

The photons per neutron absorbed were calculated assuming the emission spectra shown in FIG. 4. FIG. 7 shows the number of photons produced for each reacted neutron. The uncertainties arise from the counting statistics, PMT calibration, and the corrections applied to the PMT signal and photon flux calculation. The scattered light correction dominates the uncertainty.

[0062] At the higher noble gas pressures, the total number of photons emitted per reacted neutron was calculated from the data to be about 17,000 (Ar), 28,000 (Kr), and 35,000 (Xe). The total radiant energy produced was calculated from the mean photon energy and the photon production data. The total kinetic energies of the proton and triton are known to be 764 keV. From the data it was found that the kinetic energies of the $^3\text{He}(n, \text{tp})$ reaction products are converted into FUV radiant energy with efficiency of 20% (Ar), 29% (Kr), or 33% (Xe). Such high conversion efficiencies are comparable to those reported in noble gases excited by electrical discharges and particle beams. Here it is demonstrated that FUV excimer emissions resulting from the $^3\text{He}(n, \text{tp})$ reaction can be used as an efficient neutron detector.

Example 2

[0063] Far-ultraviolet signatures of ^{10}B and $^6\text{Li}_2\text{CO}_3$ films in noble gas mixtures.

[0064] Thin films of ^{10}B and $^6\text{Li}_2\text{CO}_3$ on silicon substrates have been exposed to slow neutrons in the presence of Ar, and Xe. Though less efficient in terms of photons produced per reacted neutron, the films nevertheless produce thousands of photons per neutron reacted. FIG. 8 shows sample results from these experiments for a 20 μm film of $^6\text{Li}_2\text{CO}_3$ in 80 kPa of Ar and a 0.20 μm film of ^{10}B in 80 kPa of Ar and Xe. There was also an observation of signals obtained with the cell was filled with a partial pressure of 28 kPa of $^{10}\text{BF}_3$ and 52 kPa of Xe. Comparing the $^6\text{Li}_2\text{CO}_3$ and ^{10}B film measurements with those for ^3He in 80 kPa of Ar (FIG. 7), the $^6\text{Li}_2\text{CO}_3$ yielded $4,700 \pm 900$ photons per neutron reacted in Ar compared to $10,000 \pm 2000$ photons per neutron reacted for ^3He in Ar at the same pressure. The ^{10}B film yielded $21,100 \pm 4,100$ and $21,500 \pm 4,700$ photons per neutron reacted in Ar and Xe compared to $10,000 \pm 2,000$ and $30,000 \pm 7,500$ for ^3He in Ar and Xe at the same pressures.

[0065] It is thought that the slow neutron detector apparatus and method of the present invention and many of its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction arrangement of parts thereof without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred or exemplary embodiment thereof.

We claim:

1. A method for detecting slow neutrons, said method comprising:

reacting a plurality of slow neutrons with a high neutron capture cross section nucleus, wherein the subsequent compound nucleus decays into a plurality of particles; exposing the plurality of particles to at least one inert gas, wherein the plurality of particles interact with the at least one inert gas to form at least one excimer; and monitoring the at least one excimer for an optical signal comprising a plurality of photons in the far-ultraviolet region of the electromagnetic spectrum, wherein the optical signal in the far ultraviolet region of the electro-

magnetic spectrum indicates radiative decay of the at least one excimer, wherein the radiative decay of the at least one excimer comprises emission of the plurality of photons in the far ultraviolet region of the electromagnetic spectrum.

2. The method of claim 1, further comprising:

detecting the plurality of photons in the far ultraviolet region emitted by the radiative decay of the at least one excimer; and

determining the number of photons emitted for each of the plurality of the reacted slow neutron.

3. The method of claim 1, wherein the compound nucleus is a high-capture cross-section nucleus.

4. The method of claim 3, wherein said high-capture cross-section nucleus is selected from a group comprising ^{10}B , ^6Li , and ^3He .

5. The method of claim 1 wherein the at least one inert gas is selected from a group comprising Ar, Kr, and Xe.

6. The method of claim 4 wherein said ^{10}B is in gaseous phase.

7. The method of claim 4 wherein said ^{10}B is in solid phase.

8. The method of claim 1, wherein the high neutron capture cross section nucleus ^{10}B in the compound $^{10}\text{BF}_3$.

9. The method of claim 1, wherein the plurality of slow neutrons is a beam having a diameter of about 4 mm and a fluence rate of about $(2.61 \pm 0.37) \times 10^5$ neutrons/cm²s.

10. An apparatus for detecting a plurality of slow neutrons, said apparatus comprising:

at least one cell among a plurality of cells, wherein the at least one cell comprising an interaction region for reacting the plurality of slow neutrons with a high neutron capture cross section nucleus and at least one inert gas; a cylinder defining the interaction region, wherein the cylinder is positioned vertically in the center of the at least one cell;

an entry port on the at least one cell of the plurality of cells for receiving the plurality of slow neutrons;

an exit window on the at least one cell of the plurality of cells for allowing the plurality of slow neutrons to exit the at least one cell of the plurality of cells;

at least one detector positioned within a field of view of the interacting region for detecting an optical signal in the far ultraviolet region of the electromagnetic spectrum from the at least one cell, wherein the detector generates a signal upon detection of the optical signal in the far ultraviolet region of the electromagnetic spectrum; and a processor associated with the at least one cell, and the at least one detector for processing the signal generated by the detector to measure slow neutron fluence.

11. The apparatus of claim 10, further comprising a chamber enclosing a differentially pumped volume for isolating and evacuating the unreacted plurality of slow neutrons exiting interaction region;

12. The apparatus of claim 10, further comprising a gas handling system for maintaining a base pressure inside the at least one cell.

13. The apparatus of claim 10, wherein the exit port is comprised of a material selected from a group consisting of MgF_2 , CaF_2 , Al_2O_3 , SiO_2 .

14. The apparatus of claim 10, wherein the cylinder is comprised of a material selected from a group consisting of magnesium, aluminum, silicon.

15. The apparatus of claim 10, wherein the cylinder has a thickness of about 0.5 mm and a diameter of about 25 mm.