Sensitometric Properties of AgBr/AgCl Tabular Core-Shell Microcrystals

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Abstract

The researches of influence of a structure of silver chlorohalogenide microcrystals on the sensitometric characteristics of emulsion layers are carried out. The influence of concentration of coupler on a photosensitivity of emulsion layers is investigated. It was shown that an emulsion layer with AgBr/AgCl microcrystals and with coupler has a high photosensitivity.

Introduction

The application of tabular crystals in modern photomaterials allows considerably to improve photographic properties of emulsion layers and to reduce the covering concentration of silver. However the AgCl and AgBr(Cl) tabular crystals have the very limited application owing to a low photosensitivity of emulsions with such crystals. On the other hand important property of AgCl and AgBr(Cl) crystals is the high speed of development and fixation, that facilitates processes of high-speed processing of emulsion layers. Use for silver chlorohalogenide crystals of the approaches used in heterocontact systems[1] can allow considerably to increase a photosensitivity of such microcrystals due to existing of effect of the directed transfer of photo induced carriers of charges (photoelectrons and photoholes) in the structurally organized systems. Such systems are the AgBr/AgCl core-shell microcrystals.

Experiments

For realization of researches the AgBr/AgCl tabular crystals were made. In the beginning by means of a double jet crystallization the AgBr tabular crystals was received. Then on these crystals the AgCl shells were grew. The molar ratio of AgBr to AgCl was 7:3. Besides the emulsion with tabular crystals $AgBr_{0.7}Cl_{0.3}$ with homogeneous distribution of halide ions was made. Both emulsions had the close dispersion characteristics and average equivalent diameter 1.5 microns. The emulsions were subjected to sulfur-plus-gold sensitization and after that were coated a polymeric support. The emulsion layers were made in two variants: with addition of various amounts of coupler and without it. The water-soluble magenta component was used. In all cases the concentration of silver in an emulsion layer was 1.0 g/m^2. After drying the emulsion layers were exposed, subjected to photographic processing and sensitometric tests. Two methods of development: on C-41 process and in a developer D-19 were used. The processing carried out at temperature 24°C. Some samples of emulsion layers after development and fixation were subjected to microscopic researches on electron microscope.

Table. The results of sensitometric investigation.

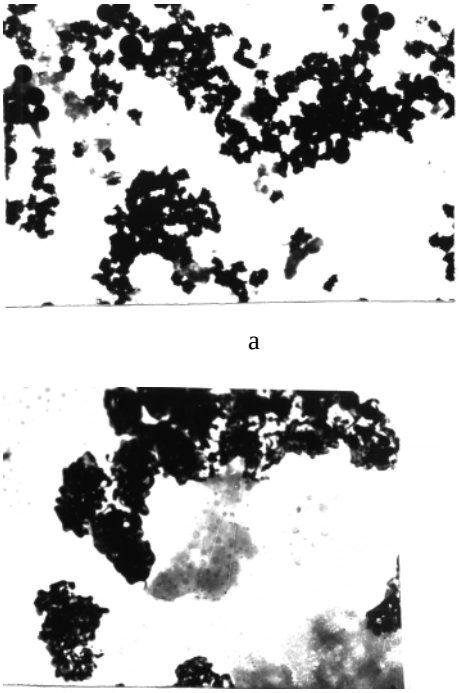
Emuls Type	Developer	Coupl. Per mol Ag	Dev. time	D_o	D^*_{max}	$S_{0,2}$
AgBr/ AgCl	C-41	—	6.0	0.01	0.3	0.6
AgBr/ AgCl	C-41	1/50	6.0	0.01	0.45	5.0
AgBr/ AgCl	C-41	1/25	6.0	0.01	0.6	10.0
AgBr/ AgCl	C-41	1/12	6.0	0.01	1.5	22.0
AgBr/ AgCl	C-41	1/6	6.0	0.01	2.0	30.0
AgBr/AgCl AgCl	C-41	1/3	6.0	0.01	2.5	35.0
AgBr/AgCl AgCl	C-41	1/6	15.0	0.03	2.7	36.0
AgBr/AgCl AgCl	D-19	1/6	6.0	0.05	1.0	10.0
AgBr/AgCl AgCl	D-19	1/6	15.0	0.15	1.5	15.0
$AgBr_{0.7}$ $Cl_{0.3}$	C-41	—	6.0	0.03	0.5	1.2
$AgBr_{0.7}$ $Cl_{0.3}$	C-41	1/6	6.0	0.06	1.3	20.0

D_{max} - optical density of the image at 2.5 lk*sek exposition.

Results and Discussion

The basic sensitometric results, received in research, are given in the table. This results show that emulsions with AgBr/AgCl and $AgBr_{0.7}Cl_{0.3}$ tabular crystals in absence of coupler at processing on C-41 process have low optical density of the black-

and-white image and low photosensitivity. The photosensitivity is increased in a high degree at introduction in an emulsion of coupler. The level of a photosensitivity strongly depends on amount of coupler in an emulsion. Such dependence specifies that the amount of the developed silver of the image is rather great, despite of very low optical density of the black-and-white silver image. The low level of optical density of the black-and-white image on the investigated samples was received also in the case of processing in a developer D-19, though in case of samples made on the base of an emulsion with the AgBr core tabular crystals the maximal optical density was more then 2.5.



a

b

Figure 1. Micrographs of coal replicas of developed and fixed microcrystals:a) AgBr; b) AgBr/AgCl

High density of the color image and strong dependence of this value on amount of coupler and also small optical density of the black-and-white image can specify that the structure of the developed metal silver of the image differs for AgBr and AgBr/AgCl microcrystals. For confirmation of this assumption the microscopic researches of emulsion layers after development and fixation were carried out. The micrographs of coal replicas are presented on Figure 1. It is possible to see that the structure of the developed silver for AgBr and AgBr/AgCl microcrystals strongly differs. At development of AgBr microcrystals the long thin filaments of metal silver, which create a high optical density, are formed. The development of core-shell microcrystals results in formation of short and thick filaments of metal silver, which create considerably smaller optical density. As a whole amount of the developed silver in case of core-shell microcrystals is significant and sufficient for formation of a plenty of dye at color development. Such form of the developed silver is very similar to the form received at development of the AgCl crystal[2] that indirectly can confirm the existence of large concentrations of AgCl on surface of crystals.

It is necessary to note that the process of development of emulsions with AgBr/AgCl microcrystals proceeds with high speed. At temperature 24°C the development practically is finished for 6 minutes, whereas the development of emulsions with microcrystals AgBr in similar conditions lasts 15-18 mines.

The comparison of the sensitometric characteristics of core-shell AgBr/AgCl emulsions and emulsions, received at processing on C-41 process shows, that for an core-shell emulsion a level of a photosensitivity for the color image more than in 1,5 times higher than for an $AgBr_{0.7}Cl_{0.3}$ emulsion. Such increase of a photosensitivity most likely specifies the realization of the separating of electrons and holes at formation of the latent image as well as at formation of the latent image in tabular crystals AgBr/AgBr(I).[3]

Conclusions

1. The developed silver in case of AgBr/AgCl microcrystals has less expressed filament form than in case of AgBr crystals and creates small optical density of the black-and-white image.
2. The presence of coupler in an emulsion layer with AgBr/AgCl crystals allows to receive levels of a photosensitivity in tens time higher than in case of its absence.
3. The speed of development for AgBr/AgCl crystals is close to speed of development of AgCl crystals.
4. In AgBr/AgCl core-shell crystals the separation of photoelectrons and photoholes during of the latent image formation can take place.

References

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