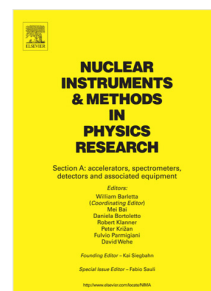


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Neutron sensitivity of $^{10}\text{B}_4\text{C}$ -coated aluminum honeycomb using a single-anode wire, P-10 continuous-gas-flow proportional counter

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1 Neutron Sensitivity of $^{10}\text{B}_4\text{C}$ -Coated Aluminum Honeycomb using a Single-Anode Wire, P-10
2 Continuous-Gas-Flow Proportional Counter

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14 Abstract

15 The intrinsic thermal-neutron detection efficiency of a $^{10}\text{B}_4\text{C}$ -coated aluminum honeycomb
16 sample was measured using a single-anode wire, P-10 continuous-gas-flow proportional counter.
17 The aluminum honeycomb sample was 1.27 cm thick with a diameter of 4.1275 cm (1 5/8 in.)
18 and was composed of hexagonal-shaped cells with a cell size of 1.5875 mm (1/16 in.). The $^{10}\text{B}_4\text{C}$
19 coating was applied by Exothermics, Inc. via magnetron sputtering to a coating thickness of 4.68
20 $\pm 1.25 \mu\text{m}$ as measured using a scanning electron microscope. Using a lower level discriminator
21 setting of 50 keV, intrinsic thermal-neutron detection efficiency was measured to be $21.45 \pm$
22 0.26% in reference to a 4.0 atm, 5.08-cm (2-in.) diameter, 15.24-cm (6-in.) long Reuter Stokes
23 ^3He tube with a known efficiency of $80.7 \pm 0.5\%$. MCNP6 simulations yielded a theoretical
24 intrinsic thermal-neutron detection efficiency of approximately 24% for a $^{10}\text{B}_4\text{C}$ -coating
25 thickness of 4.68 μm with a lower level discriminator setting of 50 keV.

26 Keywords

27 Neutron detection; Gas-filled radiation detector; Neutron convertor; Thin-film-coated substrate;
28 ^3He alternative

29 1. Introduction

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

36 Honeycomb substrates have recently emerged as a substrate of interest for thin-film-coated
37 thermal-neutron detection applications [11-15] due to the amount of surface area contained
38 within a compact substrate size. Specifically, boron-lined honeycomb substrates have previously
39 been fabricated and tested either with individual anode wires positioned within each individual
40 honeycomb cell [12] or with a series of gas electron multipliers positioned below the substrate
41 [13-15]. A representative picture of the substrate geometry is shown in Fig. 1. These light-weight
42 substrates are commonly used in commercial industries as energy absorbers, structural materials,
43 and directional flow guides due to their high strength-to-weight ratio [16]. Several companies

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