Materials Science Forum Vols. 483-485 (2005) pp. 1015-1020
online at http://www.scientific.net

PUB2005-1

Silicon Carbide for Alpha, Beta, Ion and Soft X-Ray High Performance Detectors

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Keywords: Radiation Detector, Radiation Spectroscopy, X-Ray Spectroscopy

Abstract. High performance SiC detectors for ionising radiation have been designed, manufactured and tested. Schottky junctions on low-doped epitaxial 4H-SiC with leakage current densities of few pA/cm^2 at room temperature has been realised at this purpose. The epitaxial layer has been characterised at different dose of radiations in order to investigate the SiC radiation hardness. The response of the detectors to alpha and beta particle and to soft X-ray have been measured. High energy resolution and full charge collection efficiency have been successfully demonstrated.

Introduction

Semiconductor radiation detectors are widely used for ionizing radiation spectrometry and imaging in many fields such as fundamental scientific research, materials science, medical applications, security systems, archeometry and many industrial applications. The highest performance required to the detectors in terms of energy and spatial resolution, room temperature operation and radiation hardness have brought to an intense international research activity on several compound semiconductors in order to overcome the limits imposed by the conventional materials: silicon and germanium.

Basically, a semiconductor radiation detector consists in one or more rectifying junction operating in reverse bias condition. The high electric field in the depleted region separates the electrons-hole pairs generated by the ionising photon or particle interacting with the semiconductor. The charge signal, proportional to the released energy, is then detected or measured in amplitude at one or more collecting electrode. The major problems arising with compound semiconductors (GaAs, CdTe, CdZnTe, InP...) are related to the crystal impurities and defects, which are responsible of charge thermal generation and trapping, and to the junction barrier height, which determines a component of the junction reverse current, which limit the signal to noise ratio and the maximum operating temperature.