

Photochromic Gel

Valery Zakharov, Nikolay Alekhin and Leonid Aslanov
Moscow State University
Moscow, Russia

Abstract

Gel containing silver halide in ultrafine grained form is proposed as photochromic material with variable light absorption. This protective colloid is distinguished by initial optical transparency and by existence of electric conductivity. Active gel is able to decrease of light beam intensity up to 100 times inside of visible spectrum interval.

Introduction

One of the fundamental task of optoelectronics is the investigation and development of new materials with variable light transmittance. They are, for example, photochromic compositions. Earlier the authors [1-3] have studied such compositions based on silver salts. These systems had changed their own transparency under the action of actinic light or electric current. The most essential defect of the above mentioned systems was their disability to form any necessary volume compositions. Moreover, the polymeric materials used in systems [1-3] do not possess noticeable electric conductivity. This circumstance excluded the possibility of cooperation action at these systems actinic light and electric current. In this work the attempt was made to construct the system without the enumerated defects. The system, based on copolymer of acrylamide and bisacrylamide with variable concentrations of silver halide as speed agent has been investigated.

Experimental

a) *Pure gel preparation*

To 8% water solution of acrylamide was added 1% (by weight to acrylamide) of bisacrylamide. As the initiator of polymerization the initiating system containing $(NH_4)_2S_2O_8$ and sim.N,N-tertamethylendiamine in concentration 100 mg to 100 ml of water have been used. The solution containing the enumerated components has been undergone to decontamination to remove the dissolved oxygen. Before the filling of the cell under investigation the second component of initiating mixture was added to the system. To activate the process of polymerization the system has to be heated up to 35 C°.

b) *Preliminary preparation of ultrafine grained AgBr crystals*

Ultrafine grained AgBr crystals have been obtained in accordance with [4] without silver ions excess. As protective colloid 5% solution of gelatin have been used. To obtain AgBr crystals the following solution have been used: 7,5% $AgNO_3$; 5,2% KBr and 5% of gelatin. The mixture of the solutions KBr (5,5 ml) and gelatin (1 ml) as well as the mixture of the solutions $AgNO_3$, gelatin (8 ml) and water (15 ml) have been added at the same time to 11 ml solution of gelatin under continuous mixing. Further the crystals of AgBr 10-20 nm in diameter obtained due to the fast emulsification were added to the pure gel (see item a).

c) *The active gel preparation*

To obtain active gel it is necessary to add ultrafine grained crystals (see item b) to the mixture containing copolymer and both components of initiating system. Then the mixture is subjected to homogenisation and at last it is introduced to the cell under investigation. The temperature has to be approximately 35 C°. In this work concentrations of AgBr crystals equal to 10%, 20% and 50 % in respect to the volume of monomer have been used. The redox systems which are given in [4} have been used in this research. Kinetic curves have been recorded on an experimental device [5]. The flash-lamp with electric power 36 J and flash-time 1 ms have been used as actinic light.

Results

Under the action of actinic flash the increase of optical density for initially transparent system (90%) up to value D=1,5 inside of whole visible interval of the spectrum have been noted. Kinetic curves of changing light transmittance have a typical S-character with induction time equal to 0,05 s. The typical curve for this photochromic gel is given in figure 1. The electric properties of this gel are characterized by domination of a non-electronic component of electric conductivity. The realization of the preliminary electric activation of systems before an actinic flash is possible in plane style as well as in condenser style. The use of planar electrodes inside of the cell allows to reach values of optical density D=2 for the working region of 100 cm^2 and more. The principal particular feature of this system is the possibility to obtain photochromic effect in gel volume.

The results obtained show the possibility to describe the physical and chemical laws which take place inside this gel under the flash action in framework of non-reversible thermodynamics [6].

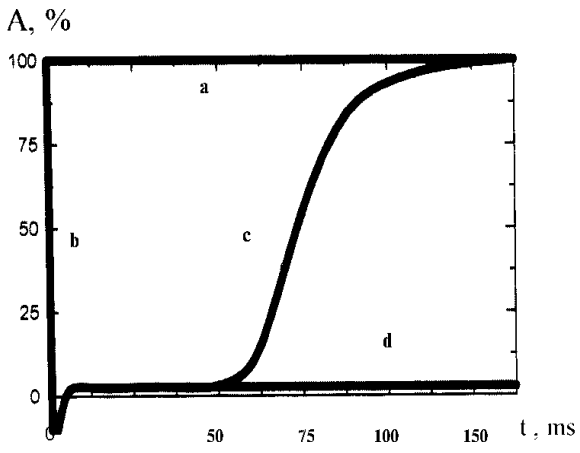

Figure 1. Kinetic curve of changing transmittance for gel under investigation a) oscilloscope signal, corresponding to 100% absorption; b) initial flash signal; c)curve of the gel; d) curve of control sample (pure glass)

Conclusion

New photochromic gel which possesses electric conductivity is proposed. The usage of this gel will allow to construct photochromic material of the appropriate configuration and thickness.

References

1. V.Zakharov, Proc. of IS&T's 50-th Annual Conference, May 18-23, Cambridge, Massachusetts, pg. 46, (1997).
2. S.Arakelian, E.Galashin, V.Zakharov, A.Kamyshny, V.Saryshev, Patent USSR 1137909 (1984).
3. V.Zakharov, N.Alekhin, Patent Russia 1790774 (1993).
4. V.Zakharov, S.Chernov, Zh. Nauchn.i Prikl. Fotorg. (rus), 43, N.6, pg.58, (1998).
5. V.Zakharov,L.Aslanov, H.Schenk, Proc. IS&T's PICS, 52-nd Annual Conference, April 25-28, Savannah, Georgia, pg. I1 (1999).
6. I.K.Kudriavtsev, Chimicheskie nestabilnosti, (rus), MSU Press, pg.254, (1987).

Biography

Valery N. Zakharov graduated from Moscow State University, Department of Chemistry, Chair of Photography in 1978. Since 1980 he has worked for the Chair of Photography and for the Laboratory of Structural Chemistry of Moscow State University. He is an author and co-author of 65 scientific papers and patents. His work has focused on silver halides crystals and the components of photographic layers inside of integrated chemical systems. V. Zakharov is a member of the IS&T.

Acknowledgement

This work was supported in part by RFBR (grant 99-03-32373) and the Netherlands Organization for Scientific Research (NWO).