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Correction procedures of the immersion mismatching in interferometric determination of refractive index profile. Part. II. Correction of the interference order for the case of the plane reference wave*

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In the method presented the orders of interference are subject to direct correction procedure which renders possibility of immediate usage of the algorithm employed for the case of perfect immersion-to-coat matching. The errors of the correction method have been analysed. The method of mismatching measurement for the refractive indices of the immersion liquid and the coat, respectively, has been proposed and accuracy of this measurement determined.

1. Introduction

This work is the second of the cycle devoted to the problem of refractive index profile measurement in both preforms and light waveguides in the case of mismatching of immersion index to that of the coat of the objects measured by using nondestructive interference methods [1].

The refractive index of the object core $\delta n(x)$ is calculated on the base of the wavefront emerging from the object tested for a plane wave incident on it perpendicularly to its symmetric axis. This is true both for the perfect matching of the refractive indices ($n_i = n_p$), and their mismatching ($n_i \neq n_p$). When $n_i = n_p$ this front is a direct source of information about $\delta n(x)$. When $n_i \neq n_p$ the abundant information should be filtered out from the needed one. The information about the wavefronts is coded in the form of the due interference fringes. The filtering of the proper wavefront from that encoded on the interferogram (for $n_i \neq n_p$) may occur in two ways: either after reconstructing the wavefront from the interferogram, or before this reconstruction. The first way is identical for all the types of interference and has been discussed in [1]. The other way of filtering may be realized differently for different types of interference and consists in correcting the input data used for

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reconstruction of the wavefront encoded on the interferogram, i.e., the interference orders of the fringes. This way of correction requires no changes in the mathematical model exploited in the case when $n_i = n_p$.

2. Interferogram with the plane reference wave ($n_i \neq n_p$) – correction of interference orders

A plane wavefront passing through the examined object perpendicularly to its symmetry axis suffers from deformation in the region of both the coat and the immersion liquid, in which the object is suspended [2], [3]. The emerging wavefronts

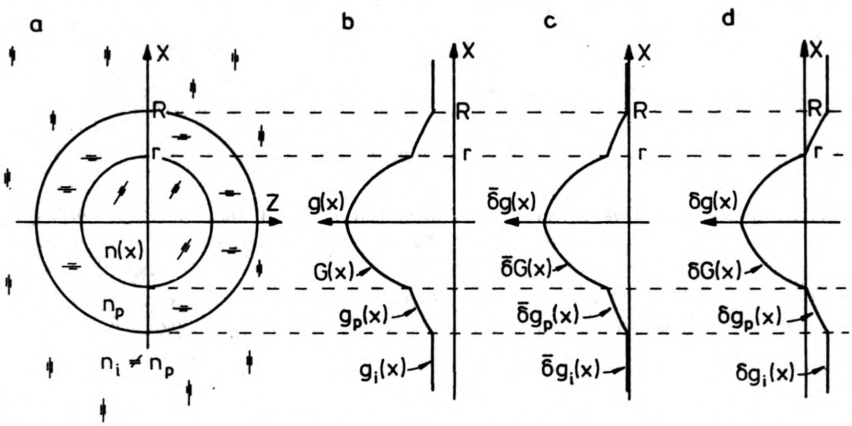

Fig. 1. Wavefront after passage through the examined object ($\delta n_i \neq 0$): **a** – object, **b** – wavefront, **c** – wavefront referred to the object coat wavefront, **d** – wavefront referred to the immersion wavefront

(Fig. 1), being referred either to wavefront of the coat (Fig. 1**d**) or to that of the immersion liquid (Fig. 1c), produce the following relative wavefronts:

$$\delta G(x) = \delta g(x) + \delta G_k(x), \quad \bar{\delta}G(x) = \bar{\delta}g(x) + \bar{\delta}G_k(x), \tag{1}$$

$$\delta g_p(x) = 2\delta n_i[\sqrt{R^2-x^2} - \sqrt{R^2-r^2}], \quad \bar{\delta}g_p(x) = 2\delta n_i\sqrt{R^2-x^2}, \tag{2}$$

$$\delta g_i(x) = -2\delta n_i\sqrt{R^2-r^2}, \quad \bar{\delta}g_i(x) = 0 \tag{3}$$

where:

$$\delta G_k(x) = 2\delta n_i[\sqrt{R^2-x^2} - \sqrt{R^2-r^2}], \quad \bar{\delta}G_k(x) = 2\delta n_i\sqrt{R^2-x^2}, \tag{4}$$

$$\delta n_i = n_p - n_i, \quad \delta g(x) = 2\int_0^{z_r} \delta n(x)dz, \quad \delta n(x) = n(x) - n_p, \tag{5}$$

$$z_r = \sqrt{r^2-x^2}. \tag{6}$$

All the emerging wavefronts interfere with the plane reference wave giving rise to the interference fringes. The interference fringes within the $0 \leqslant |x| < r$ interval carry the information about the wavefront $\delta g(x)$. Based on the reconstructed wavefront $\delta g(x)$

it is possible to calculate the distribution of the refractive index changes $\delta n(x)$ within the core of the examined object. Therefore, the fringes in this region are subject of the further analysis.

In the case of interference with the plane reference wave there exists a simple relation between the wavefront and the interference order, i.e.

$$\delta M(x) = \delta G(x)/\lambda, \quad \bar{\delta} M(x) = \bar{\delta} G(x)/\lambda, \tag{7}$$

where λ is the light wavelength. The difference operator denoted by δ means that the given magnitude is referred to the object coat, while that denoted by $\bar{\delta}$ means that the given magnitude is referred to the immersion liquid. From Eqs. (1) and (7) the following relations have been obtained:

$$\delta M(x) = \delta m(x) + \delta M_k(x), \quad \bar{\delta} M(x) = \bar{\delta} m(x) + \bar{\delta} M_k(x) \tag{8}$$

where:

$$\delta m(x) = \delta g(x)/\lambda, \quad \bar{\delta} m(x) = \bar{\delta} g(x)/\lambda, \tag{9}$$

$$\delta M_k(x) = \delta G_k(x)/\lambda, \quad \bar{\delta} M_k(x) = \bar{\delta} G_k(x)/\lambda. \tag{10}$$

In order to calculate the wavefront $\delta g(x)$ (and next, the changes of the refractive index $\delta n(x)$ of the core) the knowledge of interference order $\delta m(x)$ is needed. As it follows from (4) and (8), the relations between the sought magnitudes $(\delta m(x), \bar{\delta} m(x))$ and the magnitudes measured directly from the interferogram $(\delta M(x), \bar{\delta} M(x), R, r)$ are as follows:

$$\delta m(x) = \delta M(x) - 2\delta n_i(\sqrt{R^2 - x^2} - \sqrt{R^2 - r^2})/\lambda, \tag{11}$$

$$\bar{\delta} m(x) = \bar{\delta} M(x) - 2\delta n_i \sqrt{R^2 - x^2}/\lambda. \tag{12}$$

As is visible from the above relations, the sought function $\delta m(x)$ is obtained by correcting the interference orders $(\delta M(x), \bar{\delta} M(x))$ reconstructed from the interferograms by using the correcting factors $(\delta M_k(x), \bar{\delta} M_k(x))$:

$$\delta M_k(x) = 2\delta n_i(\sqrt{R^2 - x^2} - \sqrt{R^2 - r^2})/\lambda, \tag{13}$$

$$\bar{\delta} M_k(x) = 2\delta n_i \sqrt{R^2 - x^2}/\lambda. \tag{14}$$

The value of the $\bar{\delta} M_k(x)$ is independent of parameter r/R, and takes the value different from zero at the core-coat border (Fig. 2**a** – broken line). On the other hand, the value of the function $\delta M_k(x)$ depends on the ratio r/R of the object core radius to the radius of the whole object (Fig. 2**a** – continuous line). The continuous curves in Fig. 2 are shifted vertically with respect to the broken curve by a constant value depending on r/R. The dependence of this constant on the parameter r/R is shown in Fig. 2**b**. The functions $\delta M_k(x)$ and $\bar{\delta} M_k(x)$, normalized by the product $\delta n_i R$ to make them independent of sizes of the measured object and the value of the mismatched refractive index mismatching δn_i. For this purpose, an additional measurement is correcting factor for the interference order, it is necessary to know the values of the

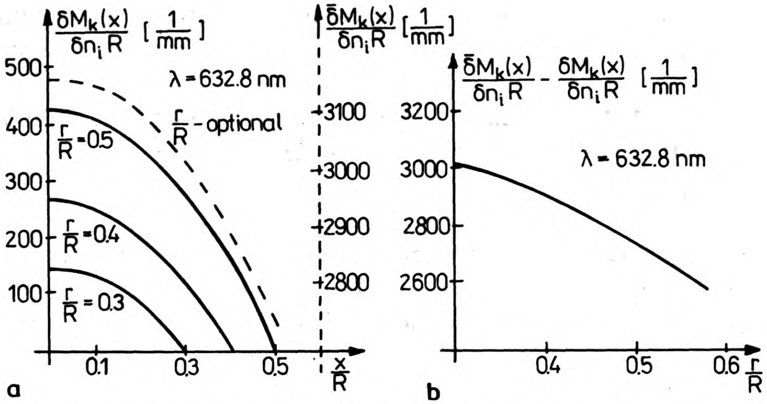

Fig. 2. Run of the interference order correcting functions $\delta M_k(x)$ (**a**), and $\bar{\delta} M_k(x)$ (**b**)

refractive index mismatching δn_i. For this purpose, an additional measurement is usually performed. The difference operator has been denoted by $\bar{\delta}$ in order to distinguish the additional measurement from the basic one. The additional measurement may be performed in the same measuring setup which was used for the basic measurement. In a special case, δn_i may be determined from the same interferogram which was exploited to calculate $\delta n(x)$. Although the measurement method of measuring δn_i as well as the measuring system may be selected quite arbitrarily, the most convenient way is to measure δn_i and $\delta n(x)$ in the same measuring system.

3. Calculation of the difference δn_i between the immersion refractive index and that of the phase object coat, based on the additional interference method

In order to measure the difference δn_i of the respective refractive indices an additional interference measurement has been performed, in which the interference fringes in the region of the immersion liquid are positioned perpendicularly to the axis of the measured object. In this measurement, the immersion liquid is accepted as a reference level (which is in contrast to basic measurements, where the part of the reference is played by the object coat). In accordance with (2), the wavefront in this region referred to the immersion liquid is equal to

$$\bar{\delta} g_p(x) = 2\delta n_i \sqrt{R^2 - x^2}, \qquad r \leqslant |x| \leqslant R. \tag{15}$$

The wavefront interfering with a plane reference wave is connected with the optical path difference in the following way:

$$\bar{\delta} g_p(x) = \lambda \bar{\delta} M_p(x), \tag{16}$$

thus

$$\delta n_i = (\lambda/2)(\bar{\delta} M_p(x)/\sqrt{R^2 - x^2}), \qquad r \leqslant |x| \leqslant R, \tag{17}$$

where $\bar{\delta}M_p(x)$ represents the change of the interference order in the region of the clad of the phase object. The value of $\bar{\delta}M_p(x)$ may be determined either by measuring the deviation of the fringes from rectilinearity or by employing interpolation or approximation methods. The choice of the method depends on the value of the measured difference δn_i of the refractive indices. When δn_i is small, it is recommended to use the method of deviation of the fringes from rectilinearity

$$\bar{\delta}M_p(x) = y_x/y_i. \tag{18}$$

In order to increase the accuracy, the measurement is made at the point $x = r$ (Fig. 3**a**). When δn_i is large, one of the other two methods should be applied by interpolating or approximating the set of points $\{M_p+i, x_i\}$ within the interval $\langle r, R\rangle$ (Fig. 3**b**).

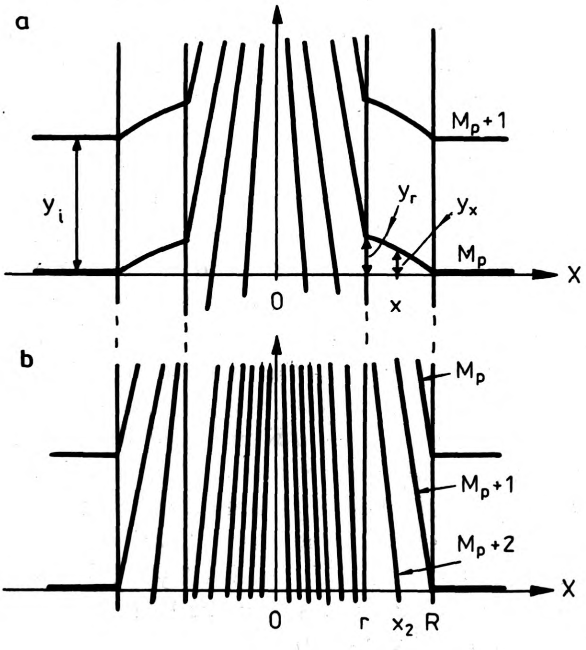

Fig. 3. Interference fringes for the fringe shift method (**a**) and the interpolation or approximation methods (**b**)

4. Error of the measurement of δn_i in the zero order approximation

Since the measurement error of the mismatching δn_i of the refractive indices of the immersion liquid and the coat, for either preform or light waveguide, affects the accuracy of correction of both the wavefront $\delta g(x)$ and the interference orders $\delta m(x)$, it is essential to analyse the factors determining this error. The absolute and relative errors of δn_i are defined as follows:

$$\Delta\delta n_i = \frac{\lambda}{2}\frac{\Delta\bar{\delta}M_p(r)}{\sqrt{R^2-r^2}} + \delta n_i\frac{R\Delta R + r\Delta r}{\sqrt{R^2-r^2}}, \tag{19}$$

$$\frac{\Delta\delta n_i}{\delta n_i} = \frac{\lambda}{2}\frac{\Delta\bar{\delta}M_p(r)}{\sqrt{R^2-r^2}}\frac{1}{\delta n_i} + \frac{R\Delta R + r\Delta r}{\sqrt{R^2-r^2}} \tag{20}$$

where $\Delta\bar{\delta}M_p(r)$, ΔR and Δr are the errors of the measurements of the interference fringe order at the point $x = r$ and the object and the core radius, respectively. The purpose of the error analysis carried out below is to determine the measurement parameters for which the measurement error δn_i is still acceptable. The measurement error δn_i is affected by both the parameters of the examined object (R, r/R), and measurement error of these parameters ($\Delta R/R$, $\Delta r/r$), as well as by the error of determining of the interference orders $\Delta\bar{\delta}M_p(r)$. The absolute value of the measured difference δn_i is also of an essential significance.

In our considerations, three types of objects were taken into account: preform (of radius $R = 6\times10^{-3}$ m), thick core light waveguide ($R = 6\times10^{-4}$ m), and waveguide ($R = 6\times10^{-5}$ m). Within each of those types of objects, the subgroups characterized by different core-to-total diameter ratios (i.e., r/R: 0.5, 0.4, 0.3) are distinguished. It has been assumed that $\Delta\bar{\delta}M_p(r) = 0.05$. For object chosen in this way the influence of the measurement error for geometrical parameters ($\Delta R/R$, $\Delta r/r$) on the absolute and relative errors of the δn_i measurement, respectively, has been analysed as depending on the measured difference δn_i, δn_i being taken from interval 5×10^{-5}–1×10^{-2}. Because of the high spread of the δn_i values, a nonlinear scale (of square root type of δn_i) has been accepted on the δn_i axis in the respective diagrams.

In Figure 4 it has been shown how the absolute (figures **a**) and relative (figures **b**) measurement errors of δn_i change depending on the accuracy of the geometric parameter determination of the object of radius $R = 6$ mm (light waveguide preform). For a small error of $\Delta R/R$ and $\Delta r/r$ determination, the absolute error is slowly changing within the considered interval of δn_i (Fig. 4**a**). The greater the error of $\Delta R/R$ and $\Delta r/r$ the quicker the $\Delta\delta n_i$ error increases with the increase of δn_i (Figs. 4**a**′ and 4**a**″). As it may be seen from the diagrams the error δn_i is higher for preforms of higher value of the r/R parameter. From Figs. 4**b**, **b**′ and **b**″ it is visible that the relative error is the highest when small values δn_i are measured, while significant differences of those errors appear for the objects of different parameters r/R. In order to improve the readibility of the figures the courses of the error curve have been presented only for $r/R = 0.5$ and the error interval for r/R ranging from 0.5 to 0.3 have been marked at several chosen points in the diagrams. For the high values of δn_i the relative error is the smallest being practically the same for different values of r/R. The increase of the measurement error of $\Delta R/R$ and $\Delta r/r$ causes no distinct increase in the $\Delta\delta n_i/\delta n_i$ error (Figs. 4**b**, **b**′, **b**″). In Figures 5 and 6 the relations analogical to those in Fig. 4 have been presented for the objects of radii $R = 0.6$ mm and 0.06 mm. The absolute error for these objects is almost stable (in the considered interval δn_i) being the greater the greater the value of r/R. The character of the relative error curve $\Delta\delta n_i/\delta n_i$ is analogical to that of the previous object being the smaller for higher values of δn_i. Since the values of these errors for $r/R = 0.4$ and 0.3, respectively, are close to its value for $r/R = 0.5$, in Figs. 5**b** and 6**b** only the ranges of their changes were marked for $r/R = 0.5$. In the case of the above objects the measurement errors δn_i do not depend practically on the accuracy of the determination of the geometric parameters $\Delta R/R$ and $\Delta r/r$. From the comparison of Figs. 4–6 it is visible that if the linear sizes of the measured objects diminish n times the

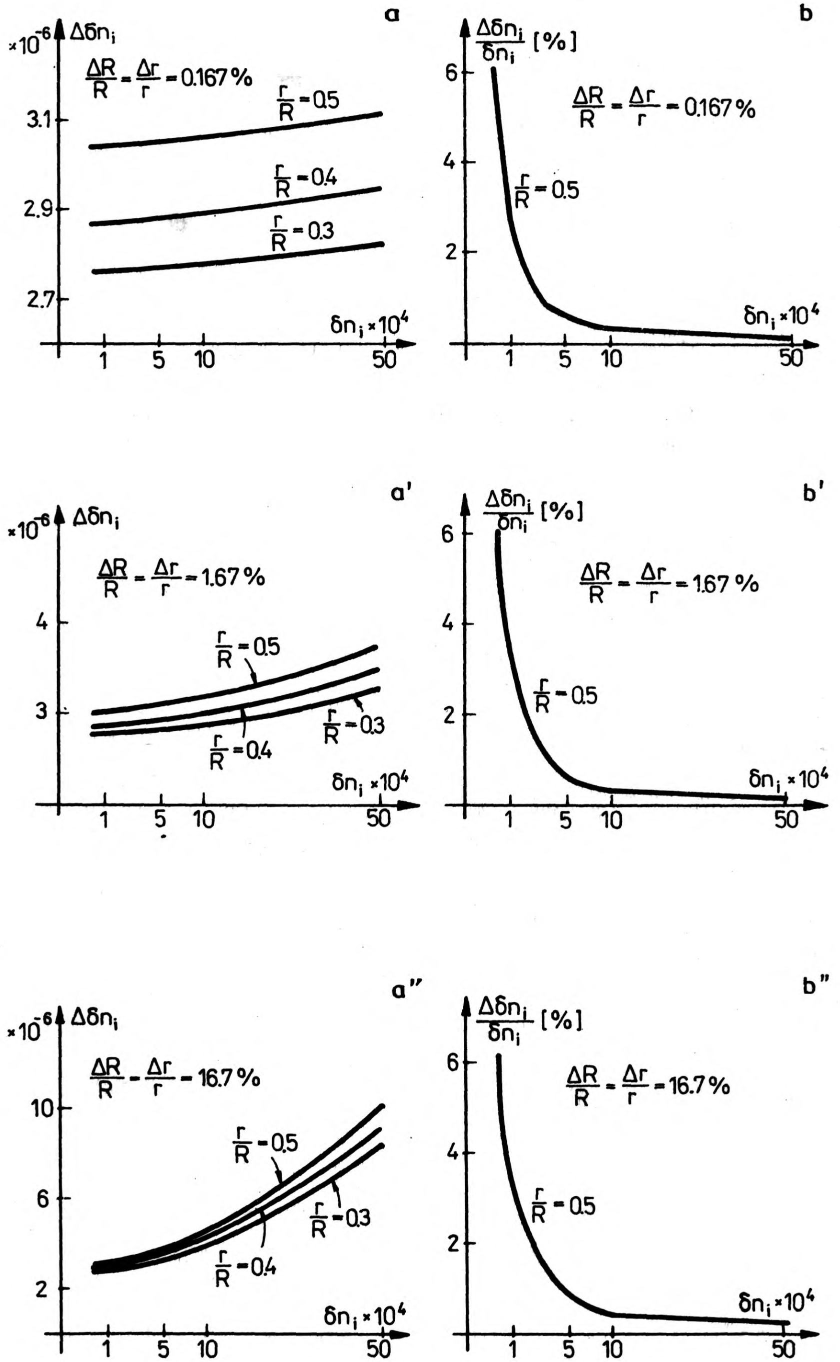

Fig. 4. Absolute (**a** – for $\Delta R/R = 0.167\%$, **a'** – for $\Delta R/R = 1.67\%$, **a''** – for 16.7%), and relative (**b** – for $\Delta R/R = 0.167\%$, **b'** – for $\Delta R/R = 1.67\%$, **b''** – for $\Delta R/R = 16.7\%$) errors δn_i in the zero-order approximation. Waveguide preform of $R = 6$ mm

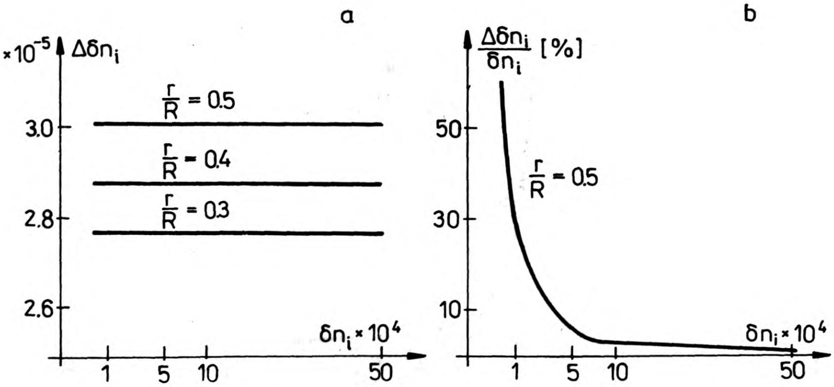

Fig. 5. Absolute (**a**) and relative (**b**) errors of the δn_i measurements in the approximation of zero-order. Thick-core waveguide of $R = 0.6$ mm

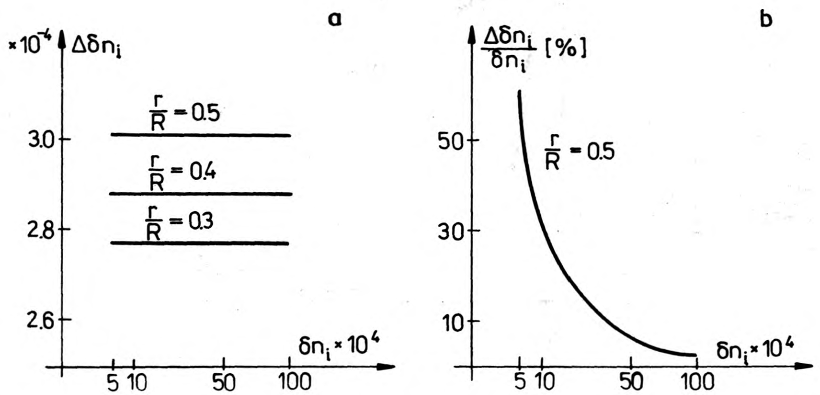

Fig. 6. Absolute (**a**) and relative (**b**) errors of the δn_i measurements in the approximation of zero-order. Waveguide of $R = 0.06$ mm

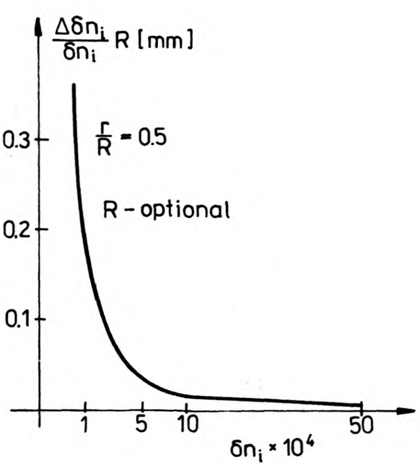

Fig. 7. Product of the relative error and the core radius $(\Delta\delta n_i/\delta n_i)R$ as a function of the refractive index difference δn_i

errors of the measurement of the refractive index differences δn_i increase by the same factor (when keeping the remaining parameter on the same level). In Figure 7 the values $(\Delta\delta n_i/\delta n_i)R$ have been presented as functions of the measured difference δn_i. On the base of the relation $(\Delta\delta n_i/\delta n_i)R$ (δn_i) it may be estimated what error $\Delta\delta n_i/\delta n_i$ has been made when measuring the object of diameter R for the coat and immersion mismatching δn_i of refractive indices. The dependence shown in Fig. 7 allows us to match the suitable immersion liquid so as not surpass the admissible error in the measurements of the object of definite size R.

5. Errors of the interference order correction

The absolute error of the function correcting the interference order is as follows:

$$\frac{\Delta\delta M_k(x)}{\delta M_k(x)} = \frac{\Delta\lambda}{\lambda} + \frac{\Delta\delta n_i}{\delta n_i} + A\Delta R + B\Delta x + C\Delta r \tag{21}$$

where:

$$A = \left| \frac{R}{\sqrt{R^2-x^2}-\sqrt{R^2-r^2}} \left[\frac{1}{\sqrt{R^2-x^2}} - \frac{1}{\sqrt{R^2-r^2}} \right] \right|,$$

$$B = \left| \frac{1}{\sqrt{R^2-x^2}-\sqrt{R^2-r^2}} \frac{x}{\sqrt{R^2-x^2}} \right|,$$

$$C = \left| \frac{1}{\sqrt{R^2-x^2}-\sqrt{R^2-r^2}} \frac{r}{\sqrt{R^2-r^2}} \right|. \tag{22}$$

Its value has been determined for the class of objects characterized by the r/R (Fig. 8). As it may be seen from (21), the relative error $\Delta\delta M_k(x)/\delta M_k(x)$ depends on the measurement errors ΔR, Δr, Δx, and on the mismatching error of the refractive index of the coat to that of the immersion $\Delta\delta n_i/\delta n_i$, as well as on the error $\Delta\lambda/\lambda$ of wavelength determination of the light used to the measurement. The value of $\Delta\lambda/\lambda$ in the case when laser light is employed is negligibly small and the value $\Delta\delta n_i/\delta n_i$ is estimated in the way discussed in the previous section. The value $\Delta\delta M_k(x)/\delta M_k(x)$ increases non linearly with the increase of the distance from the object core centre and is the greater the greater the relative measurement error of the geometric parameters of the object $(\Delta R/R, \Delta r/r)$. The last dependence is linear, i.e., if $\Delta R/R = \Delta r/r$ increases by an order of magnitude then the same is true for the $\Delta\delta M_k(x)/\delta M_k(x)$ error. As it may be seen from Figure 8, the relative error of the correction function for the interference order $\delta M_k(x)$ increases with the increase of x. This increase follows from the definition of this error and the course of $\delta M_k(x)$. Thus, the relation (21) is similar to the formula (10) given in [1]. The analysis of the measurement error connected with the relative errors introduced by the zero-order approximation and reported in [1] refers also to the case discussed in this work, since $\Delta\delta M_k(x)/\delta M_k(x) = \Delta\delta G_k(x)/\delta G_k(x)$.

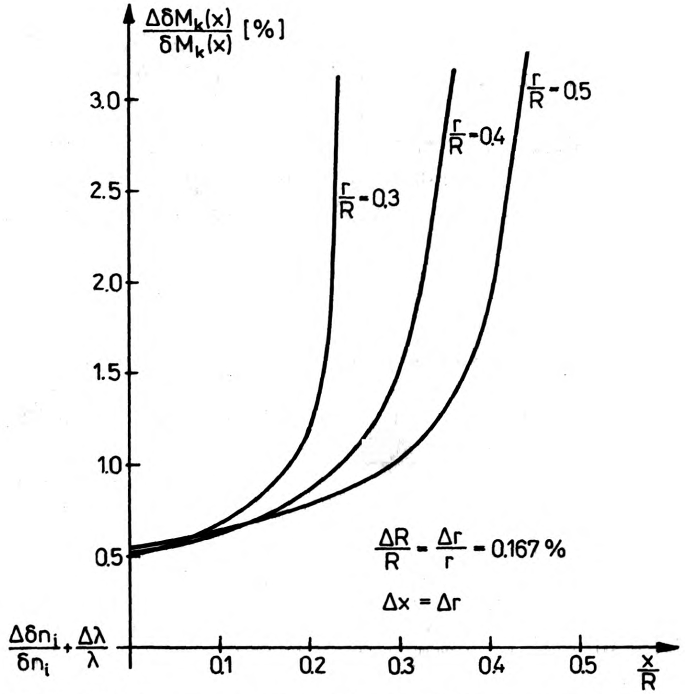

Fig. 8. Relative error of the interference order correcting function $\delta M_k(x)$

6. Calculation of the order correcting term for the real run of the ray

The correcting term for the order of interference is defined as follows:

$$\delta M_{kd}(x') = \frac{2Rn_p}{\lambda}\left[\sqrt{1-(\nu x/R)^2}-\frac{\nu}{\sqrt{1-(x/R)^2}+\frac{\nu(x/R)^2}{\sqrt{1-(\nu x/R)^2}}}\right] \tag{23}$$

where:

$$\nu = 1-\frac{\delta n_i}{n_p}, \tag{24}$$

$$x' = x/\cos\psi, \tag{25}$$

$$\cos\psi = 2[\nu(x/R)^2+\sqrt{1-(\nu x/R)^2}\sqrt{1-(x/R)^2}]^2-1. \tag{26}$$

The coordinate x denotes the height of the ray entrance to the object examined, x' is the coordinate of the point (corresponding to the point x) in the plane passing through the object centre. The value of the correcting term corresponding to the interference order at the point x being known, the value of $\delta M_{kd}(x)$ has been calculated by using either the interpolation or approximation methods. The relative error of their interference order is analogical to that reported in [1], where an appropriate analysis has been carried out.

7. Calculation of the refractive index difference δn_i of the immersion liquid and the phase object coat on the base of an additional interference measurement

Difference δn_i of the refractive indices may be determined by employing different methods. In this paper the analysis is restricted to the interference method with the plane reference wave. In particular, as a source of information about δn_i we may use the interferogram which was exploited to determine the profile $\delta n(x)$ of the refractive index of the examined object core. This additional measurement allows us to determine the interference order $\bar{\delta} M_p(x)$ from the interferogram at one point of the coordinate $x \in \langle r, R)$. The smallest relative error occurs for $|x| = r$. The calculation of δn_i from the system of Eqs. (23)–(26), under assumptions that $\bar{\delta} M_{kd}(x') = \bar{\delta} M_p(x')$, is not direct. For obtaining the solution the computer methods were used and δn_i has been approximated by the series.

$$\delta n_i = a_0 + a_1 \frac{\bar{\delta} M_p(x'/R)}{R} + a_2 \left[\frac{\bar{\delta} M_p(x'/R)}{R}\right]^2. \tag{27}$$

The coefficients of the approximating polynomial (27), for $\lambda = 632.8$ nm, $n_p = 1.4571$, $x'/R \in \langle 0.3; 0.6 \rangle$ and $\delta n_i \in \langle 0.00001; 0.1 \rangle$, are given in the Table.

Coefficients of the approximation polynomial δn_i

x'/R	a_0	a_1	a_2
0.30	5.18×10^{-10}	3.47308×10^{-4}	-7.74×10^{-9}
0.35	9.46×10^{-10}	3.59800×10^{-4}	-1.15×10^{-8}
0.40	2.81×10^{-9}	3.75241×10^{-4}	-1.66×10^{-8}
0.45	1.84×10^{-9}	3.94219×10^{-4}	-2.37×10^{-8}
0.50	-9.86×10^{-10}	4.17545×10^{-4}	-3.38×10^{-8}
0.55	-9.67×10^{-9}	4.46368×10^{-4}	-4.84×10^{-8}
0.60	-1.80×10^{-8}	4.82343×10^{-4}	-7.03×10^{-8}

8. Error of δn_i measurement for real run of the ray

In accordance with (27), the absolute error δn_i of determination of mismatching between the immersion liquid and the coat of the examined object is

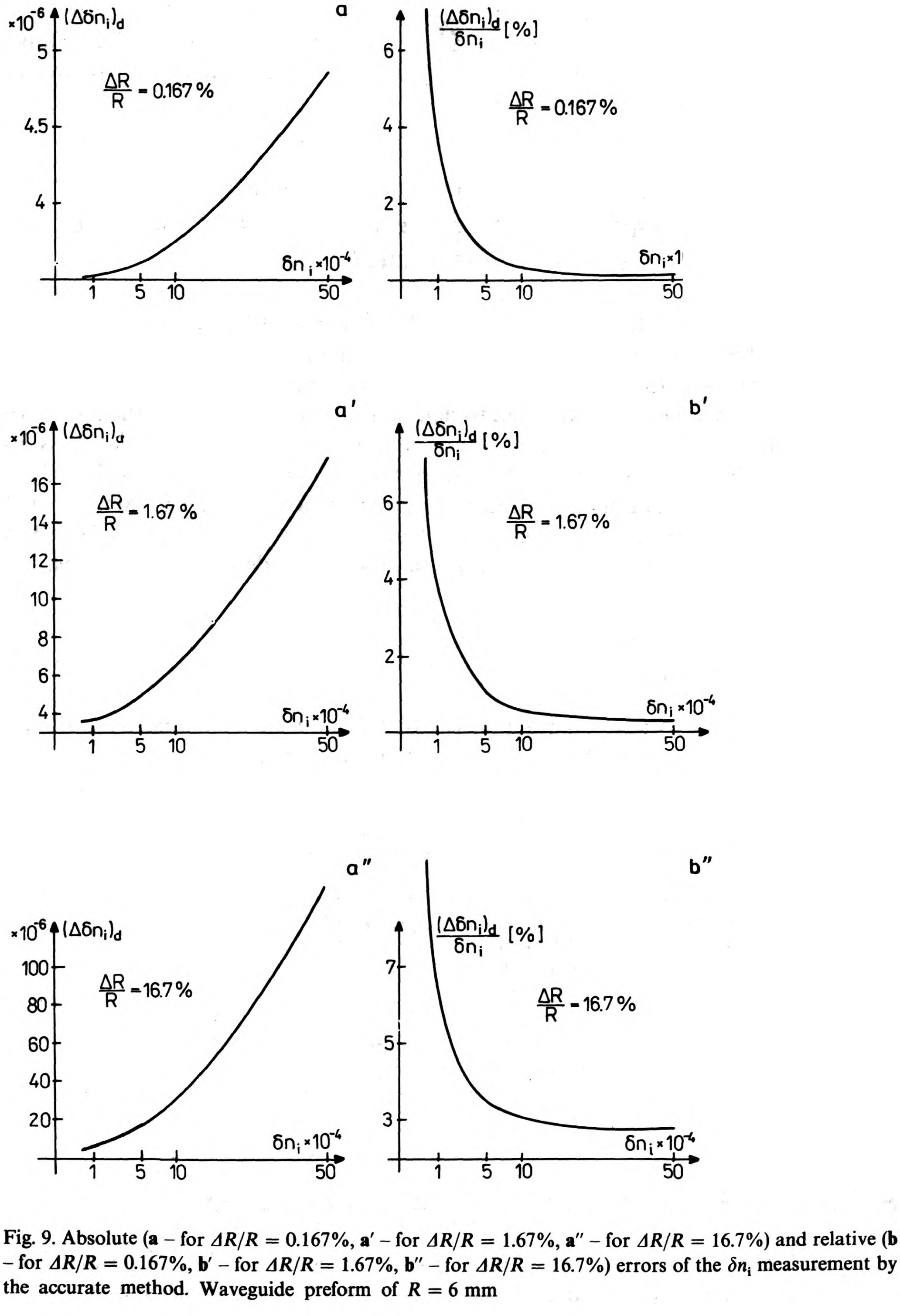

Fig. 9. Absolute (**a** – for $\Delta R/R = 0.167\%$, **a'** – for $\Delta R/R = 1.67\%$, **a"** – for $\Delta R/R = 16.7\%$) and relative (**b** – for $\Delta R/R = 0.167\%$, **b'** – for $\Delta R/R = 1.67\%$, **b"** – for $\Delta R/R = 16.7\%$) errors of the δn_i measurement by the accurate method. Waveguide preform of $R = 6$ mm

$$\Delta\delta n_{\mathrm{i}} = \left|\frac{a_1}{R}+\frac{2a_2}{R^2}\bar{\bar{\delta}}M_{\mathrm{p}}(x'/R)\right|\Delta\bar{\bar{\delta}}M_{\mathrm{p}}(x'/R)+\left|\frac{a_1}{R^2}\bar{\bar{\delta}}M_{\mathrm{p}}(x'/R)\right.$$
$$\left.+\frac{2a_2}{R^3}[\bar{\bar{\delta}}M_{\mathrm{p}}(x'/R)]^2\right|\Delta R. \tag{28}$$

The analysis of the error has been carried out in a way analogical to that concerning the zero-order approximation (Sect. 4). Relations analogical to those in Figs. 4–6 are given in Figs. 9–11, but only for $x'/R = 0.5$. As it was in the case earlier it is assumed

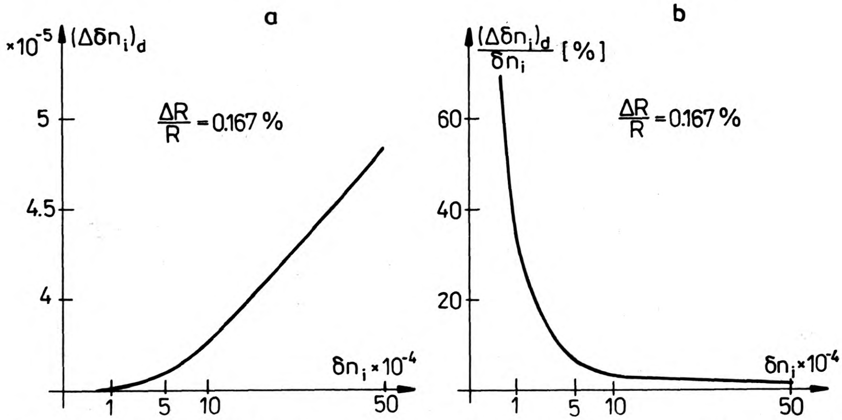

Fig. 10. Absolute (**a**) and relative (**b**) errors of the δn_{i} measurement by using the accurate method. Thick-core waveguide of $R = 0.6$ mm

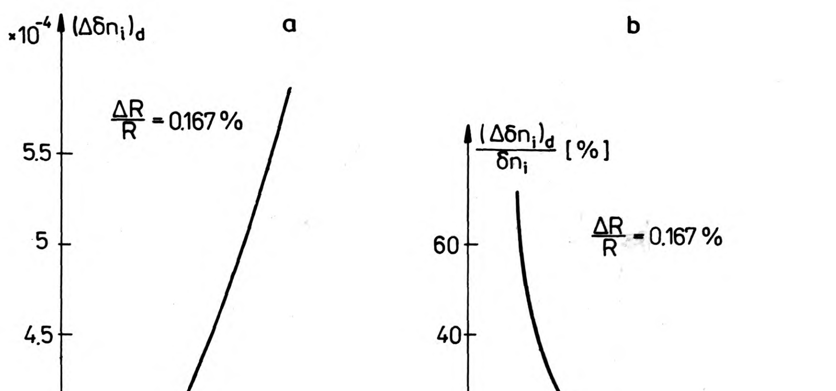

Fig. 11. Absolute (**a**) and relative (**b**) errors of the δn_{i} measurement by using the accurate method. Waveguide of $R = 0.06$ mm

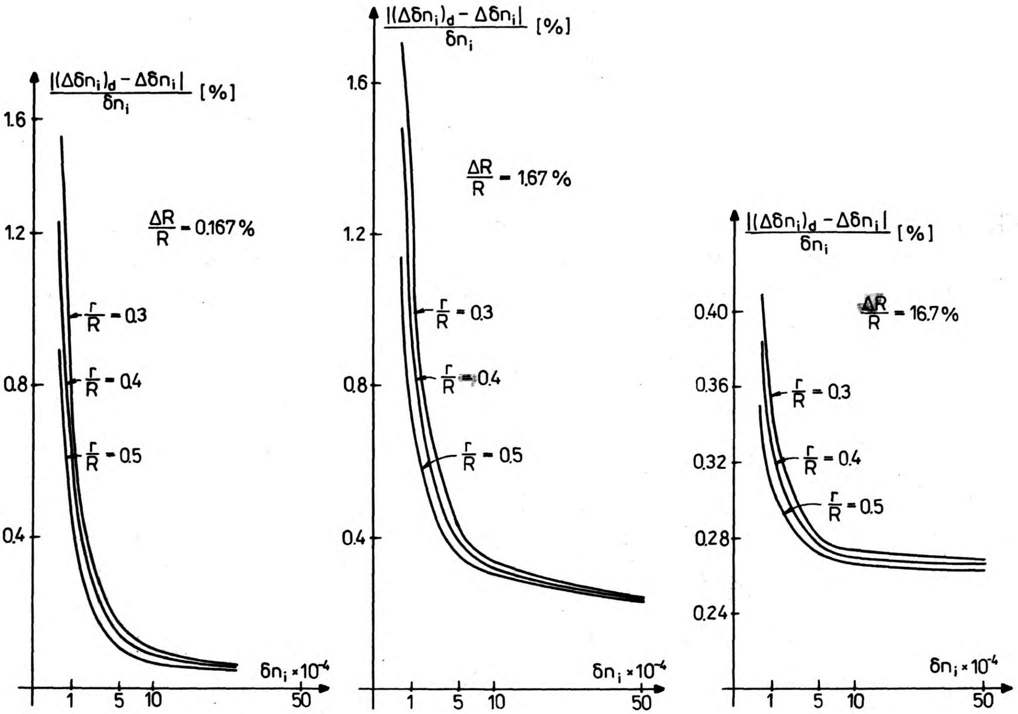

Fig. 12. Differences of absolute and relative errors of δn_i measurement estimated by accurate method and the method of zero-order approximation, respectively ($R = 6$ mm)

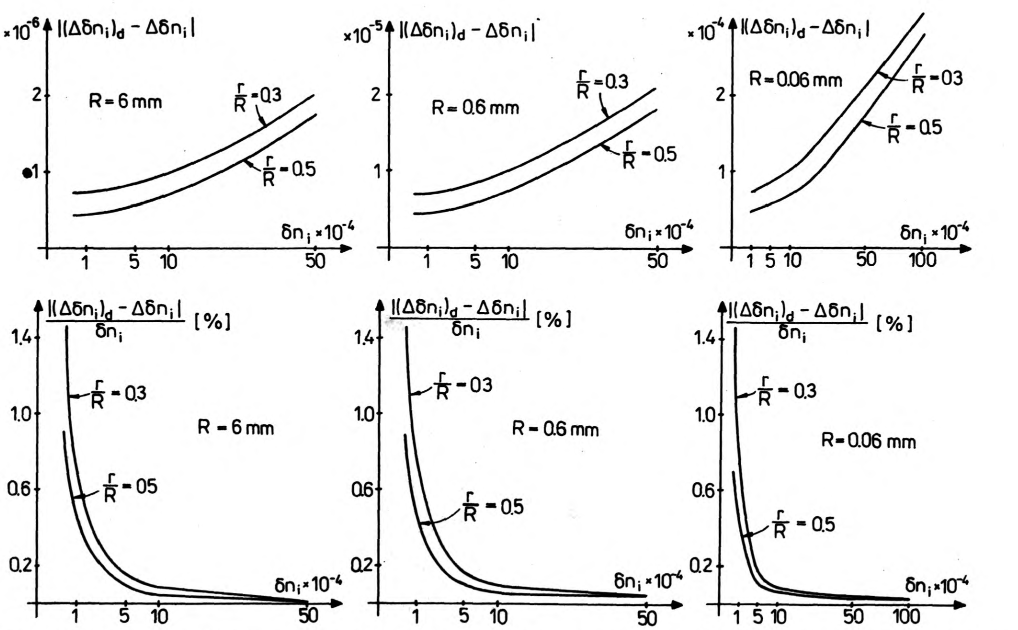

Fig. 13. Differences of absolute and relative errors of δn_i measurement estimated by accurate method and the method of zero-order approximation, respectively ($\Delta R/R = 0.167\%$)

that $\Delta\bar{\bar{\delta}}M_p(x'/R) = 0.05$. In Figs. 12 and 13, differences in the error of measurement of δn_i obtained with the help of the zero-order approximation method and for real runs of the ray are presented for the respective cases from Figs. 4 and 9, and 6 and 11. On the base of these differences, the range of applicability of the zero-order approximation may be easily determined.

9. Conclusions

The measurement of the refractive index profile is possible both for matched and mismatched refractive indices of the immersion liquid and the object (preform, light waveguide) coat. In the latter case (mismatching) is especially interesting since the matching may be very tedious or even impossible. The method proposed in this paper is simpler being reduced to correction of the interference orders measured on the interferogram.

The presented analysis of the measurement errors enables us to choose the measurement conditions in order to achieve the needed accuracies. On the base of the results of the above analysis, the choice of the correcting method is also possible, i.e., either the simpler method based on zero-order approximation or a slightly more complicated (in calculations) but more accurate one can be chosen.

The method presented in this work may be used also for purposes different from that described above.

References

[1] Kowalik W., Dubik B., Opt. Appl. **20** (1990), 3.
[2] Kowalik W., Dubik B., SPIE **670** (1986), 73–76.
[3] Kowalik W., Dubik B., Report SPR–209/87, Institute of Physics, Technical University of Wrocław, Wrocław 1987 (unpublished), in Polish.

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Процедуры, корректирующие несогласование иммерсии при интерферометрическом определении профиля коэффициента преломления. II. Корректировка порядка интерферометрии

В представленном методе корректировка проводится непосредственно на порядках интерференции, что дает возможность выполнения расчетов по алгоритму, применяемому для примера согласования иммерсии оболочки исследуемого объекта. Проведен анализ погрешностей метода корректировки. Дан метод измерения величины несогласования коэффициентов преломления иммерсионной жидкости и оболочки исследуемого объекта, а также определена степень точности этого измерения.