Investigation of optical characteristics of film NiO

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Among inorganic HTL, nickel oxide (NiO) is of considerable interest and has been extensively studied as a selective electrode for PSCs. Nickel oxide is a well-known semiconductor material with hole conductivity, which has excellent properties: it is thermally and chemically stable, has a wide band gap of 3.6–4.0 eV, providing optical transparency, and is not an expensive material whose films can be obtained by various physical and chemical synthesis methods. Like many oxides, it has a non-stoichiometric composition due to the formation of point defects: Nickel vacancies and interstitial oxygen, which form shallow acceptor levels and contribute p-type conductivity.

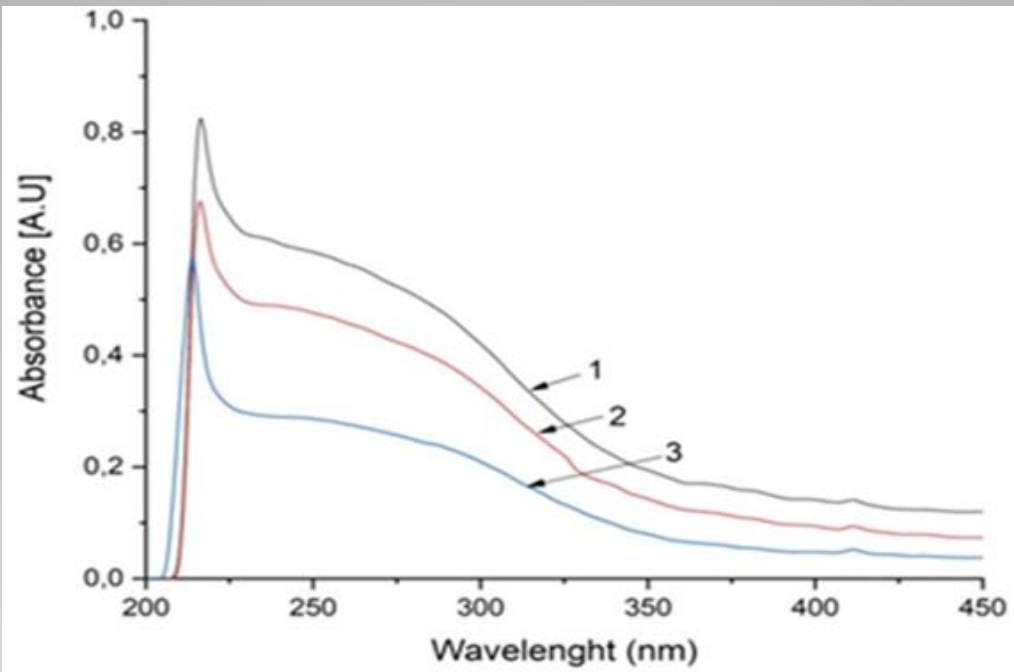
This work presents the results of a study of the optical parameters of NiO films. Increasing the speed of rotation of the substrate leads to a decrease in the optical density of the absorption spectra of NiO films

Experimental methods

Production of Nickel oxide films on the ITO surface was carried out as follows [1]: nickel nitrate hexahydrate [$Ni(NO_3)_2 \cdot 6H_2O$] weighing m = 145 mg (LLC «Polihrom») was dissolved in a volume of ethylene glycol V = 1 ml. Monoethanolamine (5 μkl) was added to the resulting solution. The solution was mixed at room temperature for 16 hours and then kept for 24 hours at room temperature. NiO films were obtained by centrifugation (SPIN150i, Semiconductor Production System). To change the film thickness, the substrate rotation speed was changed from 1500 rpm to 2500 rpm. After that, the film was annealed for 10 minutes at 100 C, and then annealed to a temperature of 350 C at a rate of 10 C/min. Ito-based substrates were prepared according to the method [2]

Figure 1 shows the absorption spectra of NiO films obtained at different speeds of rotation of the substrate: 1500 rpm, 2000 rpm, 2500 rpm.

The absorption spectrum has two peaks at 216 nm and 237 nm. The figure shows that the optical density of the absorption spectra of NiO films decreases as the substrate rotation speed increases. The positions of the maxima of the absorption spectrum do not change. Table 1 shows the characteristics of the absorption spectra of NiO films. The decrease in the optical density in the absorption spectra with an increase in the rotation speed of the substrates is associated with a decrease in the thickness of the NiO films.



1 – NiO – 1500 rpm
2 – NiO – 2000 rpm
3 – NiO – 2500 rpm

Absorption spectra of NiO films

Characteristics of the absorption spectra of NiO films

Sample	D1, λ =216 nm	D2, λ =237 nm
NiO – 1500 rpm	0.82	0.60
NiO – 2000 rpm	0.67	0.49
NiO – 2500 rpm	0.56	0.29

References

[1] J. Jung, Dong Lim Kim, Sang Hoon Oh, Hyun Jae Kim. Stability enhancement of organic solar cells with solution-processed nickel oxide thin films as hole transport layers, Solar Energy Materials & Solar Cells 102 (2012) 103–108.

[2] K. Kim, K. Ihm, B. Kim. Surface Property of Indium Tin Oxide (ITO) After Various Methods of Cleaning. ACTA PHYSICA POLONICA A, Proceedings of the 4th International Congress APMAS2014, April 24–27, 2014, Fethiye, Turkey, Vol. 127 (2015) No. 4