Effects of sputtering environment on the optical, electrical and optoelectronic properties of $ZnSnN_2$

Ngoc Kim Thanh BUI, Mathieu HALBWAX, Jean-Pierre VILCOT

Institut d'Electronique, de Microélectronique et de Nanotechnologie (IEMN), UMR 8520, Université de Lille, 59652 Villeneuve d'Ascq, France

Keywords: $ZnSnN_2$, Zn-IV-N_2 absorber, earth abundant material, magnetron sputtering, PV cell applications.

$ZnSnN_2$ is a member of ternary Zn-IV-N_2, semiconductors, where IV = Si, Ge or Sn. According to theoretical calculations and experimental results, Zn-IV-N_2 semiconductor materials have potential to replace III-nitride semiconductors. The wurtzite structure of II-IV-N_2 compounds is similar to the one of III-N semiconductors. It is then reasonable to expect similar electronic and optical properties as for InGaN, for example, direct bandgaps and large optical absorption coefficients[1][2]. Based on first-principles calculations, $ZnSnN_2$ becomes a promising material for photovoltaic. The most stable wurtzite-derived structure of bulk $ZnSnN_2$ was given to be the orthorhombic $Pna2_1$ phase by calculating the total energy per unit cell, band structure and electronic density of states[3]. Beside that, n-type carrier concentration was demonstrated in the first experimental investigations, which is up to $10^{21}cm^{-3}$ and the optical band gap is approximate 2.1eV[4]. Up to now, there are very few reports related to the preparation of the $ZnSnN_2$ thin film and the most common are based on sputtering deposition.

In this research, $ZnSnN_2$ thin films are produced on glass substrate by co-sputtering technique at room temperature. By varying the composition (argon, nitrogen and hydrogen) of the deposition atmosphere, the optical and electrical properties of material were first evaluated. The optical band gap was determinated by UV-VIS spectroscopy and ranges from 1.8eV to 2.08 eV. The n-type carrier concentration was recorded between $2.4e^{17}$ to $1.4e^{20}$ cm^{-3}, and the highest carried mobility as 1.68 $cm^2/V.s$. These obtained results, compared to theory, confirm the potential use of $ZnSnN_2$ material as a photovoltaic absorber for a top cell of tandem solar cell[5]. In addition, the morphology and crystal structure were investigated by using SEM, AFM and X-ray diffraction. Nevertheless, right now, no real demonstration of carrier photogeneration has been reported. So, optoelectronic properties of the material are now investigated for applying $ZnSnN_2$ as an absorber layer.

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