Influence of Cd(II) Ions on Photoprocess Efficiency in Photoemulsion Heterocontact AgHal Crystals

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Abstract

Photographic properties of AgBr T-crystals and AgBr T-crystals with AgBr(I) lateral shell, doped by Cd(II) ions are investigated. Phenomenological model of the mechanism of an impurity ions influence on properties of a heterocontact in system AgBr/AgBr(I) is offered.

Experimental Results and Discussion

The influence of Cd^{2+} ions on photoemulsion microcrystals' properties was repeatedly investigated. However the results of the different researchers are rather inconsistent. We investigate influence of Cd^{2+} ions and their localization on photographic properties of T-crystals AgBr with lateral AgBr(I) shells.

The emulsion microcrystals with the following dispersive characteristics: an average equivalent diameter d=2.2-2.4 micron, a variation coefficient C_v=50-55%, coefficient of crystallographic uniformity S_T=94-95% for experiments are used. The concentration of entered Cd^{2+} is 1×10^{-3} mol/mol AgHal in all cases.

Photoemulsion layers are exposed, developed in D-19 and the sensitometric characteristics are determined. The results of these experiments are submitted in the Table 1.

Table 1. The sensitometric characteristics of photoemulsion microcrystals.

No.	T-crystals	$S_{rel.}$	D_o	D_{max}	γ
1	AgBr	100	0.15	3.2	2.6
2	Ag(Cd)Br	120	0.12	3.3	2.8
3	AgBr/AgBr(I)	250	0.12	2.5	1.8
4	Ag(Cd)Br/AgBr(I)	200	0.12	2.5	2.0
5	AgBr/Ag(Cd)Br(I)	400	0.12	4.0	3.2

Emulsions 1-2 contain T-crystals AgBr, emulsions 3-5 contain T-crystals with lateral shells (core AgBr, shell $AgBr_{0.96}I_{0.04}$). Cadmium salts was entered to emulsion 4 and 5 during a core (4) and a shell (5) crystallization.

The results show, that the effect of Cd^{2+} introduction depends on structure, microcrystals composition and place of it's localization in a AgHal lattice. For example, the presence Cd^{2+} in AgBr T-crystals does not influence to photographic properties of emulsions.

It is known, that T-crystals with lateral shells (T-L-crystals) allow to receive photographic sensitivity in 2-3 times large, than T-crystals AgBr[1]. Experiments with emulsions of such type (emulsions 3-5) have shown, that the heterocontact microcrystals AgBr/AgBr(I) are very sensitive to Cd^{2+} ions localization in a lattice. The best result was received at Cd^{2+} introduction in a zone of a heterocontact and in a phase AgBr(I). Introduction of Cd^{2+} ions in a core AgBr results in reduction of sensitivity. Such large distinction in efficiency of ions Cd^{2+} action can be explained by considering the band diagram for T-L-crystals AgBr/AgBr(I) (Figure 1).

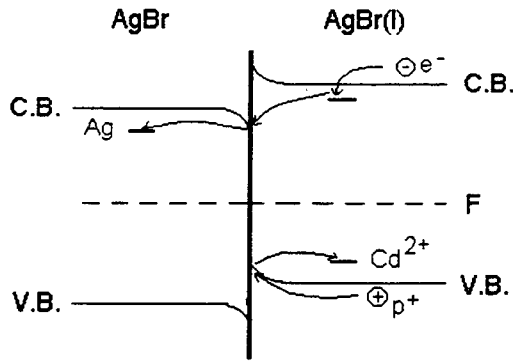

Figure 1. Band diagram for AgBr/AgBr(I) heterocontact.

In absence of Cd^{2+} ions generated in the phase AgBr(I) photoelectrons are transferred in a phase AgBr through a heterocontact. In a heterocontact zone an effective recombination of photoelectrons with photoholes is possible. Therefore the T-L-crystals sensitivity is limited by recombination processes. Presence of Cd^{2+} ions in a heterocontact zone or in a AgBr(I) phase results in formation of hole traps in these places. The presence of these traps reduces mobility of photoholes and efficiency of a recombination and increases efficiency of electrons transfer to AgBr (the latent image formations).

Thus the Cd^{2+} ions adjust processes of interaction between photoelectrons and photoholes. It is necessary to understand possible mechanisms of action of these ions on electron-hole processes for effective application of impurity ions.

References

1. E.I.Kagakin, Yu.A.Breslav, A.I.Mokhov and T.A.Larichev, "Tabular Silver Halide Grains with Lateral Shells", *J. Sci. and Applied Photogr. (Russia)*, **36:** 353-359 (1991).