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Radiation synthesis of highly luminescent nanoscintillators with fast decay

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Direct radiation syntheses of nanoclusters of various metals or metal alloys have been studied for a few decades [1]. However, only recently the method was systematically used for preparation of simple or multicomponent metal oxides [2].
The procedure is based on irradiation of aqueous solutions containing soluble precursors by UV or ionizing radiation. Finely dispersed solid phase formed during irradiation is subsequently separated from solution, dried and either used directly, or further processed by annealing at higher temperatures under various atmospheres.
Nanopowder scintillators prepared via radiation method typically show good luminescent properties [3], as the processes initiated by radiation have some advantages over common chemical methods: they are mostly independent of temperature, they impart high level of interaction between individual components in precipitated precursor and they yield materials of high purity, with relatively narrow size distribution of particles and minimum of crystal defects.
This contribution summarizes various techniques for radiation or photochemical synthesis, that have been successfully used for preparation of numerous nanopowder scintillators, namely simple and multicomponent metal oxides, synthetic garnets, core-shell systems, quantum dots, heterostructures and nanocomposites. Such nanoscale powders can be further processed by ceramisation or by embedding into an optically transparent matrices.
Among prepared nanopowders, ZnO:Ga and synthetic garnets play prominent role, each representing a different group of materials. ZnO:Ga based scintillators show intense excitonic luminescence located at 390-400 nm with ultra-fast sub nanosecond decay. Their bandgap can be further modulated by introducing 5-20% of Cd or Mg ions into the crystal lattice. Defect related luminescence typical for ZnO can be completely suppressed by annealing in reducing atmosphere. Synthetic garnets, based on YAG or LuAG and doped with various ions also feature very high intensity of luminescence when compared to BGO standards and minimum defect related luminescence. Their high thermal and chemical stability and simple cubic structure make them good candidates for preparation of optically transparent ceramics or cores of PDTX drugs.

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