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Producing nano powders for functional ceramics by pulsed electron beam evaporation method in vacuum

By method of pulsed electron beam evaporation in vacuum of targets from bulk state compounds of plain and complex oxides (ZnO-Zn, Al_2O_3, SiO_2, CeO_2,YSZ (Y_2O_3-8% Gd_2O_3 est.) and also fluorides (CaF_2 and BaF_2) nano powders (NPs) with a high specific surface were produced. The morphology magnetic, thermal and luminescence characteristics of NPs were measured. Than have studied the properties of ZnO ceramics sintered from the ZnO-Zn NPs to establish the influence of NPs prehistory on the luminescence and dilatometry properties properties of ceramics produced from them. Pressing was performed on uniaxial presses: static and the magnetic pulsed one. Sintering of ceramics was produced in air by heating to 1200°C in 60 min. Maximal density of the ceramics did not exceed 81, 25% of the theoretical density. The behavior of the shrinkage curves of ZnO-Zn NPs depends on their prehistory. The suppression of the ultraviolet emission in NP obtained by electron beam evaporation, and in ceramics sintered of them was established. Besides, two types of ZnO ceramics were fabricated and characterized by XRD, SEM methods. The radioluminescence spectra were measured within the 300-550K range. The thermostimulated luminescence (TSL) glow-curves were measured after X-ray irradiation at 300K. It was concluded that the complex overlapping peak within the 320-450 K temperature range consists of two components (~360-375K and 400-420K). The ratio of component intensities differs in both ceramics. The positions of high temperature TSL components (480-520K) also differ in both samples; therefore not only sintering conditions but also the properties of the initial powder are very important for characteristics of TSL. A linear dependence of peak intensity on irradiation dose was observed up to ~3 kGy for ceramic 1 and up to 9 kGy for ceramic 2.

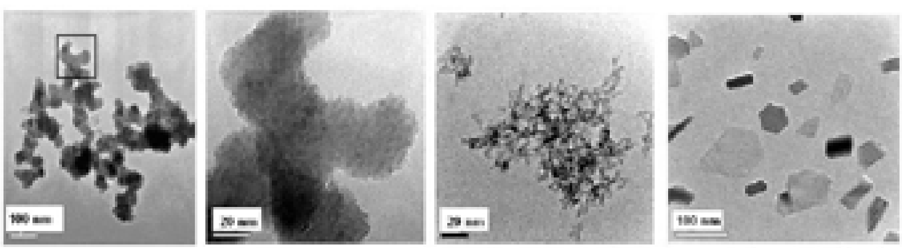

Figure 1. Morphology of the NPs: Al2O3, CeO2 and ZnO.

Recent Publications

1. Sokovnin S Y, Balezin M E and Ilves VG (2018) Effect of electron beam irradiation on the magnetic, thermal and luminescence properties of various oxide metal nanopowders. Materials Chemistry and Physics 215:127-136
2. Ilves VG, Murzakaev AM, Sokovnin SY (2018) On the interrelationship of porosity and structural defects in amorphous-crystalline nanopowders SiO_2-doped Gd_2O_3 with their magnetic and luminescent properties. Microporous and Mesoporous Materials 271:203-218.
3. Zuev M G, Il'ves V G, Sokovnin S Y, Vasin A A and Zhuravleva E Y (2017) New amorphous nanophosphors obtained by evaporation of silicates and germanates REE. Pure Appl. Chem. 89(10):150-1520.
4. Grigorjeva L, Zolotarjovs A, Sokovnin S Y, Millers D, Smits K and Il`ves VG (2017) Radioluminescence, thermoluminescence and dosimetric properties of ZnO ceramics. Ceramics International. 43(8):6187-6191.
5. Sokovnin S Y, Il'ves V G, Khrustov V R and Zuev M G (2017) Investigation of properties of ZnO ceramics sintered from ZnO-Zn nanopowders produced by pulsed electron beam evaporation. Ceramics International. 43(14):10637-10644.

Biography

Sergey Sokovnin has his expertise in pulse power technique, radiation technology and nanotechnology. He has developed a method for production of nano powders, including evaporation of a target by a pulsed electron beam, condensation of the vapor of the material in a low-pressure gas, and deposition of nano powders on a large cold square crystallizer. By this method, it is possible to produce oxide nano powders with the characteristic size of 3-5 nm and nano powder agglomerates with the characteristic size of 20-200 nm having the specific surface of up to 338 m2/g at the production rate of up to 10 g/h and the specific energy consumption of less than 120 Wh/g.

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