18p-PA6-24

Luminescence and Scintillation Properties of Selected Oxide Ceramics and Nanoceramics Sintered by SPS Method

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Scintillation materials based on aluminum garnets doped with Ce or Pr ions acting as luminescence centers, have already found their applications in several fields, such as medical imaging, radiation detection in general and so on. One of the garnet-based scintillation materials which has been deeply studied is the Ce-doped lutetium-aluminum-garnet (LuAG:Ce). Despite its favorable properties, presence of slow components in scintillation decay was one of its demerits. The slow components are related to trapping of electrons at shallow traps connected with so-called anti-site defects (AD, Lu-residing at the Al site) during the transport stage of scintillation process. These defects are created during crystal growth of the garnet materials, which is performed at high temperatures and were confirmed by several complementary methods. However, it was found that such defects are absent in the aluminum garnet ceramics, the sintering of which is performed well below the melting temperature of the material.

Spark plasma sintering method (SPS) is a unique method to prepare well densified ceramic bodies at relatively low temperature in short time. It is expected that the slow components related to AD can be absent in LuAG:Ce scintillation ceramics prepared by the SPS method. On the other hand, there is a question how the other defects and other phenomena connected with the grain boundaries will affect the material performance.

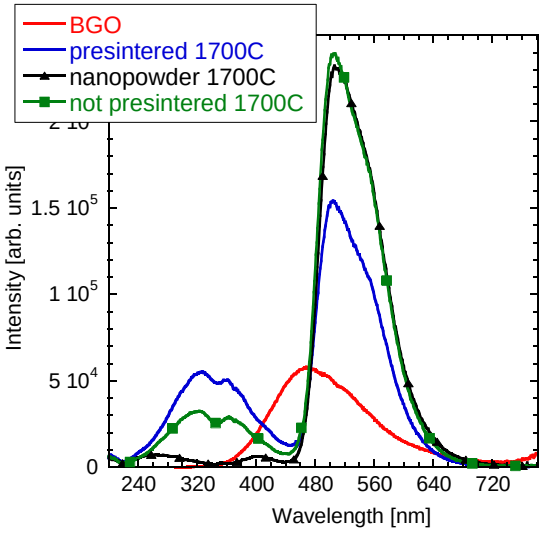

Figure 1. Comparison of X-ray-excited radioluminescence spectra of various LuAG:Ce ceramic samples with that of $Bi_4Ge_3O_{12}$ (BGO) reference crystal

LuAG:Ce ceramics were sintered by SPS method from commercially available powders (from presintered and non-presintered mixtures) and nano-powder prepared by a unique radiation synthesis. The radioluminescence measurements showed superior overall scintillation efficiency of the nano-ceramic samples sintered at the temperature of 1700°C. More luminescence-related results such as excitation and emission spectra and decay kinetics will be presented. Influence of SPS sintering temperature on scintillation properties and ceramic morphology will be shown.