Electron and ion densities distribution in reactive Zn sputtering plasma and its deposited ZnO thin film

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Abstract

Zinc oxide (ZnO) material has been extensively studied by many researchers due to its wide potential in electrical and electronic devices. ZnO thin film has been growth using various techniques such as sol-gel, pulse laser deposition and reactive sputtering deposition. One of the most promising technique to growth an advanced ZnO thin film is reactive magnetron sputtering deposition. This technique has been an interesting technique due to its flexibility to control the growth of films and its deposition repeatability. In the present work, we investigate the electron temperature, electron density and ion density in magnetron sputtering discharge using Zn solid target at various discharge conditions. Then, we deposit the ZnO thin film at the same conditions. The plasma properties are used to discuss the particle growth mechanism in magnetron sputtering plasma environment and thus investigate its correlation with the deposited ZnO thin film. We found that the electron temperature increased when we increased the oxygen flow rate. The electron temperature increased from approximately 1 eV to 2 eV when the oxygen gas flow increased. The increment of electron temperature was due to the balance of electron energy which is used to ionize the gases in vacuum chamber. The ionization energy of argon and oxygen were 15.7 eV and 13.5 eV, respectively. Therefore, at higher oxygen flow rate lower energy is used to ionize the discharge gas. In addition, we observed the increment of ionic species in plasma environment with the oxygen flow rate. We believed this ionic species influences the ZnO film crystality since the crystalite size decreased

with the oxygen flow rate. In addition, our scanning electron microscope analysis showed that we have successfully deposited a homogenous ZnO thin film at high working pressure. Further details correlation between the plasma properties and ZnO thin film will be discussed during the conference. Acknowledgment : This works were supported by Short Term Grant (STG) of Universiti Tun Hussein Onn Malaysia and MTUN COE grant of Ministry of Higher Education, Malaysia.

Keywords: zinc oxide; electron density; ion density; reactive magnetron sputtering