

Dispersion of Refractive Index of Thin Films Based on $\beta\text{-Ga}_2\text{O}_3$

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Ga_2O_3 thin films (0.2–0.8 μm) were prepared by radiofrequency (RF) ion-plasma sputtering on $\nu\text{-SiO}_2$ fused quartz substrates. Deposited films were heat treated in oxygen or Ar at 1000–1100°C and in H_2 at 600–650°C. X-ray powder patterns showed that the films were polycrystalline and differed depending on the heat treatment method. The results indicated that the films were oriented in the (400), (002), (111), and (512) planes after annealing in oxygen. Films oriented in the (400), (002), (111), and (512) planes also dominated after annealing in Ar. Films annealed in H_2 showed a weakly developed structure in which reflections from the (400), (002), and (512) planes also dominated.

We used a single-oscillator three-parametric model to describe the refractive index dispersion of films that were annealed in an atmosphere of oxygen (I), Ar (II) in the studied spectral range. It was to a certain extent a modification of the Zelmeeer approximation:

$$n^2 - A = \frac{E_0 E_d}{E_0^2 - E^2} \quad (1)$$

Here A is the approximation coefficient; E_0 , the energy at the absorption band maximum that determined the spectral course of the refractive index; and E_d , the dispersion energy (oscillator strength)

Regression analysis made it possible to determine the approximation parameters in equation (1) for the studied films.

Table 1.

Crystal-chemical and energy parameters of dispersion curve for $\beta\text{-Ga}_2\text{O}_3$ thin films from equation (1)

Films $\beta\text{-Ga}_2\text{O}_3$	A	E_0 , eV	E_d , eV	f_i	N_c
I	1.04	7.70	14.53	0.73	4.17
II	1.48	6.98	10.01	0.83	3.21

For films, which annealed in hydrogen was observed the anomalous dispersion and for films annealed in oxygen or argon observed the normal dispersion was demonstrated. At normal dispersion spectral dependence of refractive index in visible region is mainly determined by the transition from the top of the valence band formed by the 2p-states of oxygen to the bottom of the conduction band formed by the hybridization 2p-states of oxygen and 4s-states of gallium. For investigated films with normal dispersion the parameters of the one-oscillator approximation are determined, the dispersion energy, ionicity degree and coordination number are calculated.