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TECHNOLOGY OF ORGANIC AND INORGANIC CHEMISTRY

Modification of the Properties of Gelatin of Emulsion Layer of Photographic Film with Styrene Acrylate Latex

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Abstract—-The problems of modification of the gelatin properties, the polymer for the adhesion of emulsion layer of photographic films are considered. For enhancing the physicochemical parameters of emulsion layer is used styrene acrylate latex in conjunction with hydrophilic synthetic polymer for the modification of gelatin. A method is proposed that simplifies technology of introducing the gelatin modifying polymer to the emulsion layers.

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The photographic films are multilayer polymeric systems. Despite the low thickness of emulsion layer as compared with the support, it is this layer defines in much the physicochemical properties of the whole system. A principal problem at the application of gelatin as binder for the emulsion layers is its strong tendency to shrinkage due to the relaxation processes at the layer formation and after chemical photographic treatment, and this fact defines the necessity of modification of the gelatin properties.

It is desirable to use hydrophobic synthetic materials in the form of latexes for the modification of gelatin properties. Application of such type polymers promotes decrease in swelling, shrinkage and friability of emulsion layer and diminishes the whole film curling. The mechanism of gelatin properties modification with the latexes is probably similar to the mechanism of strengthening of friable polymers with resin [1]. For example, the emulsion layers containing resin dispersions, the dispersion of polybutyl acrylate in particular, have enhanced impact strength [2–4].

Thus, modification of the gelatin properties with hydrophobic polymers in the form of latex affects positively the physicochemical parameters of emulsion layer and has been well enough studied. The most often to the modification of gelatin properties are applied carboxylated resins in conjunction with less flexible polymers. From the viewpoint of the practical results the most perspective for the modification are the carboxylated latexes of butyl acrylate: styrene copolymers [5]. The results of a detaled study of the effect of the monomers ratio in the butyl acrylate–styrene copolymer on the optcal homogeneity of the gelatin layer and on the introduction of the latex modifying material to the photo emulsion in a wide concentration range have been published in [6]. It also has been shown [7] that chemical modification of the styrene–acrylate latex with water soluble polymers, e.g., poly-*N*-vinyl pyrrolidone (PVP) even in a greater extent affects positively the physicochemical characteristics of the emulsion layer and whole photographic film.

The positive effect of PVP can be explained by specific adsorption of the PVP molecules possessing positive charge on the nitrogen atoms of pyrrolidone rings on the surface of the negatively charged latex particles that leads to their screening from the gelatin macromolecules and creates denser interphase layer.

In this work we investigated effect of the type of polymer modifier of the gelatin layer and of the mode of introduction of the modifier to the emulsion layer on the basic physicochemical characteristics of the latter. According to the standard OST V 6-17-427-76 (Aerophotofilms. Methods of testing) we measured moisture capacity and strength (damaging stress) of the swollen emulsion layer. The photo emulsion was synthesized in correspondence with the standard OST 6-17-421-84 (Gelatin for photography). As the modifiers

of the gelatin properties were used styrene–acrylate latex corresponding to TU 2241-001-47923137-01 and PVP with average-viscous molecular weight 30000 Da. The following model samples of photographic films were prepared on a extrusion-drying device: sample 1, the gelatin of the photo emulsion is replaced by the latex by 10%; sample 2, the film is filled with PVP by 10%; sample 3, the latex is filled with 10% of PVP in a separate flask and then is introduced to the emulsion replacing gelatin by 10%; sample 4, initially to the emulsion was added latex to replace gelatin by 10% and then the emulsion was filled with PVP in amount 10% of the latex; sample 5, initially the emulsion was filled by PVP in amount of 10% of the latex and then was introduced the latex to replace 10% of gelatin. Note that all the samples with the latex are characterized by high flatness (curling less than 0.5%).

The results of research are given in the table. It follows that the kind of the modifier and the way of its introduction into the photographic emulsion affect the durability and moisture capacity of the emulsion layer. Use of PVP only as the modifier leads to considerable decrease in durability of the swollen emul-sion layer and to increase of its moisture capacity in comparison with the hydrophobic modifier and a mixture of the hydrophobic modifier with PVP.

Appreciable deterioration of characteristics in the case of use of PVP only as the gelatin modifier is connected with its disintegrating action on the supramolecular structure of gelatin emulsion layer that leads to increase in non-uniformity of hardening and to respective deterioration of parameters of the layer. Introduction of latex into the photo emulsion does not lead to essential change in the durability of the swollen emulsion layer, but definitely reduces the moisture capacity owing to decrease in the fraction of hydrophilic polymer gelatin in the emulsion.

Comparison of various ways of introduction of hydrophilic and hydrophobic modifiers into the emulsion layer shows that durability values of the swollen emulsion layers at the ninth day do not differ from each other and exceed values for the control sample, and also for the sample modified by latex only.

The analysis of the data obtained shows also that the maximum decrease in the moisture capacity of the emulsion layer at retention of its high durability in the swollen state is reached at the consecutive intro-duction into photographic emulsion of hydrophobic modifier of the emulsion layer gelatin. This result shows that the offered way of introduction of latex and PVP into the emulsion layer simplifies the technology of introduction of modifiers in comparison with known way used in the industry [8] when a mixture of dispersion of hydrophobic polymer with water solution of PVP is prepared preliminary. This leads to the practical conclusion about simplification of technology of introduction polymeric modifiers of the gelatin properties into the photoemulsion layers.

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Influence of structure of the modifier and a way of its introduction into the photographic emulsion on durability of the emulsion layer swollen in water and its moisture capacity at storage within 2, 4, 8 day

Sample	Durability of the emulsion layer swollen in water, H			Moisture capacity of emulsion layer, g μ m^{-2}		
	for 2 days	for 4 days	for 8 days	for 2 days	for 4 days	for 8 days
Control sample	10.9	13.1	17.0	2.5	2.0	1.9
Sample 1	12.4	14.4	16.0	1.9	1.4	1.3
Sample 2	6.4	7.6	10.0	3.1	2.5	2.4
Sample 3	12.4	17.7	21.6	2.2	1.8	1.8
Sample 4	14.4	17.4	24.5	2.0	1, 4	1.3
Sample 5	10.4	17.4	22.6	2.0	1.6	1.6

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