Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 17 (2014) 303 – 309

Procedia Technology

Conference on Electronics, Telecommunications and Computers – CETC 2013

Zinc Oxynitride Films Prepared by Pulsed Laser Deposition

R. Ayouchi[1], L. Soares de Melo[1], S. R. Bhattacharyya[2], N. Bundaleski[3], O. Teodoro[3], L. Santos[4], R. Schwarz[1]*

[1] *Departamento de Física and ICEMS, Instituto Superior Técnico, 1049-001 Lisbon, Portugal*
[2] *Department of Physics, Suri Vidyasagar College, Suri, 731101 Birbhum, West Bengal, India*
[3] *Departamento de Física and CEFITEC, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal*
[4] *Departamento de Engenharia Química and ICEMS, Instituto Superior Técnico, 1049-001 Lisbon, Portugal*

Abstract

We have studied the optimal deposition conditions for the production of low-oxygen-content Zinc nitride films (ZnON) by Pulsed Laser Deposition (PLD). In particular, substrate temperature has been varied between 100 and 500 ºC. The film properties, particularly its morphology, showed a strong dependence on substrate temperature. Substrate temperatures beyond 350ºC led to highly crystalline and smooth films with a band gap of 3.32 eV and with resistivities ranging from 10^{-2} to 100 Ωcm. Film quality and surface oxygen content changed rapidly with exposure to air as evidenced by XPS analysis.

© 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/3.0/).
Peer-review under responsibility of ISEL – Instituto Superior de Engenharia de Lisboa, Lisbon, PORTUGAL.

Keywords: Oxynitride thin films; ZnON; Wide band gap semiconductor; Pulsed laser deposition (PLD)

1. Introduction

Zinc Nitride (Zn_3N_2) is a group II-V compound semiconductor with cubic antibixyte structure, with a lattice constant of a = 9.78 Å [1]. In recent years it has drawn the attention of several research groups since it is a promising semiconductor to use in various electronic and optoelectronic applications (photovoltaic, sensors, TFTs, for example) owing to low cost and ecological friendliness.

* Corresponding author. Tel.: +351-21 841 9152; fax: +351-21 841 9118.
E-mail address: rschwarz@fisica.ist.utl.pt

2212-0173 © 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/3.0/).
Peer-review under responsibility of ISEL – Instituto Superior de Engenharia de Lisboa, Lisbon, PORTUGAL.
doi:10.1016/j.protcy.2014.10.241

The deposition of zinc nitride by Pulsed Laser Deposition (PLD) has not yet been extensively studied, to our knowledge, it has only been produced by S. Simi *et al.* [2] and recently by our group in a RF-plasma-assisted process [3].

There is consensus on the n-type nature of the films with typical electron mobilities of up to 100 $cm^2V^{-1}s^{-1}$ [4]. However, large discrepancies are reported for the optical band gap values which range from 1.01-1.47 eV [5] to 3.2 eV [6]. Moreover, oxygen contamination has been reported as a common zinc nitride production issue, with interference of various compounds like ZnO, zinc oxynitride (ZnON) or $Zn(OH)_2$ structures [7]. These two factors will be important during the discussion of the properties of PLD-deposited films.

2. Deposition Conditions

Zinc oxynitride films were prepared by Pulsed Laser Deposition (PLD) in UHV stainless steel chamber. A metallic zinc target (99.9999 % purity) was ablated by the green line of a Q-switched Nd:YAG laser (wavelength 532 nm). The frequency and duration of the pulses were set to 10 Hz and 5 ns, respectively. Deposition was done on different substrates under Nitrogen (N_2) atmosphere at a constant pressure of 0.2 mbar and the temperature was varied in the range 100-500 ºC. The film thickness was typically 150 nm, and the deposition time 2 hours.

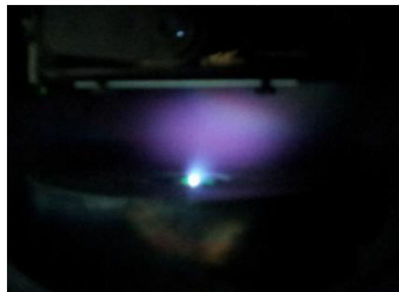

Fig. 1. Zn plasma plume expansion in nitrogen background gas.

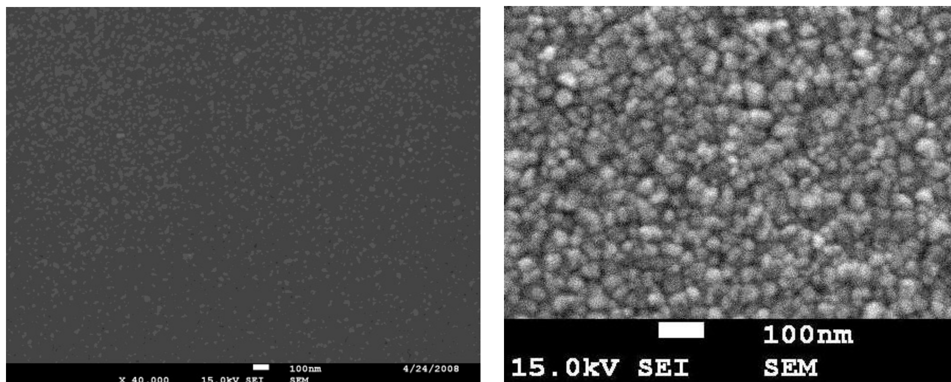

Fig. 2: (a) Smooth film surface as seen by SEM, (b) Enlargement showing grainy morphology at a 20-40 nm level.

3. Film Morphology

The film morphology, its electrical conductivity, and the optical properties depend to a large extent on substrate temperature during deposition. Figure 2 shows the morphology of a film deposited at low and high magnification:

Download English Version:

https://daneshyari.com/en/article/492704

Download Persian Version:

https://daneshyari.com/article/492704

Daneshyari.com