Detector-grade phosphors: Inorganic materials and halide perovskites for NICA beam profile monitors

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Modern low-background experiments and applied tasks under high radiation fluxes impose a set of requirements on scintillation and luminescent materials (high and stable light yield, predictable spectral characteristics and decay kinetics, optical homogeneity, minimal intrinsic background, scalable and technological fabrication, and long-term stability). In applied facilities, including beam diagnostics at accelerator complexes, additional priorities include spectral matching to photodetectors, the ability to form an active layer, and stability of parameters during operation.

This work presents results on detector-oriented materials in two directions. The first direction concerns inorganic phosphors, for which we analyze the parameters that determine the efficiency of converting excitation energy into an optical signal and the reproducibility of characteristics. The second direction is associated with halide perovskite phosphors, which we synthesize as promising materials for beam profile monitors at the NICA accelerator complex. We discuss technological aspects of forming the active medium, as well as stability and reproducibility requirements necessary for further integration of the material into the readout units of profile monitors.

The reported results refine the criteria for selecting phosphors and active media for low- background detection and beam diagnostics, and provide practical guidelines for transitioning from laboratory luminescence demonstrations to materials suitable for real detectors or diagnostic devices. The study was supported by the Russian Science Foundation (project No. 251200322).