Improving the composition of radiation protection glasses

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Scientists select the optimal composition of glasses, which will have strong protective properties, clarity, and environmental friendliness. Credit: UrFU / Anastasia Farafontova.

Scientists at the Ural Federal University (UrFU) with colleagues from the Arabian Peninsula have improved the radiation protection properties of glass, in particular borate glasses (boron oxide-based glass). They

introduced special additives into the basic composition of the glass—heavy metal oxides. This significantly increased the density of the material without affecting its transparency. A description of the experiments and the results of the study was published in the journal *Progress in Nuclear Energy*.

Borate glasses are used in scintillation detectors of ionizing radiation (devices in nuclear physics for registration of gamma radiation and study of radiation spectra of radionuclides) and for radiation protection. Glasses based on boron oxide are an environmentally friendly alternative to glasses with the addition of lead. But they have low density, which is one of the most important factors affecting the quality of radiation protection. Scientists added cadmium oxide to the composition of glass and found out that in this way the density of glasses have increased significantly. The new samples turned out to be usable for chambers that protect against gamma radiation.

"The ability of the shielding material to attenuate passing gamma or X-rays increases with increasing cadmium concentration in the glass composition. Manufactured samples showed good results as radiation shielding material in the areas of low and medium energy gamma radiation. To confirm the validity of the results, we determined their protective properties using three methods, including the well-known Monte Carlo simulation—computer simulation of the transfer of various kinds of radiation (neutrons, gamma rays, electrons, positrons). The simulation results showed good agreement with the experimental data on the attenuation coefficients of glasses with respect to gamma radiation of cesium-137 and cobalt-60 isotopes," says Oleg Tashlykov, associate professor at the Department of Nuclear power plants and renewable energy sources of UrFU.

A high level of transparency is an important prerequisite for protective glasses, since such glasses are used in a variety of applications. From

nuclear research laboratories to the X-ray rooms of hospitals, as well as in so-called hot cells where highly radioactive products are manipulated remotely. They have to protect people from radiation, allowing them to control the necessary equipment and perform any actions at a distance.

Researchers have been selecting the optimal composition of lead-free glasses for years. The main criteria are environmental friendliness and low weight (minimum lead), high radiation protection and transparency. Earlier researchers showed that partial replacement of lead with bismuth compounds leads to significant improvement of protective characteristics of glasses. Now scientists are testing three more versions of compositions of glass with different additives (oxides of barium, zinc, tungsten, etc.). This is necessary in order to find the optimal composition of the material with good protective characteristics, a high level of transparency and cost-effective production.

More information: K.A. Mahmoud et al, Assessment of mechanical and radiation shielding capacity for a ternary CdO–BaO–B_2O_3 glass system: A comprehensive experimental, Monte Carlo simulation, and theoretical studies, *Progress in Nuclear Energy* (2022). DOI: 10.1016/j.pnucene.2022.104169

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