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ELECTRON PARAMAGNETIC RESONANCE AND THERMOLUMINESCENCE OF DEFECTS IN ZrO_2*

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Zirconium dioxide (ZrO_2) is a promising material for modern optoelectronics, photonics and luminescent dosimetry of ionizing radiation. The main types of paramagnetic defects in ZrO_2 are Zr^{3+} ions with g = 1.96-1.97 [1] and F^+-centers with g = 1.999-2.003 [1, 2]. However, thermal stability of these centers and their relation to thermoluminescent (TL) properties of the material have not been fully studied now.

The aim of this work is to study thermal stability of paramagnetic centers in monoclinic ZrO_2 and its relation to TL characteristics of this material.

ZrO_2 samples were made of nanopowders with particle sizes of 40-65 nm by using a method of uniaxial cold pressing under 1000 kgf/cm^2 pressure. A linear electron accelerator UELR-10-10C was used to irradiate the samples with an electron beam of 10 MeV energy and $2.9 \cdot 10^{14}$ cm^{-2} fluence. TL was measured in a linear heating mode at 2˚C/s. ELEXSYS 580 spectrometer was used to measure electron spin resonance (ESR) in X-band.

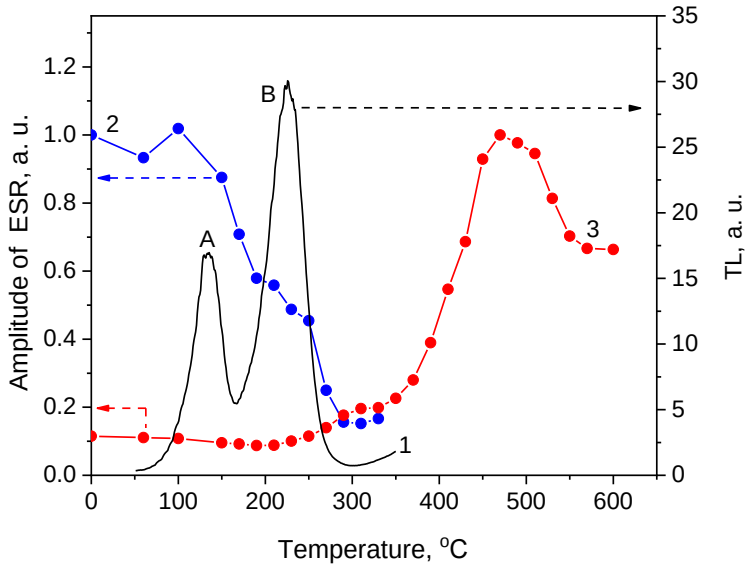

Fig.1. TL curve (1) and dependence of amplitude of ESR signals with g = 1.999 (2) and g = 1.965 (3) on ZrO_2 annealing temperature

It was found that exposure to electrons with 10 MeV energy results in TL peaks A at 135 ˚C and B at 225 ˚C (Figure 1). ESR spectra of the exposed samples feature signal I with g = 1.965, which is associated with the presence of Zr^{3+} ions in the samples; and signal II with g = 1.999, which is caused by formation of F^+-centers in the irradiated compacts. Signal I amplitude increases when the sample heating temperature grows from 250 up to 470 ˚C, and it becomes maximal at 470˚C. Further rising of temperature up to 600˚C decreases the amplitude of signal I by 35-40% from the maximum. The absence of any changes in ESR amplitude shows that Zr^{3+} does not participate in TL processes in the 50-350 ˚C temperature range.

The amplitude of signal II was found to decrease in the temperature range of TL peaks A and B. This can indicate destruction of F^+-centers due to trapping of charge carriers that were released from the traps associated with these TL peaks. The paper discusses mechanisms of changing concentrations of paramagnetic centers when the irradiated samples are annealed in the 50-600 ˚C temperature range.

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