RADIATION SYNTHESIS OF REFRACTORY OPTICAL CERAMICS

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Radiation technology for synthesis of refractory optical ceramics, which we first implemented [1, 2], fundamentally differs from conventionally used technologies. For synthesis, a mixture of stoichiometric composition required to obtain the desired phase was exposed to direct powerful electron flux with energy of 1.4 MeV and flux density of 15–23 kW/cm^2 using the ELV-6 accelerator (Institute of Nuclear Physics SB RAS). Radiation synthesis was performed with high efficiency within less than 1 s using radiation energy and mixture materials with no additives or any other materials used to promote synthesis. We obtained samples of luminescent ceramics based on YAG and YAGG doped with Ce and modified by Gd and Ga based on alkaline earth metal fluorides doped by tungsten. The luminescent properties of the samples (luminescence and excitation spectra, decay times) correspond to those known for phosphors, ceramics, and crystals of appropriate compositions fabricated by other synthesis techniques.

It was found that ceramics is synthesized in the radiation field at similar power densities above 15 kW/cm^2 from materials with significantly different melting points: from 1260 °C (MgF_2) to 2410 °C (Y_2O_3). A powerful radiation flux induces effective mixing of the base components of the mixture and dopants, their composition elements.

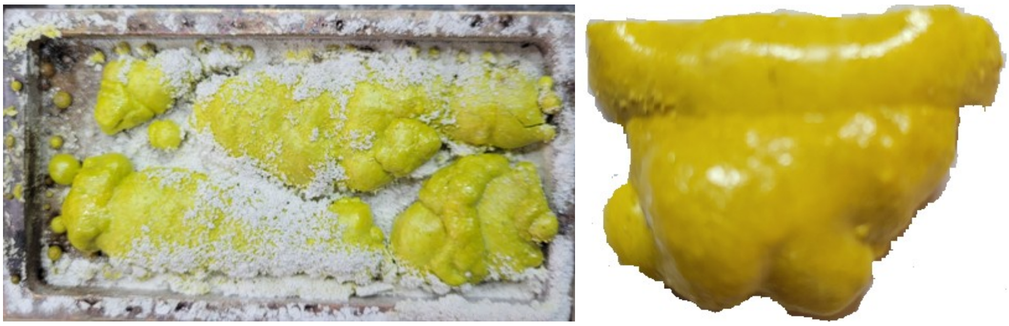

Fig.1 Photos of samples.

The cause of very high efficiency of radiative synthesis is largely incomprehensible. It is assumed that power densities of radiation fluxes used in the study increase ionization density of materials. Within the synthesis period, radiation creates a number of electronic excitations comparable to the number of lattice sites in the irradiated area. The electronic excitation decay causes formation of a high concentration of active radiolysis products, their interaction, and formation of new phases. Decomposition occurs at high temperatures and, hence, with an extremely high yield.

The report is supposed to show the main patterns revealed in synthesis of materials based on metal oxides and fluorides to formulate the basic ideas about the totality of processes occurring in dielectric materials in the field of powerful hard radiation fluxes.

REFERENCES

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