Contribution ID: **88**   Type: **Oral Presentation**

#10-88 Applications of 4H Silicon Carbide Radiation Detectors in Fission and Fusion Reactor Environments

Wednesday, June 11, 2025 11:20 AM (20 minutes)

Semiconductor radiation detectors based on the 4H polytype of Silicon Carbide (4H-SiC) have many advantages for high-temperature, high-radiation and mixed-radiation applications. The wide band gap of 4H-SiC (3.27 eV) allows measurements at temperatures up to 700 ℃ and probably much higher. Conventional lower band-width semiconductors such as silicon or germanium are limited by thermally generated noise to measurements at lower temperatures and can require external cooling. 4H-SiC has a high thermal conductivity, high breakdown voltage, and high electron saturation velocity. Furthermore, 4H-SiC detectors have also been demonstrated to have outstanding radiation hardness.

These properties make 4H-SiC Schottky barrier and p-n diode detectors compatible with radiation monitoring applications in both fission and and fusion reactors. For fission reactors, measurements of the neutron fluence rate and energy spectrum characteristics are required and monitoring environments with temperatures up to and exceeding 700 ℃ can be encountered. For fusion reactors, extremely high-temperature monitoring environments will also be encountered. In both cases, the detector service lifetime in the extreme radiation environment is a prime consideration. 4H-SiC Schottky barrier detectors have been demonstrated to be operational after 137Cs gamma ray doses up to 22.7 MGy and fast-neutron (E> 1 MeV) fluences up to 1.7 x 1017 cm-2.

4H-SiC detectors have been demonstrated to provide linear count-rate responses as a function of fluence-rate for thermal, epithermal and fast fission neutrons. In addition, linear fluence-rate responses have been demonstrated for deuterium-deuterium (D-D) and deuterium-tritium (D-T) fusion neutrons. In the latter case, the 14-MeV neutron energy exceeds the thresholds for 12C(n,α)9Be and 28Si(n,α)25Mg reactions and allows peaks to be observed from neutron reactions with the SiC detector. The energy widths of these reaction peaks can be used to deduce information on the plasma temperature as well as neutron yield for fusion devices. 4H-SiC detectors with lithium neutron convertor foils can be used to monitor 6Li(n,α)3H reaction rates directly to measure tritium breeding rates in fusion reactors.

In this paper we will review relevant developments in 4H-SiC radiation detectors and discuss their potential and planned applications in fission and fusion reactors.

Primary author: RUDDY, Frank (Ruddy Consulting)

Co-authors: LYOUSSI, Abdallah (CEA Cadarache); Mr DESTOUCHES, Christophe (CEA/DES/IRESNE/DER/SPESI); OTTAVIANI, Laurent (AMU); HOURY, Michael (CEA); REYNARD-CARETTE, Christelle (Aix-Marseille University); POTIRON, Quentin; LLIDO, Olivier

Presenter: RUDDY, Frank (Ruddy Consulting)

Session Classification: #10 - Current Trends in Development of Radiation Detectors

Track Classification: 10 Current Trends in Development of Radiation Detectors