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Influence of Annealing on Electrical Properties of an Organic Thin Layer-Based *n*-Type InP Schottky Barrier Diode

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The electrical properties of a fabricated Au/polymethylmethacrylate (PMMA)/*n*-InP Schottky barrier diode have been analyzed for different annealing temperatures using current–voltage (*I*–*V*) and capacitance–voltage (*C*–*V*) techniques. It is observed that the Au/PMMA/*n*-InP structure shows excellent rectifying behavior. The extracted barrier height and ideality factor of the as-deposited Au/PMMA/*n*-InP Schottky contact are 0.68 eV (*J*–*V*)/0.82 eV (*C*–*V*) and 1.57, respectively. However, the barrier height (BH) of the Au/PMMA/*n*-InP Schottky contact increases to 0.78 eV (*J*–*V*)/0.99 eV (*C*–*V*) when the contact is annealed at 150°C for 1 min in nitrogen atmosphere. Upon annealing at 200°C, the BH value decreases to 0.72 eV (*J*–*V*)/0.90 eV (*C*–*V*) and the ideality factor increases to 1.48. The PMMA layer increases the effective barrier height of the structure by creating a physical barrier between the Au metal and the *n*-InP. Cheung's functions are also used to calculate the series resistance of the Au/PMMA/*n*-InP structure. The interface state density (N_{ss}) is found to be 6.380×10^{12} cm^{-2} eV^{-1} and 1.916×10^{12} cm^{-2} eV^{-1} for the as-deposited and 150°C-annealed Au/PMMA/*n*-InP Schottky contacts, respectively. These results indicate that the interface state density and series resistance have a significant effect on the electrical characteristics of Au/PMMA/*n*-InP Schottky barrier devices. Finally, it is noted that the diode parameters change with increasing annealing temperature.

Key words: Electrical properties, Au/PMMA/*n*-InP Schottky diode, series resistance, interface state density

INTRODUCTION

Group III–V compound semiconductors, particularly indium phosphide (InP), are promising materials for high-speed electrical and optoelectronic devices. This is due to the superior characteristics of InP, such as the large direct bandgap and high electron mobility, substrate velocity, and breakdown voltage, which are very important parameters in electronic devices.[1,2] Metal–semiconductor (M–S) contacts are one of the most widely used rectifying contacts in the electronic industry. Schottky contacts play an important role in controlling the electrical performance of devices. However, it is difficult to achieve a Schottky barrier height (SBH) greater than 0.5 eV,[3–6] due to the large current for metal–InP substrate at room temperature. There have been several attempts to effect modification and continuous control of the barrier height by using an organic layer[7–15] at InP M–S contacts. This layer converts a metal/semiconductor structure into a metal/organic layer/semiconductor device.

In recent years, many studies have reported an enhancement of the barrier heights of the M–S structure by using an organic interfacial layer between the metal and semiconductor;[16–25] For example, Lonergan et al.[16] studied a tunable diode based on a hybrid inorganic/organic, *n*-type InP/polypyrrole nonaqueous electrolyte architecture. They reported that the turn-on voltage of the diode could be continuously and actively tuned by more

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