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A NEW INSULATING MATERIAL FOR THE FABRICATION OF InP BASED METAL-INSULATOR-SEMICONDUCTOR DEVICES

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Insulating layers play crucial role on metal-insulator-semiconductor (MIS) structures. Finding a more suitable insulating material and/or layers with high resistivity and high stability is rather demanding. Good insulating layers for indium phosphide (InP) are very much essential since InP based MIS structures find wide and potential applications in the modern high speed, high power as well as optical devices because of its high values of saturation current, breakdown voltage, thermal conductivity and radiation resistance. Generally, realisation of an insulating layer on InP has been carried out mainly by two ways. They are: (i) deposition of the insulating layers such as SiO_2, Si_3N_4, Al_2O_3 etc., using thermal evaporation or sputtering methods (ii) growth of native oxides on InP. High surface state density (of the order of 10^{12} eV^{-1} cm^{-2}, the thermal damage caused during the deposition and/or sputtering is detrimental in the first process. Instability upon exposure to moisture and/or a slightly elevated temperature is the typical problem encountered with the native oxides grown on InP and moreover their oxide resistivity is limited to 10^{13} Ω cm. Hence, with searching of a better insulating material and also to overcome the problems relating to the insulator deposition of InP, effort has been made to find a suitable insulating material as well as a simple method in which materials could be deposited at room temperature with less cost effective. In this present work, barium titanate ($BaTiO_3$, a good dielectric material has been proposed as a new insulating material for InP based MIS structures. $BaTiO_3$ thin films have been deposited on InP substrates using sol-gel technique through organic precursor route. The precursor solution was coated on InP substrate by spin coating method. As-deposited $BaTiO_3$ films are amorphous in nature and post-deposition annealing yields polycrystalline films. XPS analysis confirms the formation and composition of $BaTiO_3$ layer on InP. The MIS structures were fabricated on the $BaTiO_3$ deposited InP samples and they show better capacitance-voltage characteristics. A minimum hysteresis width of 0.5 V and a minimum flat band voltage shift of 0.75 V have been obtained for Au/$BaTiO_3$/InP MIS structures. It indicates a high resistivity and good stability of the insulating layer on InP. Furthermore, a reduced surface state density value of as low as 6×10^{10} cm^{-2} eV^{-1} has been achieved and is very much less when compared to other conventional deposited insulators. DLTS measurements were carried out to study the defects incorporation and only one interface trap has been observed at 0.55 eV below the conduction band. The characteristics and properties of this new insulating layer for InP MIS device applications will be presented in detail.

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