CRYSTAL GROWTH AND LUMINESCENT PROPERTIES OF Nd:BaY_2F_8 SINGLE CRYSTAL FOR VUV EMITTING SCINTILLATOR

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Many fluoride crystals doped with rare earth element (RE) such as Nd, Er, Tm show vacuum ultraviolet (VUV) emission (Visser et al., 1993). The emission is due to parity-allowed radiative transitions from the lowest level of the excited $4f^{n-1}5d$ configuration to various lower lying $4f^n$ levels of RE^{3+}. These VUV emitting crystals are interesting as tunable VUV laser materials, e.g. Nd:LaF_3. In recent years, they were also considered as candidates for VUV scintillators in radiation detectors which employ photosensitive gases (such as TMAE or TEA) or photocathodes (such as CsI) sensitive mainly to VUV photons. Therefore, RE^{3+}-doped fluoride crystals (RE= Nd, Er, Tm) became a subject of luminescence studies and applications in the field of VUV lasers or scintillators. Especially, recent development of gas counter, such as μ-PIC, MSGC and GEM (Takada et al., 2007) motivate us to the systematic study of VUV scintillators, which are indispensable part of such gas counter-scintillator detectors.

Nd: BaY_2F_8 (BYF) single crystals with different Nd concentration were grown by the micro-pulling (μ-PD) down method. BYF has a very wide band gap and Nd^{3+} luminescence center shows fast and intense 5d-4f emission in this host.

Stoichiometric mixture of 4N BaF_2, YF_3 and NdF_3 powder (Stella Chemifa Co. Ltd.) were used as starting materials. Nominally, NdF_3 were added in the BaY_2F_8 host with the formula of $Ba(Y_{1-x},Nd_x)_2F_8$. Crystal growth was carried with graphite crucible under Ar + CF_4 atmosphere using μ-PD furnace with vacuum-tight systems. Platinum wire was used instead of the seed for the initial crystal growth. Further crystal growth attempts were carried out using the seed of undoped BYF crystal obtained in the initial experiments. The growth rate was 0.05-0.1 mm/min. The scheme of a typical thermal setup as well as the baking procedure for fluoride crystal growth is given in Ref. (Yoshikawa et al., 2004).

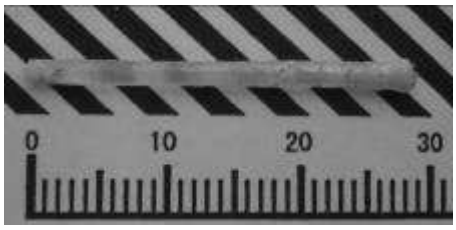

Fig. 1. Nd:BaY_2F_8.single crystal grown by the μ-PD method.

In order to study optical properties, we used Synchrotron radiation at the Superlumi station in HASYLAB at DESY (Hamburg, Germany). At these experiments, VUV excitation spectrum, emission spectrum, and photoluminescence decay time were evaluated. Under 160 nm excitation the 5d-4f emission lines peaking around 185 and 235 nm are observed, which are identified as $5d_1$-$^4I_{9/2}$ and $5d_1$-^4F_j transitions, respectively. Their decay is 16 ns in Nd5%:BYF and 13.3ns in Nd10%:BYF.

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