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Refractive index measurement using the laser profiler

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Abstract

The paper proposes a method for measuring the refractive index of the plane-parallel samples of the material using laser profiler. The method is based on measurement of the displacement due to refraction of the laser beam passing through a sample of known geometry. The developed method was used to measure the refractive index of gallium nitride on the range of optical wavelengths (470, 561 and 632 nm). The measurement error of the refractive index was 10^{-3}. The experimentally obtained values of the refractive index match with the reference data within measurement error. The relative simplicity of the measurement procedures distinguishes this method.

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Keywords: refractive index; laser profiler

The refractive index is one of the most important parameters of optical material. There are various methods for determining the refractive index among which goniometric, refractometric, and ellipsometric (Babichev et al. (1991)). This paper proposes a method for determining the refractive index using an alternative method based on the use of laser profiler.

The peculiarity of the method of measuring the refractive index using a laser profiler is that the measured sample should be known geometry. In this case it is possible to apply the laws of geometrical optics and to determine the refractive index by the known formulas. It is known that the geometry in the form of thin plates with parallel to each

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other facets (that often provided automatically when the crystal growth) is the most simple and natural, as well as technologically more easily and more often implemented in practice (Pimpinelli et al. (1998)).

Diagram illustrating the principle of measuring the refractive index of the plane-parallel sample using the laser profiler is shown in Figure 1.

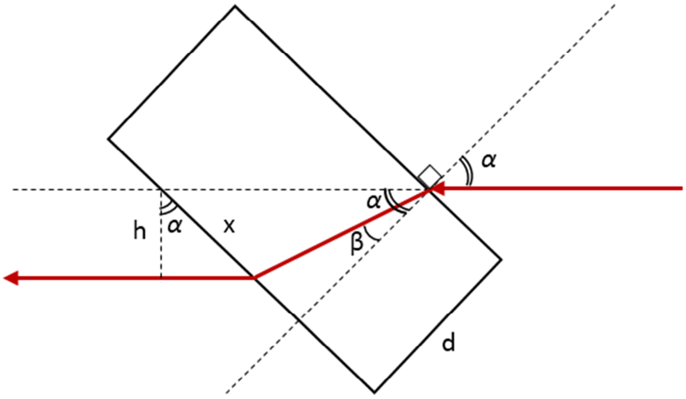

Fig. 1. The direction of the rays in a plane-parallel plate (α - angle of rotation, β - the angle of refraction, h - beam deflection, measured using a laser profiler, d - thickness of the sample).

Thin laser beam falls at an angle α to one of the face of the plane-parallel investigated sample, whereupon the beam is refracted and shifted due to refraction at the value h determined by a laser profiler. Herewith this beam should be much thinner than the expected shift h. Rotation of the sample leads to a change of the incidence angle α and, respectively, to change of the beam displacement h, which can be found by measuring the refractive index according to the formula derived from Snell's law:

$$n = \frac{\sin\alpha}{\sin(a\tan(\tan\alpha - \frac{h}{d\cdot\cos\alpha}))} \quad (1)$$

where d - thickness of the sample.

Experimental setup scheme of measuring the refractive index of plane-parallel sample using a laser profiler is shown in Figure 2.

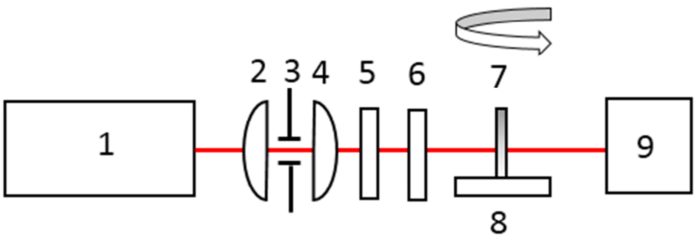

Fig. 2. Scheme of installation: 1- laser, 2 - plano-convex lens, 3 – diaphragm, 4 - plano-convex lens, 5 – polarizer, 6 - λ / 4 plate, 7 – sample, 8 - precision rotatory table, 9 - laser profiler.

In the work laser diodes for generating a wavelength of 470 and 561 nm, and He-Ne laser (632.8 nm) were used