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Czochralski growth of YAG- and LuAG-based scintillators under reducing conditions.

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Y3Al5O12 (YAG), and Lu3Al5O12 (LuAG) crystals doped with Ce3+ or Pr3+ ions, YAG, and LuAG possess attractive scintillation properties and, for instance, are candidates for application in new HEP experiments at colliders. The production cost is a basic criterion in the material choice for practical applications. In the present work, undoped, as well as Ce, Pr-doped YAG, and LuAG crystals were grown under the reducing Ar+CO conditions in W crucibles by a novel fabrication procedure enabling to avoid the usage of expensive Ir crucibles and ceramic heat insulation.

Optical and scintillation parameters, as well as phase and admixture content of crystals were analyzed. Effect of thermal annealing on YAG optical properties was studied on samples fabricated from the crystals grown in Ir crucible by the conventional technology under weakly oxidizing atmosphere, and in W crucible under Ar+CO reducing conditions. In parallel the admixture content in crystals, including carbon concentration was determined and the element composition of the ˜50 μm thick surface layer before/after the annealing were controlled. The important role of crystal surface interaction with the growth atmosphere was demonstrated [1]. The optimized post-growth annealing procedure of such crystals in reducing or oxidising atmosphere provides an irreversible discoloration of YAG crystals and a high transparency in the 200 –1100 nm spectral range.

The growth procedure of YAG and LuAG doped with Ce3+, Pr3+ and Sc3+ was developed. Absorption, cathodoluminescence and photoluminescence spectra of LuAG:Pr and LuAG:Sc crystals grown under the reducing conditions, besides the activators bands, contain the strong bands corresponding to F+-centers. The procedure to suppress these parasitic absorption/luminescence properties of as-grown crystals was elaborated. As a result, the light yield and scintillation decay parameters of the doped garnets are similar to those obtained with the crystals grown by the conventional technology in Ir crucibles.

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[1] P. Arhipov, S Tkachenko, S. Vasiukov et al, J. Cryst. Growth, 449 (2016) 104-107.

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