DETERMINATION OF THE THICKNESS AND OPTICAL PARAMETERS OF Gd_2O_3 THIN FILMS BASED ON THE INTERFERENCE EFFECT

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A set of key optical parameters of Gd_2O_3 thin films deposited on a glassy silica substrate by magnetron sputtering technique was determined using optical transmittance and absorption data. The refractive index dispersion in the wavelength range 400-660 nm was obtained by analyzing the interference e

Gadolinium oxide thin films are of interest as functional materials for multilayer devices of nanophotonics, optoelectronics, alternative energy and systems of radiation conversion [1]. Such parameters as thickness (d), refractive index (n), absorption coefficient (α) and optical band gap (Eg) directly influence on the functional characteristics of thin film coatings. In this work, we determine the thickness and key optical parameters of Gd2O3 thin films from transmittance and absorption spectra using the interference effect.

Thin film of Gd_2O_3 were deposited on silica glass substrates by radio frequency (13.56 MHz) magnetron sputtering using the metallic gadolinium as a target. Based on the synthesis mode data, the expected film thickness is 500 nm. Optical transmission and absorption spectra were recorded on a Perkin Elmer Lambda 35 spectrophotometer at room temperature.

Optical transmission spectrum $T(\lambda)$ of Gd_2O_3 thin film is shown in Fig. 1. There are two spectral ranges we can distinguish: (I) – the interference-free range of strong absorption and (II) – range of medium and weak absorption with interference extremes. The basis for determining the thickness and optical parameters of films from transmittance spectra with interference-effect is an envelope method developed by Swanepoel [2]. The essence of the method is to analyze the upper T_M and lower T_m envelopes (blue and red lines in Fig. 1) of $T(\lambda)$ spectrum. The refractive index of film can be calculated by equations:

$$n = \sqrt{(N + \sqrt{(N^2 - n_s^2)})}\ , \quad (1)$$

$$N = 2*n_s*(T_M-T_m)/(T_M*T_m)+(n_s^2+1)/2, \quad (2)$$

where T_M, T_m, are values of upper and lower envelopes at certain wavelength, and refractive index of substrate (ns = 1.47 for silica glass in the investigated spectral range), respectively.

Using the obtained values of the film thickness can be determined:

$d=(\lambda_1*\lambda_2)/(2*(\lambda_1*n_2 - (\lambda_2*n_1))$, (3)

where n_1 and n_2 are refractive indexes at two adjacent interference maxima (or minima) λ_1 and λ_2 . Using the method described above we determined that: the refractive index of Gd_2O_3 thin film takes values n= 2.55 - 2.03 in the wavelength range λ = 400-660 nm; the thickness of film is d = 460 nm.

The range of strong absorption (I) was analyzed using the optical absorption spectra. On the basis of Tauc equation [3] in the coordinates for direct interband transition the band gap of Gd2O3 film was determined as Eg = 3.98 eV.

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ЛЮМИНЕСЦЕНЦИЯ МОНОКЛИННОГО ZrO_2 ПОСЛЕ ЭЛЕКТРОННОГО ОБЛУЧЕНИЯ

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LUMINESCENCE OF MONOCLINIC ZrO_2 AFTER ELECTRON IRRADIATION

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A comparative analysis of luminescent properties for three type ZrO_2 samples, which differ in grain size and raw material composition, has been carried out. Differences in the TSL curves are established and the results of its optical bleaching are presented.

Люминофоры на основе диоксида циркония нашли широкое применение в современной оптоэлектронике, фотонике и дозиметрии ионизирующего излучения [1]. Несмотря на активное исследование люминесцентных свойств моноклинного диоксида циркония, природа ловушек, ответственных за появление пиков термостимулированной люминесценции (ТСЛ), остается неясной. Известно, что одним из способов возбуждения ТСЛ является облучение электронами различных энергий.

Целью настоящей работы являлось изучение люминесценции моноклинного ZrO_2, облученного электронами различных энергий.

Использовались три типа образцов: тип 1 и 2 – нанопорошки (40-100 нм), изготовленные из различного сырья, тип 3 – микропорошок со средним размером