11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Study of optical and electrical properties of nanostructured indium nitride films

M. Sparvoli[(1)*], R. D. Mansano[(1)], J. F. D. Chubaci[(1)]

(1) Laboratório de Sistemas Integráveis da Escola Politécnica, Universidade de São Paulo, e-mail: marinsparvoli@yahoo.com.br
* Corresponding author.

Abstract – In this work, the optical and electric properties of nanostructured indium nitride (InN) films were studied. For this study, the films were deposited by reactive magnetron sputtering using a pure indium target and nitrogen and hydrogen as processing gases. The InN films are naturally nanostructured and show properties as photoemission in the visible/Infrared range and photoelectric effects. The characteristics of these films were observed by FTIR (Fourier Transform Infrared) analyzes, optical absorbance, electro-optic analyzes and high step meter analyzes. After these measurements, indium nitride films with best properties will be chosen for the development of a high sensibility photo detector.

Research on InN initiated in 1938 when synthesized powder samples were analyzed by X-ray diffraction in order to determine the crystallographic properties of this material [1]. Indium nitride (InN) has been the subject of intensive research in the past few years due to its potential applications in optoelectronic field, such as solar cells and photo sensors [2,3].

This work main objective is to study the influence of deposition process on the optical and electrical properties of RF reactive sputtered InN films using nitrogen and hydrogen. First, the Si wafers were cleaned for contaminants. After the cleaning process, the deposition of InN films was performed in a Magnetron Sputtering system using an In pure target, nitrogen and hydrogen as process gases and 200 W constant RF power. Four hydrogen gas concentrations were used in deposition processes: 0%, 5%, 10% and 20%. To obtain the band gap Tauc analysis was used, a method based in UV-Vis spectra. In IxV analysis, for electrical measurements, 300 nm thick layers contacts were deposited at the front side of the wafer by Al evaporation. The electrical conductivity was measured with a HP 4140A picoammeter.

FTIR spectra revealed that samples are crystalline with In – N bonding. InN thin films showed a band gap around 1,4 eV. In current versus voltage (IxV) analyses, all samples showed semiconductor characteristics and photoelectric effect, the results are similar to degenerated transistors. The photoelectric effects occur on some regions because the increase of charge in the electronic gap. The films did not show photoelectric effect for the positive voltage region and the current don't change with the light incidence. This effect is more pronounced with the increasing of H_2 percentage in film. Hydrogen promotes more bonds. The occurrence of free electrons in the sample surface increased the conduction over the light influence. This study enables a new generation of devices in photonics (sensors and photovoltaic cells).

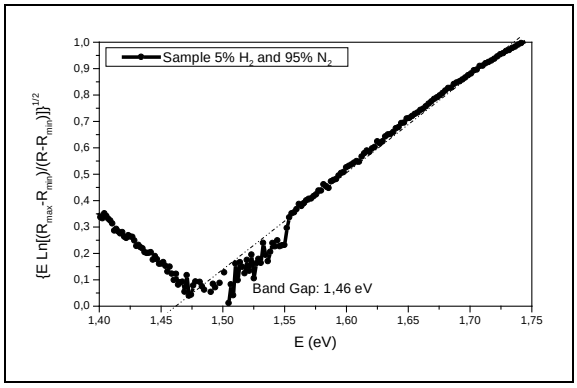

Figure 1: Band Gap Tauc analysis.

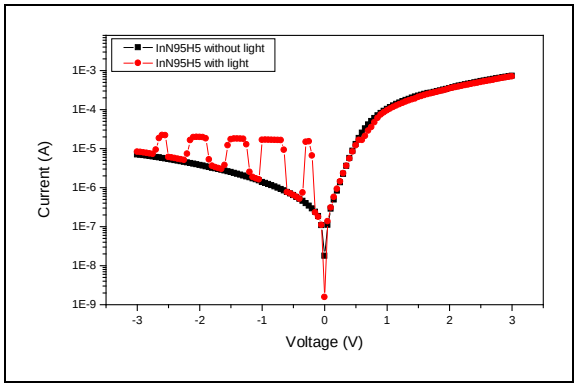

Figure 2: IxV analysis of electro-optics characteristics of InN thin film deposited with H_2 5% and 95% N_2.

References

[1] M. Alevli, Growth and characterization of indium nitride layers grown by high-pressure chemical vapor deposition, Doctor of Philosophy dissertation, Georgia State University (2008).
[2] L. C. Chen, W. H. Lan, R. M. Lin, H. T. Shen, H. C. Chen, Optical properties of In2O3 oxidized from InN deposited by reactive magnetron sputtering, Applied Surface Science, 17, p. 8438–8441 (2006).
[3] C. K. Chao, H. S. Chang, T. M. Hsu, C. N. Hsiao, C. C. Kei, S. Y. Kuo, J. I. Chyi, Optical properties of indium nitride nanorods prepared by chemical-beam epitaxy, Nanotechnology, 17, p. 3930–3932 (2006).