

Nanocrystals of AgBr in the Integrated Chemical System

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It is wellknown that thermodynamical equilibrium condition for metallic nuclei in redox buffer is determined by the value of overvoltage between microelectrode with radius r and massive metal electrode [1]. Knowledge of such electrochemical and optical characteristics for this objects is essential for creation of modern integrated chemical systems (ICS), e.g. optical and electrochemical sensors, different indicator devices, photoelectrochemical systems and catalysts. To determine the overvoltage values we compute the number of silver atoms in the clusters on the AgBr nanocrystal surface in the framework of the percolation model suggested earlier [2]. We considered this model in order to explain high speed of photochromic effect in AgBr nanocrystal ICS [3].

The principal possibility of cooperative process existence in silver halides has been stated earlier [4,5], the optimal speed of emulsion grain development being 10^{-3} s. For the first time this effect was experimentally observed for the integrated chemical system based on AgBr nanocrystals [3]. The kinetic aspects of fast development of AgBr nanocrystals placed into redox systems and exposed to actinic flash were discussed in detail in [6,7]. Photoinduced spectral characteristics for such ICS are distinguished by high optical densities $D=3$ in the visible spectral interval. An essential decrease of actinic light beam is observed in the millisecond time interval. This does not correspond to the speed of ionic processes during nonselective reduction of AgBr nanocrystals.

In paper [2] we suggested an explanation for the origin of high optical densities in ICS under actinic light for very short period of time. In our opinion, this effect is due to the achievement of the percolation threshold, when a silver cluster with metallic properties is produced from the neutral silver atoms. This process has an electronic nature and this explains the high speed of the photochromic effect. In this work the percolation model of photochromism in AgBr nanocrystal ICS has been analyzed numerically. The process of statistical formation of Ag atoms on the silver halide surface with the subsequent formation of Ag_i cluster is described. The estimates for the probability of cluster formation and for the number of photons necessary for it were done. The values obtained are compared with the results obtained experimentally for such ICS.

References

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Acknowledgement

This work was supported by Russian Foundation for Basic Research (RFBR) – Grant N 02-03-32526.