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Composite scintillators for high energy physics

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High energy physics need radiation hard large area detectors. The composite base scintillators are an alternative to bulk scintillation detector due to ability to make the large area detectors at reasonable price.
This work is devoted to the development of thin-layer scintillation detectors development for high granularity calorimeters. Depending on radiation intensity, the use of detectors based on radiation-resistant single crystal or composite scintillators was proposed.
The design of thin-layer detectors based on silicate crystals with wavelength shifter (WLS) fiber based on garnet crystals were studied. The scintillators for detector and WLS fiber were selected on the base of overlapping of their excitation and luminescence spectra. The dimensions of single crystals and the position of the WLS fiber which providing high light output uniformity of detector were determined.
The granulometric composition and dimensions of thin-layer YSO:Ce composite detectors were optimized. YSO:Ce granules were obtained by sol-gel method, solid-phase synthesis or mechanical grinding of single crystals [1]. Radiation-resistant optical polysiloxane was used as a immersion binder for the granulas [2]. For light collection quartz or leukosapphirer light-conducting layer and WLS fiber Y-11 or YAG: Ce were used.
The radiation resistance tests of composites were carry out. YSO:Ce, YSO:Ce,Ca YAG:Ce single crystals, optical polysiloxanes, quartz glass and leucosapphire were irradiated with electrons (E0 = 8.3 MeV) at room temperature. The total integral dose reached 300 ± 0.5 Mrad. Also degradation of optical polysiloxanes was investigated under exposure of 2 MeV protons, the fluence was 1014 protons•cm-2. Optical, luminescent and scintillation characteristics of tested materials before and after irradiation were measured. It is shown that up to 300 Mrad these material are radiation stable. The decrease of the light output is up to 2% for single crystal and up to 15% for composites. The transmittance decreasing for optical materials is within 5%. With increasing the proton fluence, the optical degradation of polysiloxanes occurs in the visible region.

1. Ukraine patent 111455 (2016).
2. Boyarintsev A.Yu., Galunov N.Z., Karavaeva N. L. et al. Func. Mat. 2013, 20, P.471-476.

Has accepted

Authors: Dr BOYARINTSEV, Andrey (ISMA); BOBOVNIKOV, Alexandr; Dr GEKTIN, Alexandr; Prof. GRYNYOV, Borys; Dr GERASYMOV, Iaroslav; Mr KOVALCHUK, Sergey; Ms NEPOKUPNAYA, Tatiana; Mr ONUFRIYEV, Yuriy; Dr SIDLETSKIY, Oleg

Presenter: Dr GEKTIN, Alexandr

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