# Scintillating Ceramics Based on Zinc Oxide

Piotr Rodnyi

Saint-Petersburg State Polytechnical University, Russia

e-mail: Rodnyi@tuexph.stu.neva.ru

Zinc oxide has a unique combination of properties of a semiconductor material with a significant fraction of ionic bonding. Powdered ZnO is known to be an effective phosphor, while thin ZnO films are used as particle detectors in deuterium–tritium generators [1]. It was recently proposed to use ZnO optical ceramics as scintillators [2]. The scintillators based on ZnO show a high radiation hardness and sufficient stopping power.

Densification of different ZnO powders into ceramics was realized by uniaxial hot pressing method [2]. Ceramics were prepared from a commercial zinc oxide powders (Alfa Aesar Company) with initial particle sizes within 120÷160 nm and from the highly purified powders produced in Russia with initial particle sizes within 300÷600 nm. The sample preparation conditions (temperature, pressure, gaseous medium, etc.) were varied so as to obtain the optical ceramics with maximum transparency and light yield (LY).

Obtained ZnO and ZnO:Zn ceramics of 24 mm diameter and 1.0 mm thickness exhibit high transmission up to 45% in the region of maximum wavelength of X-ray induced luminescence (520 nm); an absolute LY about 29000 photons/MeV; and very good linearity of the relative light output in a 10÷662 keV energy range. The decay constant of the ZnO ceramics is about 1.1 μs. The level of afterglow is about 0.01% at 10 ms after an X-ray excitation pulse. These characteristics show that ZnO ceramics is a promising scintillator for use in X-ray computed tomography (CT).

In ZnO:Ga ceramics the long-wavelength emission band is suppressed and excitonic emission peaked at 385 nm predominates. Excitons in the doped ceramics possess subnanosecond decay time of scintillations, such a short decay time is very important for the Positron Emission Tomography (PET) which operates in the time-of-flight mode.

It is shown that in ZnO, ZnO:Zn and ZnO:Ga luminescence centers are zinc vacancies $V_{Zn}$, oxygen vacancies $V_O$ and excitons localized on the donors, respectively.

References

1. A. Beyerle, J.P. Hurley, and L. Tunnele, Nucl. Instr.Meth. Phys. Res. A **299**, 458 (1990).
2. E.I. Gorokhova, P.A. Rodnyi, K.A. Chernenko et al., Optical Materials, **78**, 85 (2011).