FAST NEUTRON DETECTOR WITH A SURFACE-BARRIER VPE GaAs SENSOR

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Introduction

Neutron detectors are widely adopted. For some applications detectors based on semiconductor materials are used. Generally, the operation principle of such detectors is based on the detection of secondary particles produced by neutrons in a converter material with a semiconductor sensor. Depending on the neutron energy, different detectors are used for the thermal neutron detection and the detection principle is based on the reaction of the converter material with the incident neutron (e.g., elastic scattering or nuclear fission). For the detection of fast neutrons, semiconductor detectors with a sensitive layer made of high-purity semiconductor (Si, Ge, or GaAs) are used. The detector's sensitivity is determined by the detection cross-section, the mass absorption coefficient, the stopping power of the converter layer, and the slowing down distance. The use of semiconductor detectors is based on the detection of secondary particles produced by neutrons in a converter material with a semiconductor sensor. Depending on the neutron energy, different detectors are used for the thermal neutron detection and the detection principle is based on the reaction of the converter material with the incident neutron (e.g., elastic scattering or nuclear fission). For the detection of fast neutrons, semiconductor detectors with a sensitive layer made of high-purity semiconductor (Si, Ge, or GaAs) are used. The detector's sensitivity is determined by the detection cross-section, the mass absorption coefficient, the stopping power of the converter layer, and the slowing down distance.

Characteristics of the epilayers

The GaAs, AlxGa1-xAs, and InyGa1-yAs layers are grown by metalorganic chemical vapor deposition (MOCVD) on (001) semi-insulating GaAs substrates. The following parameters are chosen: growth temperature, 1000°C; reactor pressure, 80 Torr; dilution ratio, 100; and As/H2 flow rate ratio, 1.0. The epilayer thickness is typically 0.1–1 µm. The layers are grown for the following purposes: (1) to improve the carrier mobility by increasing the carrier concentration; (2) to reduce the density of defects by increasing the carrier concentration; and (3) to improve the carrier mobility by increasing the carrier concentration.

Alpha-particle characterization

Measurements conditions:
- Measurement with an AFG channel analyzer
- Room temperature
- Vacuum (residual pressure 1.33 Pa)

The alpha-particle transmission characteristics are measured using a thin sample of a semiconductor detector. The alpha-particles are generated by a radioactive source and are detected by the detector. The transmission characteristics are measured at different angles and temperatures. The results are analyzed using a computer program.

Fast neutrons

The fast neutron transmission characteristics are measured using a radioactive source and a semiconductor detector. The transmission characteristics are measured at different angles and temperatures. The results are analyzed using a computer program.

Applications

- Fast neutron detectors are used in various applications, including: (1) neutron sources for nuclear facilities; (2) neutron sources for neutron scattering experiments; (3) neutron sources for background measurements; and (4) neutron sources for neutron imaging experiments.

Conclusions

- The use of semiconductor detectors for the detection of fast neutrons is based on the detection of secondary particles produced by neutrons in a converter material with a semiconductor sensor. Depending on the neutron energy, different detectors are used for the thermal neutron detection and the detection principle is based on the reaction of the converter material with the incident neutron (e.g., elastic scattering or nuclear fission). For the detection of fast neutrons, semiconductor detectors with a sensitive layer made of high-purity semiconductor (Si, Ge, or GaAs) are used. The detector's sensitivity is determined by the detection cross-section, the mass absorption coefficient, the stopping power of the converter layer, and the slowing down distance.

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