

## Cathodoluminescence of Thermoregulating Composite Materials

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Silicates and other refractory composite thermoregulating coatings (TRC) form a basis of technically important products and articles such as "solar reflectors" for space vehicles. TRC properties crucially depend on the peculiarities of their structure at the atomic level such as their chemical bond, defectiveness, and nature of defects in crystal lattices.

The work presented is aimed at the study of optical characteristics (cathodoluminescence) of zirconium silicate obtained by hydrothermal microwave synthesis.

The cathodoluminescence (CL) experiments were performed using a special installation. CL spectra ( $ZrO_2$  and  $SiO_2$ ) were measured within the temperature range of 77 - 300 K using a low temperature cryostat. CL excitation was performed using a compact electron accelerator with the following beam parameters: adjustable electron energy of 1 - 30 keV and electron current of 10 - 100 nA. When TRC are exposed to 10keV and 5keV pulsed electron beams at different temperatures, an intense luminescence is observed within the spectral range of 2.75 eV - 3.5 eV. CL spectrum at 78 K is a broad band with a maximum shifted depending on the excitation energy (2.75 eV - 3.5 eV). With increasing temperature (300 K), a decrease of CL intensity is observed, and the maximum of luminescence band becomes 3.0 eV. Excitation of CL in TRC within the spectral range of 1-5 eV by pulsed electron beams of different energies has revealed that the intensity of the CL spectra depends strongly on the excitation energy. 2.75eV, 3.0eV and 3.25eV bands observed in the CR spectra of the studied TRC ( $ZrO_2$  and  $SiO_2$ ) are characteristic of luminescence of many silicates and are usually associated with radiation of defect centers. Zirconium ions may be located in tetrahedral surrounding in the form of (OH) - Zr - (OSi)<sub>3</sub> or Zr - (OSi)<sub>4</sub> and [SiO<sub>4</sub>]<sup>4-</sup> groups due to the presence of zirconium ions and local distortions of silicon- oxygen tetrahedra. [SiO<sub>4</sub>]<sup>4-</sup> center occurs in the case of violation of the symmetry of silicon-oxygen tetrahedra because of a nearby defect. In the formation of above centers and their metastable states, impurities can play an important role: as charge compensators or as the factors of change in electron density distribution of the tetrahedra. The fact that CL luminescence of defect centers is efficiently excited at low temperatures testifies to the possible transfer of the excitation energy from excitons and, thus, to the formation of specific excited states in distorted lattices. The emission band at 3.0 eV is apparently related to an intermediate stage of the formation of exciton-defect complexes or short-living defects in the form of vacancies  $V_{Zr}^-$  and interstitial ions  $Zr^+$  formed at bond breaking - the optical transitions in  $V_{Zr}^-$  center.