

Lithium 6 vs Helium 3 for Neutron Detection

Neutron detectors can be found in a variety of applications in our modern society. Large neutron detection systems are used and are being developed in a wide range of research applications where new materials are explored using the unique properties of neutrons. Neutrons have no charge and interact with matter via the nuclear force and not electromagnetic as most other detection systems like x-ray, electron, and proton beams do. These unique properties of neutrons are now also utilized for security and non-destructive testing applications. To inspect large objects made from high Z elements like most metals, higher and higher X-ray energies are required to penetrate the item to be inspected. Neutrons, however, bounce between the heavy atoms without losing a lot of energy and can reveal the hidden content.

Another important application for neutron detection is nuclear proliferation. Elements that can be used for the manufacture of nuclear weapons are neutron emitters, and it is of essence that these materials can be detected with high sensitivity and accuracy. The sensitivity is required to be able to detect small quantities of neutron-emitting isotopes, and accuracy is required to ensure that the measured response was due to a neutron and not due to a gamma ray that can have been emitted from a large variety of different sources.

Helium 3

Helium 3 has been and is still used as a neutron detector, since ^3He has a large cross-section for neutron capture and has a very low cross-section to react with a gamma ray, and is therefore ideal for nuclear proliferation applications. However, ^3He detectors have a few drawbacks. ^3He is a gas and in order to have high neutron detection efficiency, a high-pressure container is required to get the ^3He density needed. Furthermore, ^3He is a very rare element, and most of the ^3He is a byproduct of nuclear weapons. The nuclear stockpile has luckily been reduced since the beginning of the century, reducing the amount of ^3He generated, and at the same time, the demand for ^3He has increased. This has resulted in an enormous price increase of ^3He . Such a shortage is expected that the EU has developed plans to mine the ^3He on the moon.

Lithium 6

Lithium 6 is a very suitable replacement for Helium 3 for neutron detection. Although the thermal neutron cross-section for ^6Li is 940mb instead of 5330mb for ^3He , ^6Li can be incorporated into solids resulting in high neutron detection efficiency.

Our Lithium glasses have different amounts of ^6Li dependent on customer requirements. The glass is thermal and chemical resistant and its transparency enables thick glass layers with high neutron absorption efficiency. GS20 with a thickness of 1mm with 95% enriched ^6Li has a thermal neutron detection efficiency of 77%, and a 4 mm thick GS20 has a neutron detection efficiency of 99.8%.

When large flat or curved area neutron detection is required, our Neutron Detection screens (ND) are the ideal solution. The ND screen consists of ^6LiF embedded in a scintillator, ZnS for high light output, and ZnO when high counting rates up to 100,000 cps are required. The ND Screens can be customized in shape. Screen sizes up to 1m² are available. Our ND screens come in two standard thicknesses of 225 μm and 450 μm and in two different LiF to scintillator ratios. Our ND screens with the highest Li content and 450 μm thickness have a thermal neutron absorption efficiency of 49%.