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Electrical Property of Titanium Doped Gallium Phosphide Thin Film Deposited by Asymmetric Bipolar Pulsed-DC Magnetron Sputtering for Intermediate Band Solar Cell (IBSC)

Ti-Ga-P thin films were prepared by an asymmetric bipolar pulsed-dc magnetron sputtering technique using GaP:Ti targets onto glass substrate at 300℃ in an argon atmosphere. The sputtering targets contained GaP powder compacted between metallic titanium (Ti) sheets, at the surface area ratio GaP:Ti of 1:1, 2:1, and 5:1. The crystal structure, electrical sheet resistance, and surface morphology of the as-deposited films were analyzed by X-ray diffraction (XRD), the linear 4 point probe technique, and atomic force microscopy (AFM), respectively. The XRD patterns showed that the as-deposited films are polycrystalline of cubic zinc blend structure. The sheet resistance at room temperature were 0.97E+1 and 6.02E+1 Ω/cm2 for the films obtained from the GaP:Ti_1:1 and GaP:Ti_2:1 targets, at the deposition time of 60 minutes. The film obtained from the GaP:Ti_2:1 target exhibited the sheet resistance which exponentially increases with decreasing temperature in the range of 180K – 50 K, indicating semiconducting behavior. On the other hand, the film obtained from the GaP:Ti_1:1 target showed the sheet resistance which is independent on the decreasing temperature, suggesting a rather metallic behavior. AFM images indicated the formation of metallic Ti clusters within crystalline grains of the films. The cluster density appears higher in the films obtained from the GaP:Ti_1:1 target than those obtained from the GaP:Ti_2:1 target. The results of this study suggest that it is possible to dope Ti into GaP host semiconductor by co-sputtering of GaP and Ti. However, above a certain concentration of Ti, the formation of metallic titanium inclusions within crystalline grains is promoted, leading to metallic like electrical behavior.

Primary author: Mr PONKEN, Tanachai (Department of Physics, Faculty of Science, Khon Kean University, 40002, Thailand)

Co-author: Dr BURINPRAKHON, Thanusit (Department of Physics, Faculty of Science, Khon Kean University, 40002, Thailand)

Presenter: Mr PONKEN, Tanachai (Department of Physics, Faculty of Science, Khon Kean University, 40002, Thailand)

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