Luminescent Properties of Composite Materials in the VUV Region

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Photo- and radiation resistances of white powders used as pigments for reflective thermoregulating coatings (TRC) are fundamental characteristics that determine their quality. The change in the diffuse reflection and luminescence spectra due to the formation of the absorption bands induced by light quanta in the solar spectrum range or by charged cosmic particles leads to an increase in the proportion of energy absorbed and increase in temperature of the objects with such coatings.

Spectroscopic characteristics of zirconium silicate ($ZrO\ nSiO_4$): luminescence excitation and luminescence properties were investigated over a wide spectral range of 2-20eV at different temperatures.

Doping was performed during hydrothermal microwave synthesis of zirconium silicate. The luminescent properties of the ($ZrO\ nSiO_4$) TRC were studied at HASYLAB laboratory using SUPERLUMI station. The station provides ample opportunities for research within the luminescence VUV spectroscopy region with time and energy resolution. The experiments were performed at 300 and 10 K. 2.78eV, 4.96eV, 6.52eV, 2.88eV, 3.65eV, 4.13eV, 4.96eV, 6.2eV, 11.0eV broad bands observed in the excitation and luminescence spectra of the studied $ZrSiO_4$ are characteristic of many silicates and are usually associated with the radiation of defect impurity centers and $[SiO_4]^{4-}$ which are due to impurity ions and local distortions of silicon-oxygen tetrahedra. $[\ ZrO_4]^{4-}$ center can be formed when in the regular tetrahedral position zirconium atom substitutes silicon atom. $[SiO_4]^{4-}$ center occurs in the case of violation of the symmetry of silicon-oxygen tetraedra because of a nearby defect. Violation of regular bonds in zirconium and silicon sublattices may cause short-living optically active defects such as anionic vacancy luminescence centers of F and F^+ type within UV and VUV spectral regions. Electrons are trapped by anion vacancies which always are present in the synthesis of zirconium silicate, and thus F and F^+ color and radiation centers or emission arise with maxima in UV and VUV excitation and luminescence spectra. The reason for the shift of radiation maxima in the excitation and luminescence spectra is that the generation of excitonic excitation takes place directly in those lattice sections distorted by the presence of a defect, and its non-radiative relaxation is carried out mainly with the participation of local oscillations of the defect center.

In conditions of low-temperature (T = 10 K) experiments, radiative relaxation is dominated, and the probability of non-radiative transitions is practically equal to zero.

Thus, the luminescence of silicates in the case of photoexcitation (with the photon energy in the region of interband transitions) of said optically active centers is effectively excited in UV –VUF regions, and their relaxation process includes the step of forming multicomponent defect complexes.