RADIATION RESISTANCE OF THERMOREGULATING COATINGS IRRADIATED USING IBR-2

V.V. Harutyunyan[1], A.P. Aprahamian, E.M. Aleksanyan, V.V. Arzumanyan,
A.H. Badalyan, A.H. Hovhannisyan,V.V. Baghramyan[2], A. A. Sargsyan, O.A. Culicov[3],
I.A. Bobrikov

[1]*A.Alikhanyan National Science Laboratory, Yerevan, Armenia*
[2]*Institute of General and Inorganic Chemistry of NAS RA, Yerevan, Armenia*
[3]*FLNP JINR, Dubna, Russian Federation*

E-mail: vharut@mail.yerphi.am

The main trends of modern instrumentation are the use of physical modeling methods for a comprehensive study of the behavior of thermoregulating coatings under conditions of ground-based forced action of the main factors of outer space: deep vacuum, flows of high-energy charged particles (electrons, protons, and neutrons), electromagnetic solar radiation, thermal cycling, etc. [1]. Ideal thermoregulating coatings should have high melting point, low thermal conductivity, excellent chemical stability, and no phase transitions at operating temperatures, high adhesion to the substrate, and their thermal expansion coefficient should be similar to that of the substrate. The absorption coefficient of solar radiation (α_s) and the light reflectance of coatings are important characteristics of absorption and heat transfer for the spacecraft surface.

Coatings with α_s of about 0–30% and reflectance of about 0.8–0.9 can effectively remove excess heat from the spacecraft surface [1, 2]. To a greater extent, this applies to the thermoregulating coatings of the “solar reflector” class that includes enamel and ceramic coatings based on pigments with organic and inorganic binding agent. Among the pigments for coatings of this class, powders of silicate solutions of silica-containing rocks, such as zinc silicates, zirconium, etc., have found the greatest application as the most stable to the action of charged particles.

To study radiation-structural properties (crystallinity and phase composition) by X-ray diffraction analysis (XRD), zinc silicates obtained by hydrothermal microwave synthesis, modified by rare earth elements (Ce, Y), and subjected to neutron flux irradiation at doses of 10^{12} and 10^{15} n/cm^2 using at the FLNP JINR IBR-2 reactor were used. Phase constitution Zn_2SiO_4 silicate in of zinc crystalline form is rarely found in nature, however its optical, anticorrosive properties, high chemical stability, radiation resistance, and other properties determine its high demand, which determines its wide application in various fields. Zn_2SiO_4 exists in α- and β-crystalline phases. β-Zn_2SiO_4 is metastable and transforms into the α-phase at high temperatures. α-Zn_2SiO_4 does not exhibit solid phase transitions below its melting point (1550°C) and is a suitable phosphor matrix due to its excellent luminescence properties in the blue, green and red spectral regions. Ceramics based on Zn_2SiO_4 is traditionally produced by the solid-phase reaction of well-mixed ZnO and SiO_2 powders at 1100–1500°C. To completely remove bound water, the zinc orthosilicate samples Ce/Y-Zn_2SiO_4 were thermally treated at 1050^0C [2]. It has been established that the mechanism of action of neutron flux on zinc silicates is completely different and determined by the atomic and molecular structure of the substance. When thermoregulating powders are irradiated with neutron flux, radiation color centers can form, namely, the following two types of defects: a) on the defects formed before the irradiation due to the crystal structure nonstoichiometry and on surface intrinsic point defects, b) on the defects formed in the crystal lattice during the irradiation. The concentration of the first type defects largely depends on the specific surface area and grain size of the powders. With increase in the specific surface area, the concentration of defects, as a rule, increases and then decreases. Doping with cerium or yttrium up to 5% helps to obtain a highly crystalline nanoscale structure. These elements also stabilize the