також методику досліджень електрооптичних, модуляційних та часових параметрів рідкокристалічного модулятора.

Висновок

Використання вимірювального комплексу із використанням мікроконтролера дозволило суттєво підвищити точність вимірюваннь електрооптичних характеристик рідкокристалічних модуляторів лазерного випромінювання, суттєво спростити експериментальну установку.

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AMPLITUDE OPTICAL FIBRE SENSOR

The paper presents the results of proprieties measurements of the amplitude sensor which is made on a base on an optical plastic fibre sensor. This element can be served to marking shifts, powers etc. This work shows also an influence of length of waves on sensor proprieties. All measurements are executed to the results which were obtained by the extensometer sensor subjected the same influential factor measured.

Описані результати вимірювань характеристик амплітудного сенсора, виготовленого на основі пластикового оптоволоконного сенсора. Також досліджено вплив довжини хвиль на властивості сенсора.

1. Introduction

An optical fibre sensors conquer more and more greater popularity and many new fields of uses. Wide measuring possibilities (dislocation, power, pressure, acoustic twitches) offer so-called amplitude sensors in which the magnitude of measure changes the shape of an optical fibre element. Each bend and microbend are effective to an optical power losses driven in optical fibre. All these results find two explanations:

- bend losses which are the result of bending the track of the optical fibre and depend of the ray of curvature,
- losses of passage among two sections of optical fibre with different rays of curvature, otherwise not-fitting decays of modulation fields in transverse direction to axis of an optical fibre.

An analysis of influence of bends is a composite problem and it is difficult to describe. The Fig. 1 below graphically shows the example of an exude module.

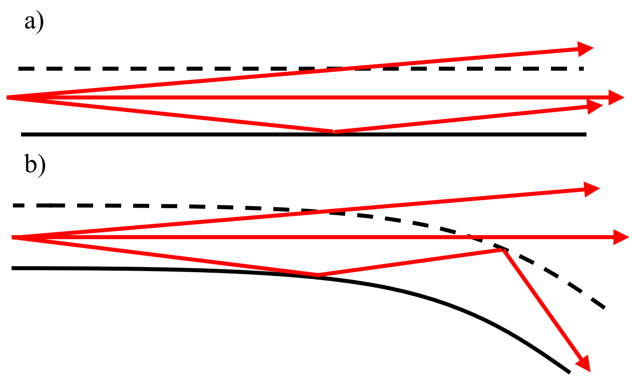

Fig. 1. An occurrence of losses of power which is the consequence of bends of an optical fibre
(a) lack of bend
(b) modules flowing out in a consequence of bends

The strand of an optical fibre can additionally realize the function of the resilient element. Then we can consider it as a stiff beam supported in two points A and B distant from each other on L distance on which acts the assemble power P. The activity of this power causes deformations of optical fibre about Δx.

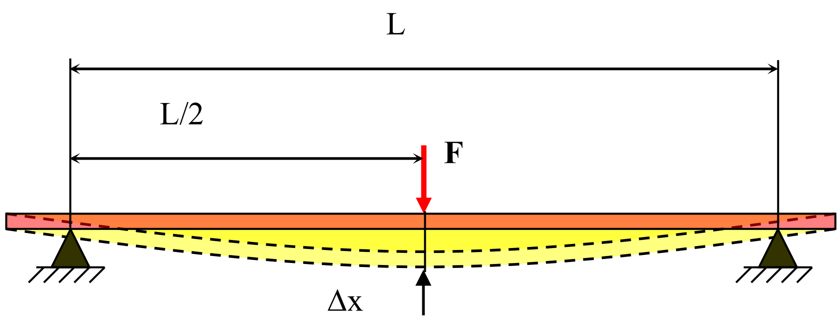

Fig. 2. The schematic diagram of deflectors of a optical fibre

Using the method of integrating equalizations of an axis bent we get:

$$EJ\frac{d^2y}{dz^2} = \pm M_g \tag{1}$$

where:

E – Young`s module,

Mg – bending moment,

J – moment of an inertia of the transverse section. Here is $J = \frac{\pi}{4}a^4$

Solving above comparisons we get the dependence of the deflector Δx from acting the P power where:

$$\Delta x = \frac{L^3}{48EJ}F \tag{2}$$

To initiate constant A_n dimension characterizing a univocally optical fibre sensor we get:

$$\Delta x = A_n L^3 F \tag{3}$$

From here we get a mechanical susceptibility:

$$\frac{dx}{dF} = A_n L^3 \quad (4)$$

Taking into account a tenderness of dislocation which is characterizing by the speed of changes of exit-signal on a shift, defined as:

$$S_x = \left| \frac{dT}{dx} \right| \quad (5)$$

where:

T – change of exit-signal

To define a tenderness of a sensor:

$$S_F = A_N S_x L^3 \quad (6)$$

we can univocally ascertain that to obtain greater tenderness we should enlarge L distance which means to enlarge the length of an element of an active sensor.

2. The measuring arrangement

We have examined three sensors executed of different optical fibres. The measuring arrangement in principle made possible an immediate comparison of results of optical fibre sensor with results from a deformeter sternum. Sensors supplied by sources of different rays of light – ankle bone changing – lengths of wave.

Purposely we have executed a sensor with a considerable length (a support in distant points accomplished 10cm). An acting power on a sensor was exerted by a micrometric screw which pointed a specified deflector of Δx sensor. In a point of an activity of simultaneously powers and an optical fibre sensor we have stuck a deformeter which was a source of standard measurements.

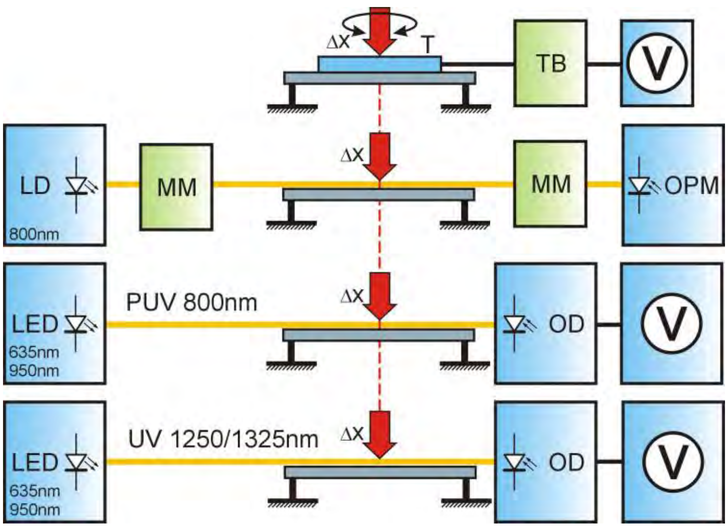

Fig. 3. Measuring system: LD – optical source with laser diode, LED - optical source with LED diode, MM – modes mixer, TB – extensometer bridge, OPM – optical power meter, OD – measuring amplifier with pin photodiode

The two sensors using plastics optical fibres and the one sensor based on the multimode communication fibre have been made. The damping characteristics of plastics optical fibres in relation to wave length are presented in Fig.4 and 5.

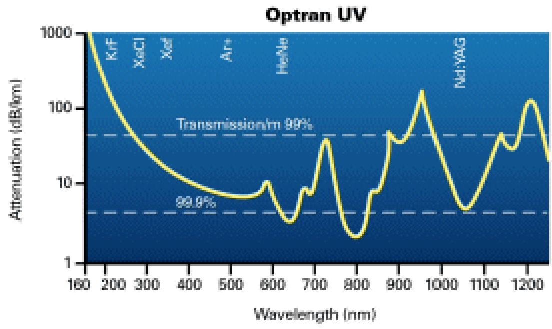

Fig. 4. Dependence of a suppression waves length for an optical fibre UV 1250/1325 [5].

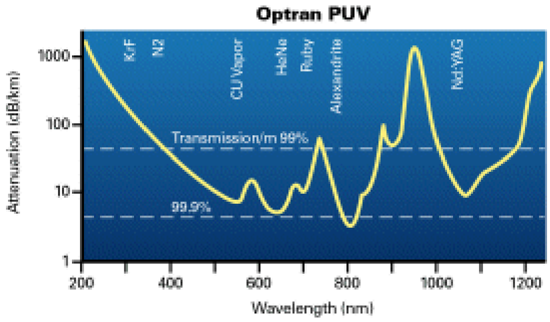

Fig. 5. Dependence of a suppression waves length for an optical fibre PUV 800n [5].

The sensors made on the basis of plastics optical fibres cooperated with the light sources (LED diodes) with wave length equal 635nm (small fibre damping) and 950 nm (big fibre damping) as well as the sensor built with using communication optical fibre cooperated with the light source (laser diode) with wave length equal 850 nm. The measurements of optical power losses were carried out using precise measuring amplifier (for sensors with plastics fibres) and professional meter of optical power (for sensor with communication optical fibre).

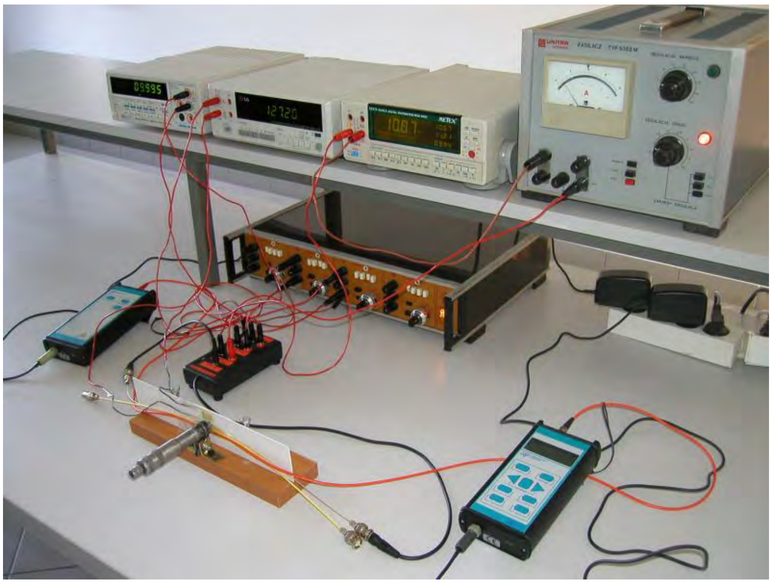

Fig. 6. Measuring stand

The measuring stand is shown in Fig. 6.

3. The measurements results

The comparative measurements of the amplitude parameters in optical fibre test sensors have been made.

The light intensity changes were not observed (in measured range) for sensor constructed on the basis of communication optical fibre, so it was omitted in the presented below results. It can be applied as transmission medium between optical sensors and supplying/measuring devices.

For all sensors the measurements were made from the state without aberration to the maximum and back. It is presented in included below figures. The measurements repeatability was very good and small deviations are caused by measuring errors.

a) **b)**

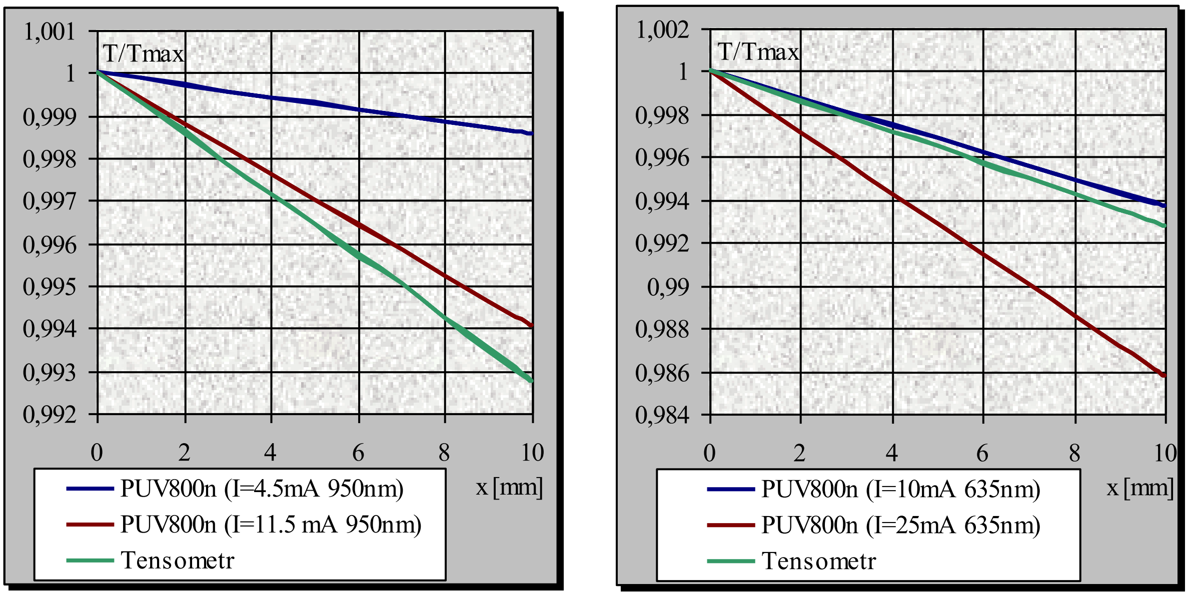

Fig. 7. Light intensity influence on sensitivity of sensor with PUV800n optical fibre:
a) wave length - 950nm, b) wave length - 635nm

a) b)

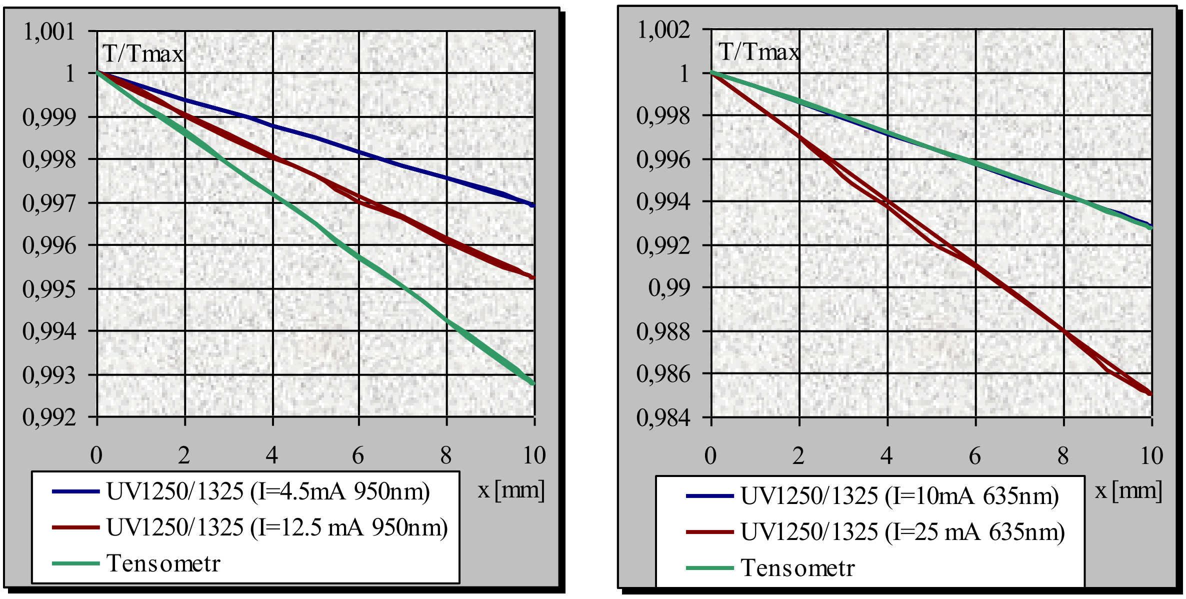

Fig. 8. Light intensity influence on sensitivity of sensor with UV1250/1325 optical fibre:
a) wave length - 950nm, b) wave length - 635nm

The light intensity influence on the sensor sensitivity was presented in Fig.7 and 8. The light intensity increasing supplied optical fibre sensor causes increase of the sensitivity in such measuring element. With the application of proper light source the big increase of the dynamics can be obtained – much more bigger than in RL extensometer (in this case used as reference). It can be observed for both types of optical fibres and both light sources.

a) b)

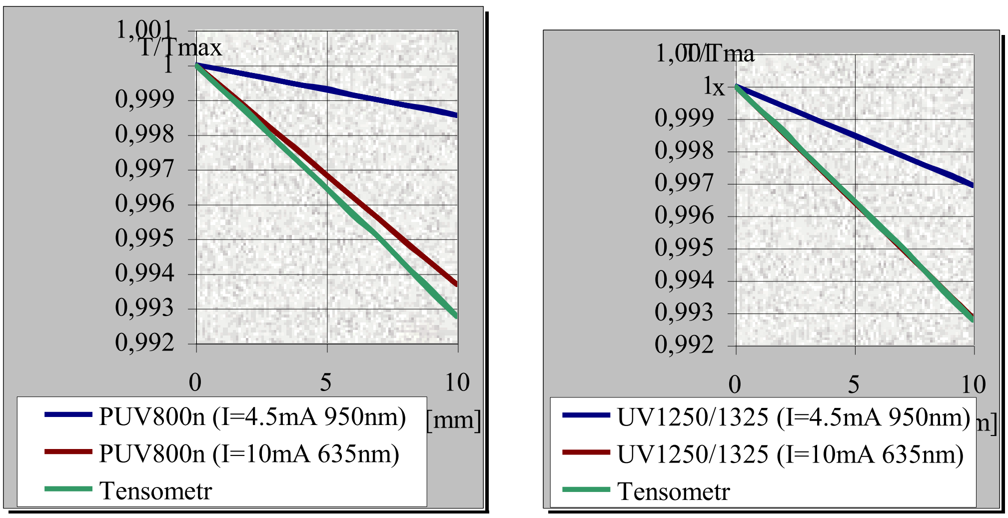

Fig.9. Influence of wave length of used light source on sensors sensitivity:
a) sensor with PUV800n optical fibre, b) sensor with UV1250/1325 optical fibre

The comparative analysis (for each optical fibre) of the sensor wave length influence on its dynamics has been made. The wave lengths were selected on the basis of damping characteristics of each optical fibre (obtained from the manufacturer). They values were estimated for the one damping minimum (635nm) and one damping maximum (950nm). For the each wave length the light source was calibrated for obtaining one common value of the light intensity in the case without pressure on the sensor. The measuring results are presented in Fig.8. For the more accurate measurements for both sensors the light sources can be selected with wave lengths from the range of the smallest damping of the optical fibre. The sensor based on UV1250/1325 optical fibre is characterized by a little biggest range of dynamics changes than sensor with

PUV800n (in the case of the same operational conditions).

a) b)

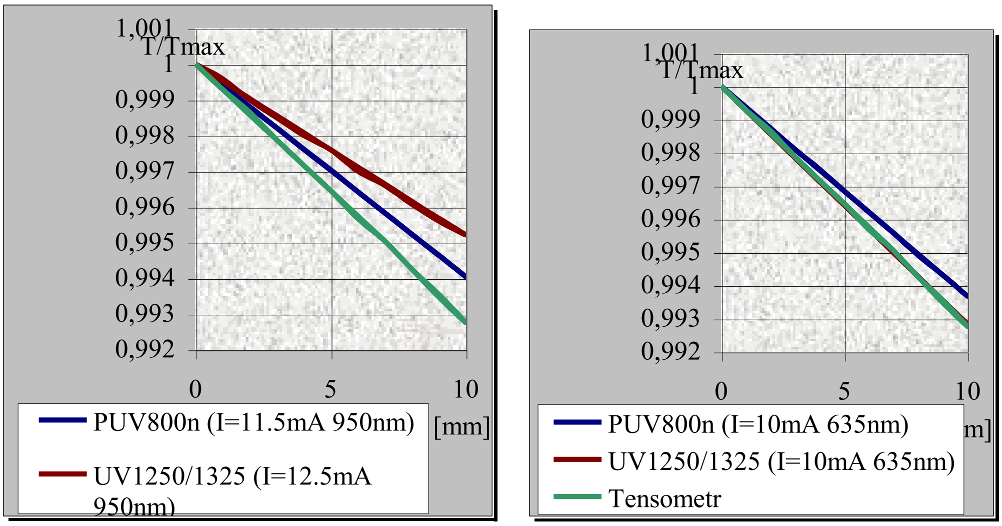

Fig. 10. Comparison of the sensors' sensitivity made from different optical fibres with the same operational conditions: a) wave length - 950nm, b) wave length - 635nm

The sensors based on two different optical fibres which operate in the same conditions have a differences. In the infrared range the better parameters has sensor with PUV800n optical fibre (better dynamics) but in the visible light range (wave length - 635nm) the better is sensor with the UV1250/1325 optical fibre (dynamics comparable with extensometer sensor).

4. Conclusions

The using of changes of the selected optical fibres parameters (occurred with different external factors) is justified measurements of physical phenomena.

The beam deflection sensor has been presented in this paper. Especially, the plastics optical fibres (with relative high damping) are very good basis for the such sensors. The sensitivity of optical fibre sensor operated in test configuration was comparable with the sensitivity of extensometer sensor. The sensitivity increase can be obtained by increasing of the light intensity which supplied sensor. Also, the big influence on the sensor parameters has the change of wave length emitted by light source. From those reasons the proper selection optical fibre type and parameters of its supplying determine the exploitation sensor parameters.

In any applications the presented optical fibre sensor can be substitute of the extensometer sensor, especially for significant deflections.

The big advantage of the optical fibre sensors is their immunity on external electromagnetic fields, so they can be widely applied in different industry branches.

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