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RADIATION SYNTHESIS OF CERAMICS BASED ON $ZnWO_4$, $MgWO_4$

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The multicomponent materials based on metal oxides are among the most future advanced scintillators [1, 2]. The synthesis of dopant-free self-activating materials is complicated, difficult to monitor and requires high temperatures and pressure. In [3, 4], for the first time, synthesis of YAG based phosphors and doped ceramics, based on alkaline earth metal fluorides, was realized under the action of a high-energy electron flow in air at 300 K.

This presentation reports on the synthesis of $ZnWO_4$ and $MgWO_4$ ceramics on air at 300 K under irradiation with 1.4 MeV electrons which the power density flux varied in the range of 18–23 kW/cm^2. We used an ELV-6 electron accelerator created at the G. I. Budker Institute of Nuclear Physics of the SB RAS.

It should be noted that the difference in the melting temperatures of the charge components: 1975 (ZnO), 1473 (WO_3) and 2825 °K (MgO), was not an obstacle to the realization of the synthesis process.

High density of an ionization initiates the processes far from equilibrium unattainable with traditional synthesis methods: modification of an interionic interaction, destruction of the short-range order, creation of multiple types of the disordering, including complexes of intrinsic defects of various sizes, types, charges, creation conditions for evaporation and coagulation of atoms, defects, for the forming of new chemical compounds. The formation from such radiation chaos of a new crystalline phase of $ZnWO_4$ or $MgWO_4$ for a time not exceeding 1 s indicates at the extraordinary efficiency of the radiation-initiated processes of structure ordering as well.

Density of as-prepared charge was about of 1.8–1.6 g/cm^3. The synthesized ceramic samples were plates about 4 mm thick with a vitreous surface limited crucible dimension (Fig.1(on the left)).

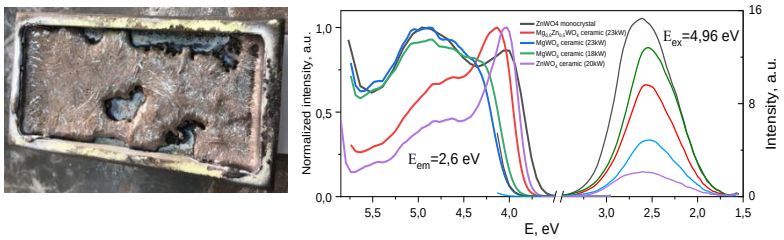

Fig.1. (Left) Photographs of the $ZnWO_4$ ceramic sample after synthesis in a massive copper crucible. (Right) Spectra of an excitation and photoluminescence at 300 K of the $ZnWO_4$ monocrystal and the samples of the different synthesized ceramics subjected to mechanical crushing.

The first studies of synthesized ceramics have been carried out. Figure 1 (on the right) shows the excitation and luminescence spectra of a single crystal of ZnWO4 and different types of synthesized ceramics. The similarity of the emission spectra in crystal and ceramic samples is obvious: peak positions of emission bands and the values of the FWHM are in restricted ranges of 2.6 –2.5 eV and 0.7– 0.6 eV, respectively. Similarity of excitation spectra also occurs.

In the paper will be also presented the radioluminescence and XRD patterns of the synthesized ceramics samples.

REFERENCES

[1] H. Kraus, V.B. Mikhilik, Y. Ramachers, D. Day, K.B. Hutton, J.Telfer. “Feasibility study of a ZnWO4 scintillators for exploiting materials signature in cryogenic WIMP dark matter searches”. Phys. Lett. B V. 610, P. 37-44, 2005

[2] M. Nikl, V.V. Laguta, A. Vedda. “Complex oxide scintillators: Material defects and scintillation performance”. Phys. Stat. Sol. (b) V. 245, P. 1701-1722, 2008

[3] V M Lisitsyn, M G Golkovsky, D A Musakhanov, A T Tulegenova, Kh A Abdullin and M B Aitzhanov “YAG based phosphors, synthesized in a field of radiation”, IOP Conf. Series: Journal of Physics: Conf. Series,V. 1115, P. 052007, 2018.

[4] V.M. Lisitsyn, M.G. Golkovskii, L.A. Lisitsyna, A.K. Dauletbekova, D.A.Musakhanov, V.A. Vaganov, A.T. Tulegenova, Zh.T. Karipbayev, “MgF2–Based Luminescing Ceramics,” Russian Physics Journal, V.61, Issue 10, P. 1908–1913, 2019