World Academy of Science, Engineering and Technology
International Journal of Electrical and Computer Engineering
Vol:17, No:06, 2023

Development of Wide Bandgap Semiconductor Based Particle Detector

Authors : Rupa Jeena, Pankaj Chetry, Pradeep Sarin

Abstract : The study of fundamental particles and the forces governing them has always remained an attractive field of theoretical study to pursue. With the advancement and development of new technologies and instruments, it is possible now to perform particle physics experiments on a large scale for the validation of theoretical predictions. These experiments are generally carried out in a highly intense beam environment. This, in turn, requires the development of a detector prototype possessing properties like radiation tolerance, thermal stability, and fast timing response. Semiconductors like Silicon, Germanium, Diamond, and Gallium Nitride (GaN) have been widely used for particle detection applications. Silicon and germanium being narrow bandgap semiconductors, require pre-cooling to suppress the effect of noise by thermally generated intrinsic charge carriers. The application of diamond in large-scale experiments is rare owing to its high cost of fabrication, while GaN is one of the most extensively explored potential candidates. But we are aiming to introduce another wide bandgap semiconductor in this active area of research by considering all the requirements. We have made an attempt by utilizing the wide bandgap of rutile Titanium dioxide (TiO2) and other properties to use it for particle detection purposes. The thermal evaporation-oxidation (in PID furnace) technique is used for the deposition of the film, and the Metal Semiconductor Metal (MSM) electrical contacts are made using Titanium+Gold (Ti+Au) (20/80nm). The characterization comprising X-Ray Diffraction (XRD), Atomic Force Microscopy (AFM), Ultraviolet (UV)-Visible spectroscopy, and Laser Raman Spectroscopy (LRS) has been performed on the film to get detailed information about surface morphology. On the other hand, electrical characterizations like Current Voltage (IV) measurement in dark and light and test with laser are performed to have a better understanding of the working of the detector prototype. All these preliminary tests of the detector will be presented.

Keywords : particle detector, rutile titanium dioxide, thermal evaporation, wide bandgap semiconductors
Conference Title : ICSST 2023 : International Conference on Semiconductor Science and Technology
Conference Location : San Francisco, United States
Conference Dates : June 05-06, 2023