Accepted Manuscript

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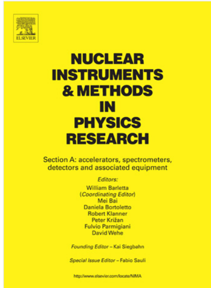

PII: S0168-9002(18)30554-0
DOI: https://doi.org/10.1016/j.nima.2018.04.046
Reference: NIMA 60766

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date : 16 February 2018
Revised date : 13 April 2018
Accepted date : 23 April 2018

Neutron Sensitivity of $^{10}B_4C$-Coated Aluminum Honeycomb using a Single-Anode Wire, P-10 Continuous-Gas-Flow Proportional Counter

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Abstract

The intrinsic thermal-neutron detection efficiency of a $^{10}B_4C$-coated aluminum honeycomb sample was measured using a single-anode wire, P-10 continuous-gas-flow proportional counter. The aluminum honeycomb sample was 1.27 cm thick with a diameter of 4.1275 cm (1 5/8 in.) and was composed of hexagonal-shaped cells with a cell size of 1.5875 mm (1/16 in.). The $^{10}B_4C$ coating was applied by Exothermics, Inc. via magnetron sputtering to a coating thickness of 4.68 ± 1.25 μm as measured using a scanning electron microscope. Using a lower level discriminator setting of 50 keV, intrinsic thermal-neutron detection efficiency was measured to be 21.45 ± 0.26% in reference to a 4.0 atm, 5.08-cm (2-in.) diameter, 15.24-cm (6-in.) long Reuter Stokes ^{3}He tube with a known efficiency of 80.7 ± 0.5%. MCNP6 simulations yielded a theoretical intrinsic thermal-neutron detection efficiency of approximately 24% for a $^{10}B_4C$-coating thickness of 4.68 μm with a lower level discriminator setting of 50 keV.

Keywords

Neutron detection; Gas-filled radiation detector; Neutron convertor; Thin-film-coated substrate; ^{3}He alternative

1. Introduction

Several alternative neutron detection technologies have been developed to achieve the neutron detection and gamma-ray discrimination capabilities of commercially-available ^{3}He proportional counters at a fraction of the cost [1-5]. Given the abundant deployment of commercial ^{3}He proportional counters in the oil-well logging industry [6-8], motivation exists to define alternative neutron-conversion materials that are capable of operating in oil-well logging instrumentation temperatures up to 200°C [9, 10].

Honeycomb substrates have recently emerged as a substrate of interest for thin-film-coated thermal-neutron detection applications [11-15] due to the amount of surface area contained within a compact substrate size. Specifically, boron-lined honeycomb substrates have previously been fabricated and tested either with individual anode wires positioned within each individual honeycomb cell [12] or with a series of gas electron multipliers positioned below the substrate [13-15]. A representative picture of the substrate geometry is shown in Fig. 1. These light-weight substrates are commonly used in commercial industries as energy absorbers, structural materials, and directional flow guides due to their high strength-to-weight ratio [16]. Several companies