Simultaneous DSC-TGA-MS analyses of RE_2O_3 compounds for growth multicomponent oxides

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Scintillation materials are widely used as detectors of ionizing radiation (photon or particle based) in multiple fields of human activities consisting of both research & development and industrial applications. This includes fields for instance of medical imaging techniques, high-energy physics, industrial defectoscopy, geological survey and oil well logging, astronomy, homeland security and others [1]. Scintillation detectors for all these applications mostly employ inorganic materials based on single crystals of garnets, perovskites, heavy silicates, halides or other multicomponent compounds. Crystals of multicomponent compounds such as garnets and perovskites are usually prepared from their melts by traditional methods (e.g. Czochralski, Bridgman, or Kyropoul method) or by methods suitable for research screening, e.g. micro-pulling-down (mPD) method [2]. The mPD enables to prepare single crystals of various materials (e.g. oxides, halides, metals, etc.) with dimensions of several millimeters (3-5 mm) in diameter and several centimeters long in a very short time (in matter of hours to tens of hours) [3,4]. However, the preparation of crystals using above mentioned methods requires a compliance with precisely calculated starting composition of the input raw materials. Thus, the composition and initial purity of the raw materials are required to be determined before the crystal growth experiments.

This contribution is focused on the study of the thermal properties of rare earth oxides, e.g. lanthanum oxide (La_2O_3), scandium oxide (Sc_2O_3), gadolinium oxide (Gd_2O_3), etc., which are often used as raw materials in the preparation of crystals of multicomponent oxides based on garnets and perovskites. La_2O_3 was previously used, for example, in the growth of the lanthanum-aluminum perovskite LaAlO3:Ce crystal [1]. The aim of this work is to study the purity of the starting materials and to determine the optimal conditions for their treatment and storage. Such goals were achieved using simultaneous thermoanalytical methods consisting of differential scanning calorimetry (DSC), thermogravimetry (TGA), and mass spectrometry (MS). In this way one can record changes in sample(s) regarding: (i) heat flow e.g. exo- and endo-thermic effects (e.g. phase transitions, reactions, etc.), (ii) mass change (decomposition, reactions, etc.), and (iii) detection of evolved gases and their fragments. Obtained results will be presented and discussed.

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[2] V. Vaněček et al., Advanced Photonics Research 3 (2022) 2200011.

[3] A. Yoshikawa et al., Optical Materials 30 (2007) 6–10.