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Materials for tritium solid-state radioluminescent light sources (SRLS). Modified technique of phosphor screens manufacturing

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1. Introduction

Radioluminescent light sources (RLS) are very promising energy-saving types of devices which are highly sought in various fields of industry due to their energy independence, self-reliance and longevity. The key idea of SRLS is bonding the working isotope (tritium) in the solid matrix and combining it with the phosphor. This approach allows to decrease the radiological hazard and create safe and endurable light sources of various forms and sizes [1]. The main factor of raising the SRLS effectivity is providing the closest contact between the tritiated carrier matrix and phosphor screen. Also, achieving the optimal thickness for the phosphor screen is a crucial task for the SRLS creating. The screen being too thin will not be able to provide enough brightness, and the one too dense will absorb all the light. So the development of the working method of making the strong and uniform phosphor screens of adjustable thickness is indeed a very promising challenge.

2. Experimental

For our experiment we used the tritiated titanium carrier matrix on the stainless steel plate, so that we get the tritium ionizing radiation sources with surface area of 1 cm^2 and fixed activity 420 mCi per source. For the experiment we took the inorganic zinc-sulphide radiophosphors: FK-2; FK-3; FK-4; Z-3/11; Z-16/3; G-2/1, and zinc-sulphide cathodophosphor: P31-G1A. We have conducted series of experiments to develop the working technique of phosphor coating, firstly on the glass plates and then on the tritiated carrier matrix.

3. Results

Firstly, the phosphors preselection was done to choose the best ones according to their spectrum and brightness characteristics. For the preselection tests phosphor layer was fixed on the sticky tape and tightly hitched to the tritiated source to provide the closest contact of the phosphor and the source. Then, for the phosphor screens we used the type of method that uses the phosphor grains fully covered with the binder - sol-gel suspended sedimentation, based on the method stated in [2], which includes water, potassium silicate, polymeric surface-active agent and electrolyte. We have modified this technique since in the exercise it has been noted that the existence of surface-active agent in the suspension suppresses the effect of coagulating electrolyte $Sr(NO_3)_2$. The modified sol-gel technique allowed getting the strong, thin and uniform phosphor screens avoiding the usage of the secondary dispersing agents. Using this technique we prepared two sets of samples of phosphor screens with various thicknesses. Then the brightness and luminescence spectra were measured, and the optimal thickness of the phosphor screen was stated.

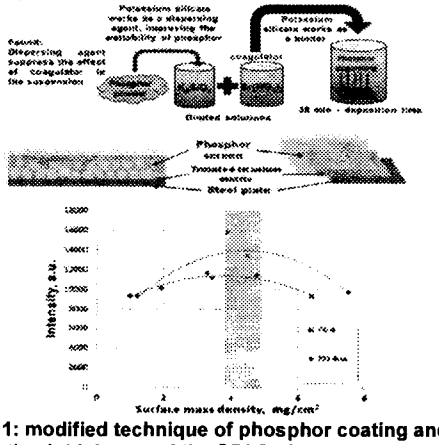

Figure 1: modified technique of phosphor coating and the optimal thickness of the SRLS phosphor screen

4. Conclusions

The technique of coating the phosphor screens of various thickness on the tritium sources was developed. The spectral and brightness characteristics of the phosphor screens were studied at the tritium ionizing radiation source and the optimal screen thickness of 4-5 mg/cm^2 was determined. It was demonstrated that coating the phosphor screen directly on the tritium β-source gives a 15% increase of brightness in comparison with the coating on the glass.

5. Acknowledgements

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6. References

[1] Prospects for the Development of Tritium-Based Solid-State Radioluminescent Light Sources, E. Zelenina, M. Sychov, A. Kostylev, K. Ogurtsov / Rdiochemistry, vol. 61, №1, 2019.
[2] Russian Federation patent №: 2032243; 27.03.1995