Hydrophobic Phosphorescent Coating for Firehoses

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Fire pressure hoses are one of the main types of firearms. Combat capabilities of firefighters and therefore the successful extinguishing of fires largely depend on technical characteristics and functional capabilities of used weapons. Improving the equipment and armament of rescuers directly affects the effectiveness of rescue operations as well as the life and health of rescuers is also highly dependent on enhancement in equipment and ammunition.

The basis of the firehose is a woven frame, inside which a waterproofing coating (mainly latex, rubber, polyurethane, etc.) is applied. But in some cases, impregnation or coating is also used on the outer surface. Among the technical innovations of foreign market are fluorescent firehoses created in Sweden. The outer covering of these sleeves contains special fluorescent dopands. Enough few minutes of exposure to sunlight for the sleeves to emit light for hours. The commercially available Syntex Signal firehose has a phosphorescent coating on the outer side. Firehoses with prolonged afterglow is very handy when performing rescue operations in dark or smoky rooms and basements when it is difficult to find a way out. Note that the modern trend in development of protective coatings is their multifunctionality [1].

Among the functional uses of protective coatings, the hydrophobicity is primarily considered. In the case of providing a coating of superhydrophobic properties, it is possible to realize the situation when fire hoses are not wetted with water and do not become dirty in summer, and also do not freeze in winter. The urgent task is to develop modern coatings that can combine several functional uses, such as superhydrophobic properties with long afterglow.

A luminescent polymer composition is proposed for the protective coating of the outer surface of fire hoses having a long afterglow in the green region of the spectrum. Spectrum of phosphorescence for noted coating is shown in Fig. 1 (the excitation of the phosphorescence was carried out by sunlight for 1 min). The necessary corrections have been made in curve 1 to take into account the dispersion of monochromator and sensitivity of photoreceiver as well as the decrease of afterglow intensity over the measurement time. It is seen that maximum of phosphorescence spectrum located at 515 nm

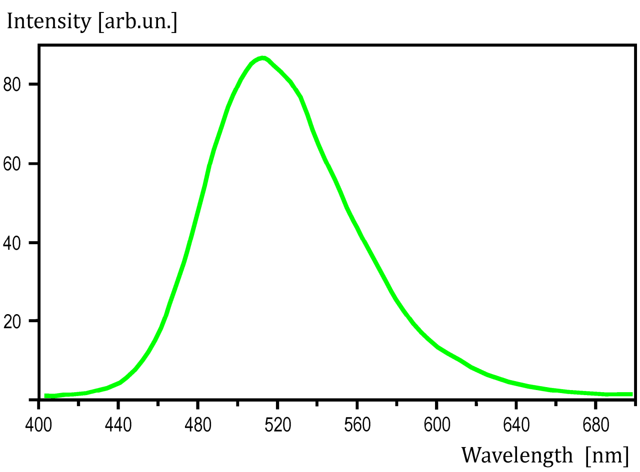

Fig. 1. Spectrum of phosphorescence for protective coating with $SrAl_2O_4$:Eu,Dy dopand

and the curve in Fig. 1 almost coincides with the fluorescence spectrum when excited by photons with λ = 380 nm.

The kinetics of phosphorescence decay is shown in Fig. 2 after exposure to daylight for 1 min. It can be seen from the figure that a decrease in the intensity of afterglow by a factor of 10 occurs in 11 minutes, but even after 60 minutes the eye clearly distinguishes the green emission of fire hose in the dark. It should be noted that after prolonged exposure to blue or UV light, phosphorescence is observed for 10 hours or more and new components in decay kinetics are appeared.

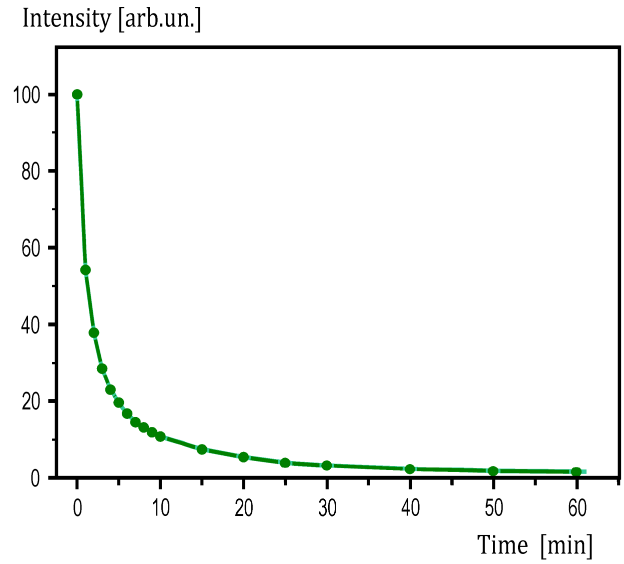

Fig. 2. Kinetic of afterglow for proposed luminescent coating after excitation by daylight during 1 min.

Traditionally, the technology for producing such coatings involves the application of four layers. The first layer is a primer for better adhesion of the coating to the surface, the second is a white reflector to enhance the phosphorescence intensity, the third layer is the phosphor itself, and the latter serves to smooth out the roughness caused by phosphor particles of 30-40 microns in size.

The polymer base of the proposed composition consists of silicone rubber, namely, SKTN-med, which has a very good transparency in visible and near UV region of spectrum. It is known that this polymer is relatively thermostable and has pronounced hydrophobic properties [2]. As a luminescence dopand the micro-particles of strontium aluminates ($SrAl_2O_4$:Eu,Dy) were used. First layer (the primer) do not used as rule due to good adhesion of rubber to surface of firehose. As a reflector the aluminum oxide (Al_2O_3) powder was used with particle size of ~100 nm. The composition also contains additionally QM-siloxane [3]. The thickness of second layer (the reflector) depends on type of substrate and has a minimum deep for firehose of white colour.

REFERENCIES

1. L.A. Andryushchenko, A.M. Kudin, V.I. Goriletsky, et al. Functional Possibilities of Organosilicon Coatings on the Surface of CsI-based Scintillators // Nuclear Instruments and Methods in Phys. Research. A486 (2002) 40-47.
2. E.V. Tarakhno, L.A. Andryushchenko, A.M. Kudin, L.N. Trefilova, Application of organosilicon polymers for flameproof clothing // Problems of Fire Safety. 36 (2014) 243-265.
3. Application № a201808296 to patent of Ukraine. C09D 5/00 «Superhydrophobic composition for coating» / L.A. Andryushchenko, M.N. Goroneskul, A.M. Kudin, et al. Publication 25.02.2019, Bul. № 4.