University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Applied Science

of

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“Effect of oxidation on the optical properties of Zn3N2 powders”

Department of Electrical and Computer Engineering

Friday, November 17, 2017
3:00 P.M.
Engineering Office Wing
Room 230

Supervisory Committee:
Dr. Thomas Tiedje, Department of Electrical and Computer Engineering, University of Victoria (Supervisor)
Dr. Tao Lu, Department of Electrical and Computer Engineering, UVic (Member)

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Dr. Michael Miller, Department of Computer Science, UVic

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Abstract

Zinc nitride is currently attracting research interest because of its potential for novel electronic and photonic properties. In this thesis the optical properties of Zn_3N_2 powders have been investigated by photoluminescence (PL) and diffuse reflectance spectroscopy (DR) measurements. The micro structure and composition of zinc nitride were assessed by scanning electron microscopy (SEM) and powder X-ray diffraction (PXRD). Measurements of PL, PXRD and DR were carried out on zinc nitride powder samples with different oxygen-nitrogen (O/N) ratios. Photoluminescence spectroscopy of the zinc nitride powder samples allows us to find the optical bandgap of the samples. To the best of our knowledge, this is the first report on the low temperature photoluminescence of zinc nitride powder. This showed us how the band gap energy depends on temperature. The diffuse reflectance measurement let us determine a direct bandgap of 1.12eV for Zn_3N_2 powders and the PL measurements also demonstrated emission at the same photon energy. In this work, the effect of oxidation on the optical properties has been investigated. The surface oxidation of Zn_3N_2 powders and the oxygen-nitrogen (O/N) ratio were detected through PXRD scans. Our measurement show that the optical bandgap energy shifts to lower energy due to the oxygen incorporation. The reduction of the Zn_3N_2 bandgap by oxygen incorporation can be explained by a resonant interaction between the extended states of the conduction band of Zn_3N_2 and localized oxygen states near the conduction band edge. Additionally, the thermal nitriding process was carried out on the oxidized Zn_3N_2 powders to vary the O/N ratio which increased the bandgap energy. From our result, the optical bandgap of the Zn_3N_2 powders is estimated to be 1.2 ±X eV which decreases by small amount of oxygen contamination due to exposure to air. Powder XRD measurements of thermal oxidation of Zn_3N_2 indicated that the oxidation of these powders is slow at room temperature.