the solid solution is surface-active; these are 402–582 and 607–620 cm^{-1}.

Using the DTIR method, let us elucidate the peculiarities of SP propagation in the hexagonal structure of $Mg_{0.2}Zn_{0.8}O$ for the orientation $E \perp C$ with respect to the surface and the SP wave vector. Let the solid $Mg_{0.2}Zn_{0.8}O$ solution with the dielectric permittivity $\varepsilon(\nu)$ occupy the half-space $z < 0$ and be in contact with an isotropic medium with the dielectric constant $\varepsilon_2 = 1$ (air) occupying the half-space $z > 0$. The electric vector E of a surface wave propagates in the xy-plane and decays exponentially along the z-axis when moving away from the interface between the indicated media.

The calculation of DTIR spectra was carried out according to the following formulas, which account for the interaction of IR radiation with the phonon and plasma subsystems of ceramics in the $E \perp C$ case [1] (the calculations were performed using the MathCad mathematical editor):

$$\frac{I(\nu,\varphi)}{I_0(\nu,\varphi)} := 1 - \frac{4p''(\nu,\varphi)}{(1 + p''(\nu,\varphi))^2 (p')^2}; \qquad (2)$$

where

$$p'(\nu,\varphi) := \frac{\beta_2(\nu,\varphi)}{\beta_1(\nu,\varphi)}(1 - A(\nu,\varphi)\,B(\nu,\varphi));$$

$$A(\nu,\varphi) = 1 - \tanh(k_2(\nu,\varphi)\,d);$$

$$B(\nu,\varphi) = \Big[\beta_2(\nu,\varphi) + \beta'(\nu,\varphi)\tanh(k_2(\nu,\varphi)\,d)/$$

$$/(\beta_2(\nu,\varphi) + \beta'(\nu,\varphi)\tanh(k_2(\nu,\varphi)))^2 +$$

$$+ (\beta''(\nu, \varphi) \tanh(k_2(\nu, \varphi) d))^2 \Big];$$

$$p''(\nu, \varphi) := \frac{\beta_2^2(\nu, \varphi)}{\beta_3(\nu, \varphi)};$$

$$\beta_1(\nu, \varphi) := \frac{\varepsilon_1}{k_1(\nu, \varphi)} = \beta' + i\beta'';$$

$$\beta_2(\nu, \varphi) := \frac{\varepsilon_2}{k_2(\nu, \varphi)};$$

$$\beta_3(\nu, \varphi) := \frac{\varepsilon_3(\nu, \varphi)}{i \, k_3(\nu, \varphi)};$$

$$k_i(\nu, \varphi) := \sqrt{(k_x^2(\nu, \varphi))^2 - q^2 \varepsilon_i};$$

$$k_x(\nu, \varphi) := q\sqrt{\varepsilon_3} \, \sin(\varphi);$$

$$q := \frac{\omega}{c}.$$

The subscripts $i = 1, 2, 3$ denote the DTIR prism, the vacuum gap of the thickness d_z, and the $Mg_xZn_{1-x}O$ specimen, respectively; and $\varepsilon_3(\nu)$ is the dielectric permittivity of ceramics, which additively accounts for the contributions of active optical phonons, ν_{TO}, and plasmons, ν_p.

In Fig. 3, the DTIR spectra of $Mg_{0.2}Zn_{0.8}O$ ceramics calculated for the $E \perp C$ orientation are shown. The spectra in Fig. 3, *a* were obtained for the incidence angles of IR radiation in the DTIR prism $\phi = 30 \div 32°$ (curves *1–3*) and the constant thickness of the gap between the specimen and the DTIR prism (for all indicated spectra, $d_z = 10.5 \, \mu$m). The spectra in Fig. 3, *b* were obtained for the incidence angles of IR radiation in the DTIR prism $\phi = 44 \div 46°$ (curves *1–3*) and the constant thickness of the gap between the specimen and the DTIR prism (for all indicated spectra, $d_z = 4.0 \, \mu$m). In both cases, the DTIR spectra were calculated by varying the frequency within an interval of 200–1500 cm^{-1} at a fixed incidence angle of IR radiation in the DTIR prism. The calculation technique described in works [1, 3] was applied. The calculation parameters for the $Mg_{0.2}Zn_{0.8}O$ phonon subsystem are quoted in Table 1.

In the presented spectra of $Mg_{0.2}Zn_{0.8}O$ ceramics, an absorption band is observed in an interval of 400–650 cm^{-1} in the case of *p*-polarization, when the electric vector E is located in the radiation incidence plane xy. There is no such a band in the normal absorption spectrum [1, 3]. The indicated band is located between the transverse and longitudinal optical phonon frequencies in $Mg_{0.2}Zn_{0.8}O$ ceramics, where
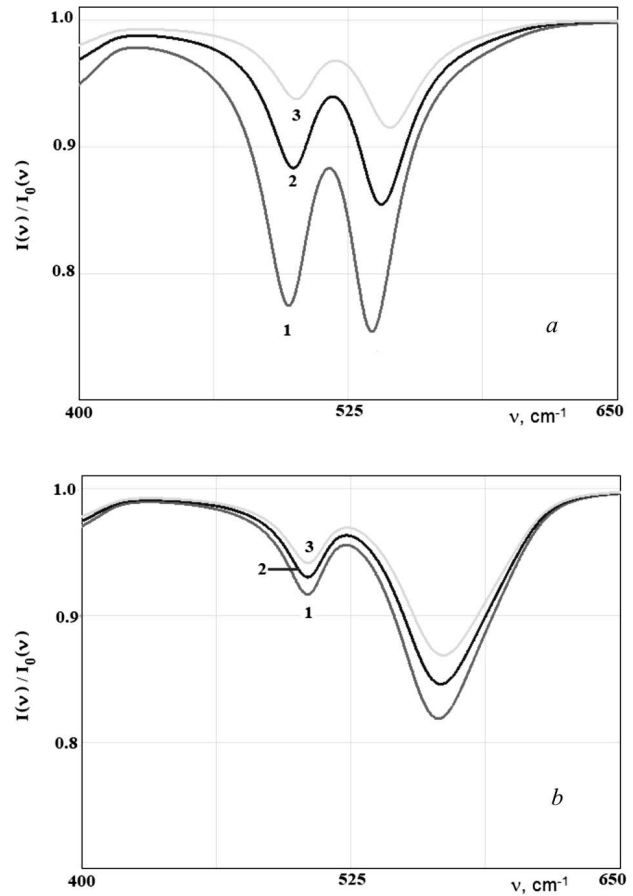
Fig. 3. DTIR spectra of $Mg_{0.2}Zn_{0.8}O$ ceramics: (*a*) at angles of 30° (*1*), 31° (*2*), and 32° (*3*); (*b*) at angles of 44° (*1*), 45° (*2*), and 46° (*3*)

$\varepsilon_1'(\nu) < 0$, which is a necessary condition for the existence of SPs. The dependence of the spectrum position and half-width on the size of the gap between the specimen and the DTIR prism confirms the surface origin of the band. In works [1, 3], it was found that a narrow enough gap between the specimen and the DTIR element results in a radiation broadening of the absorption bands. Therefore, the optimal gap width is chosen so that the presence of the DTIR prism would not affect the SP spectrum, but the reduction of the reflection coefficient could still be registered experimentally.

From Fig. 3, one can see that there are two minima in the IR spectral interval, which, according to the terminology of works [1, 3], correspond to SPs in "semiinfinite" $Mg_{0.2}Zn_{0.8}O$ ceramics. Together with the indicated factors, the cited authors showed that
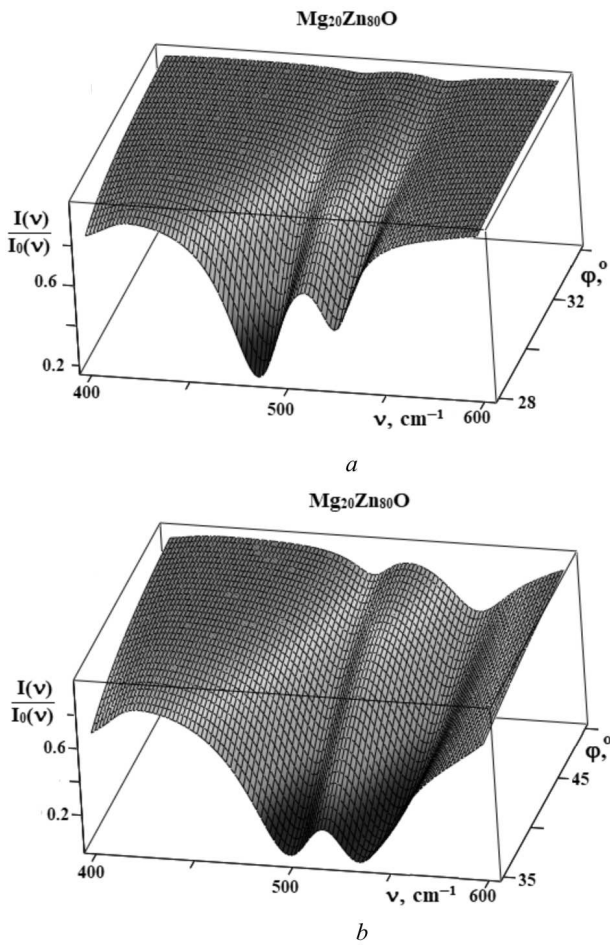
Fig. 4. Modified DTIR surfaces for $Mg_{0.2}Zn_{0.8}O$ ceramics: $\phi = 25 \div 34°$ (a), $\phi = 35 \div 50°$ (b)

Table 2. **Frequencies of minima in DTIR spectra for $Mg_{0.2}Zn_{0.8}O$ ceramics**

ϕ, °	d_z, μm	ν_{min1}, cm^{-1}	$\frac{I(\nu)}{I_0(\nu)}$	ν_{min2}, cm^{-1}	$\frac{I(\nu)}{I_0(\nu)}$
30	10.5	497.3	77.4	535.8	75.3
31	10.5	499.4	88.3	540.7	85.4
32	10.5	501.3	93.7	545.5	91.5
44	4	505.0	91.6	565.7	81.8
45	4	505.5	93.0	566.6	84.5
46	4	505.6	94.1	567.4	86.8

an increase in the concentration of free charge carriers manifests itself in the broadening of the DTIR spectrum and the shift of its minimum. In Fig. 3, the minima in the spectra of examined specimens of

$Mg_{0.2}Zn_{0.8}O$ ceramics correspond to the frequencies of SPs of the phonon type, which is characteristic of weakly doped ceramics. In other words, the plasmon-phonon interaction does not manifest itself in the IR reflection and DTIR spectra of the $Mg_{0.2}Zn_{0.8}O$ ceramic specimens, because the concentrations of free charge carriers do not satisfy the condition $\nu_{LO} \leq \nu_p$ [3, 10]. It is worth noting that the semiinfinite ceramics is characterized by a single air-ceramics interface.

According to Fig. 3, the DTIR spectra of $Mg_{0.2}Zn_{0.8}O$ ceramics demonstrate all those features that we observed experimentally for ZnO, MgO, and 6H–SiC single crystals [3, 15]; namely, a band intensity reduction for larger incidence angles of IR radiation, a substantial broadening of the SP spectrum in the region of "residual rays" for larger incidence angles of IR radiation in the DTIR prism, the asymmetric shape of the spectral minimum and its shift toward low frequencies, and others. The manifestation of minima in the DTIR spectra only in the case of p-polarized IR radiation and the negative values of the dielectric permittivity in the interval between the transverse and longitudinal optical phonon frequencies (Table 2) confirm that surface polaritons can be excited in $Mg_xZn_{1-x}O$ ceramics.

Furthermore, the minimum in the DTIR spectrum becomes shifted toward high frequencies both at larger light incidence angles in the DTIR prism and if the absorption intensity decreases, provided that the gap between the DTIR prism and the $Mg_{0.2}Zn_{0.8}O$ ceramic specimen remains constant [1, 3]. When calculating the DTIR spectra, the gap size was chosen so that the value of the reflection coefficient near the minimum was larger than 0.7–0.8. In the previous work [3], we experimentally showed that the radiative broadening is minimum in this case. We associate the absorption observed in the DTIR spectra on the surface of $Mg_{0.2}Zn_{0.8}O$ ceramics with the interaction of light with surface optical vibrations. Indeed, the absorption bands obtained by us (see Fig. 4) possess properties that are characteristic of SPs in $Mg_{0.2}Zn_{0.8}O$ ceramics. Those absorption bands cannot be substantiated as a result of the radiation absorption by impurities or defects in $Mg_{0.2}Zn_{0.8}O$ ceramics, because no appreciable dispersion dependence is observed for them [1, 3].

The analysis of SP spectra of $Mg_{0.2}Zn_{0.8}O$ ceramics, which include three surface-active sections, showed that SPs of two types can exist at the air-

ceramics interface, and they reveal themselves in a spectral section of 402–588 cm^{-1}. As follows from Fig. 3, in a surface-active section of 607–620 cm^{-1}, one of the conditions for the existence of SPs is not fulfilled, namely, we have $\varepsilon_1(\nu) < -1$. The DTIR spectra in Fig. 4 were registered by scanning over the IR frequency and keeping fixed the radiation incidence angle in the DTIR prism.

However, in works [1, 3], it was shown that the DTIR spectrum corresponding to the scanning over the incidence angle φ at a fixed IR radiation frequency ν can be calculated. Each of the indicated approaches has its advantages and disadvantages. More complete information is possible for the calculation of a family of spectra (surfaces of disturbed total internal reflection) covering all possible values of the incidence angle (25–60°, the DTIR prism is fabricated from KRS-5 with the refractive index $n_{pr} = 2.38$) and IR frequency (200–1500 cm^{-1}).

Hence, it should be noted that the analysis of the DTIR spectra presented in Fig. 4 testifies to the existence of non-radiative surface polaritons in the vacuum-$Mg_xZn_{1-x}O$ ceramics system, which propagate along the x-axis and decay in the z-direction on the both sides of the vacuum-$Mg_xZn_{1-x}O$ interface. The indicated electromagnetic-mechanical oscillations are polarized in the xz-plane.

4. DTIR Surface for $Mg_{0.2}Zn_{0.8}O$ Ceramics in IR Spectral Interval

The DTIR surface is a three-dimensional representation of the dependence of the transmission coefficient for the above system on the radiation frequency and incidence angle. If radiation does not interact with the structure surface, then $I(\nu)/I_0(\nu) = 1$, and the DTIR surface is flat in the specified area. But if SPs are excited in the film or substrate, there appear a number of "gorges" (Fig. 4). The depth of the latter depends on the system parameters, in particular, the size of the gap between the DTIR semicylinder and the specimen, the radiation frequency, and the radiation incidence angle. The frequency of the minimum in the reflection surface corresponds to the SP frequency. The existence of SPs in MgZnO is also confirmed by the fact that if the incidence angle increases, the minimum in the DTIR spectra shifts toward higher frequencies, and the "half-width" of the spectrum decreases.

Figure 4 illustrates the DTIR surfaces plotted for the ceramic structure $Mg_{0.2}Zn_{0.8}O$ within a radiation frequency interval of 350–650 cm^{-1} and intervals of 25–34° (panel a) and 35–50° (panel b) for the IR radiation incidence angle in the DTIR prism. The gap size equals $d_z = 10.0$ μm for panel a, and $d_z = 4.0$ μm for panel b. One can easily see that if the incidence angle increases from 25° to 50°, the frequencies of the minima in the DTIR spectra for surface polaritons in $Mg_xZn_{1-x}O$ ceramics increase from 497.3 cm^{-1} (at 30°) to 570.1 cm^{-1} (at 50°).

The account for the optical phonon damping gives rise to the formation of two "gorges" in the DTIR surface $I(\nu)/I_0(\nu)$ in the interval of frequencies that can be registered experimentally when recording the DTIR spectra of SPs by the scanning over the angles.

5. Conclusions

IR reflection spectra of $Mg_{0.2}Zn_{0.8}O$ ceramics are measured experimentally and modeled theoretically. The optical and electrical characteristics of $Mg_{0.2}Zn_{0.8}O$ ceramics are determined. Conditions required for the excitation of surface polaritons by the DTIR method in $Mg_{0.2}Zn_{0.8}O$ ceramics are found. It is shown that, in the interval of "residual rays" in ZnO and MgO, there exist frequency "windows" where the excitation and propagation of phonon-type surface polaritons in $Mg_{0.2}Zn_{0.8}O$ ceramics are possible.

With the help of a mathematical experiment, the frequency intervals for the experimental study of surface polaritons in $Mg_{0.2}Zn_{0.8}O$ ceramics using the DTIR method are indicated: It can be done either by the scanning over the frequency at fixed IR radiation incidence angles or by the scanning over the angle at fixed frequency values. In calculations, real data for oscillator parameters obtained for $Mg_{0.2}Zn_{0.8}O$ ceramics by the non-destructive method of external reflection IR spectroscopy are used. Three-dimensional reflection surfaces are obtained for ceramic $Mg_xZn_{1-x}O$ specimens for the first time; they can be applied to analyze experimental data.

Since the characteristics of SPs are related to the properties of the near-surface region in the crystal, the study of SPs – first of all, their dispersion dependences – can be used to perform a non-contact control over the ceramic surface state, which is required while creating devices of solid-state optoelectronics and integrated optics.

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З'ЯСУВАННЯ УМОВ ЗБУДЖЕННЯ
ПОВЕРХНЕВИХ ПОЛЯРИТОНІВ У КЕРАМІЦІ
$Mg_{0,2}Zn_{0,8}O$ МЕТОДОМ ПОРУШЕНОГО
ПОВНОГО ВНУТРІШНЬОГО ВІДБИВАННЯ

Уперше для кераміки $Mg_{0,2}Zn_{0,8}O$ теоретично з'ясовано умови збудження поверхневих поляритонів та побудовано поверхню порушеного повного внутрішнього відбивання $I(\nu)/I_0(\nu)$, яка являє собою тривимірне подання коефіцієнта пропускання в ІЧ-діапазоні спектра. Визначено його залежність від частоти і кута падіння випромінювання. Для одержання оптичних і електрофізичних параметрів кераміки, необхідних для розрахунків, виміряні спектри зовнішнього ІЧ-відбивання. З них одержано відповідні параметри методом дисперсійного аналізу. Продемонстровано можливість досліджень резонансної взаємодії оптичних фононів та плазмонів. Отримані результати добре узгоджуються з відомими в літературі даними.

К л ю ч о в і с л о в а: (Mg,Zn)O, твердий розчин, оптичні властивості, інфрачервона спектроскопія, дисперсійний аналіз коефіцієнта відбивання.