Contribution ID: **131** Type: **Oral presentation**

Scintillation properties of pure YAG crystals

Tuesday 19 September 2017 16:45 (15 minutes)

Last studies [1-3] demonstrated high efficiency of UV luminescence of undoped yttrium aluminum garnet (YAG). Radio-luminescence of pure crystals most probably related to excitons localized around defects, due to violation of the stoichiometric composition. At the same time there are different types of defects presence in the lattice. Pure YAG crystals emit a broad UV emission band under high-energy excitation, which is associated with the presence of anionic and cationic vacancies, their complexes and antisites. Which of them play the positive or negative role is still not clear that makes a problem with optimization of scintillation performance and potential application of pure YAG.

This study is directed to reveal the defects related to scintillator performance of pure YAG single crystals. The main goal is to evaluate the type of optimal defects presence for efficient scintillation.

The variable types and concentration of defects, which correspond to the absorption bands in the range of 190 - 400 nm, was estimated. It was found that the undoped crystals excited with X-ray demonstrate the broad complicated emission band in UV range with maximum at around 300 nm. The experimental results point out that some native structure defects and impurity'traces plays the negative role in scintillations. Iron and carbon ions presence is displayed by absorption, visible and NIR photoluminescence and high temperature TSL. Infrared absorption spectra provide the information about hydroxyl and carboxyl groups incorporation in the structure.

It was shown that the emission is enhanced in samples with the best optical transparency in UV and IR regions as well as the negligible contribution of additional luminescence. The intensification of intrinsic UV luminescence is only due to suppressing these trapping defects.

Factors affecting the scintillation efficiency in YAG are discussed. The best scintillation performance can be modified with purity and intrinsic defects change. The light output for such scintillators can reach the level of BGO or pure CsI scintillators and is about the same value for Ce-doped YAG crystal. Decay time consists of 7 and 460 ns components, which agrees the data resulted in [3]. The rate between these component and the optimal conditions are still under investigation.

The first data show that scintillation properties of pure YAG are reasonable for the use of this crystal for different applications. Modification of defects structure allows to reach better scintillation performance comparing to activated YAG.

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Session Classification: Characterization

Track Classification: S08_Characterization (Orals)