

RESEARCH ARTICLE

Evidence of formation of dye–surfactant ion pair micelle in the anionic surfactant mediated alkaline fading of methyl violet carbocation

 Dinesh C. Ghosh^{1,2} | Pratik K. Sen¹ | Biswajit Pal² 
¹ Department of Chemistry, Jadavpur University, Kolkata 700032, India

² Department of Chemistry, St. Paul's Cathedral Mission College, 33/1 Raja Rammohan Roy Sarani, Kolkata 700009, India

Correspondence

Pratik K. Sen, Department of Chemistry, Jadavpur University, Kolkata 700 032, India.

 Email: senpkju@gmail.com

Biswajit Pal, Department of Chemistry, St. Paul's Cathedral Mission College, 33/1 Raja Rammohan Roy Sarani, Kolkata 700 009, India.

 Email: drbiswajitpal@gmail.com

Abstract

In the submicellar solution of anionic surfactants sodium dodecyl sulfate (SDS) and dioctyl sodium sulfosuccinate (AOT), the alkaline fading of methyl violet (MV⁺) carbocation has been studied spectrophotometrically in the temperature range 293–308 K. The interaction behavior of the dye carbocation with the anionic surfactant and the observed submicellar rate retardation is consistent with the ion pair and subsequent ion-pair micelle formation. The change in the spectral pattern along with a change in the peak intensity and shoulder intensity with increasing surfactant concentrations indicates the shifting of the equilibrium between the helical and distorted helical isomers of MV⁺ owing to the existence of dye–surfactant ion pair, ion-pair micelles, and dye-embedded micelles. This dynamic dye–surfactant ion-ion interaction has been corroborated by the tensiometric studies. The decrease in the fading rate and the change in the spectral pattern in the presence of anion, especially I[−], support the existence of the dye–anion interaction. The premicellar rate inhibition and the corresponding interaction have been accounted for by the use of two kinetic models namely, Olson–Simonson and Piszkiwicz cooperativity models. The cooperativity index value suggested a 1:1 dye–surfactant association in both the surfactants. The ratio of the concentration of the premicellar complex and the free dye cation indicates appreciable binding. The kinetic and thermodynamic parameters associated with the dye–surfactant complex have been explained in terms of dye–surfactant, dye–water, and surfactant–water interactions.

KEYWORDS

alkaline fading, dye–surfactant ion-pair micelles, methyl violet carbocation, submicellar solution

1 | INTRODUCTION

Methyl violet, *N*-(4-(bis(4-(dimethylamino)phenyl)methylene)cyclohexa-2,5-dien-1-ylidene)methanaminium chloride) (MV⁺), is an important water-soluble cationic

triaryl methane dye. It exists as a blackish green powder; and although the aqueous solution is violet in color, it changes first to blue-violet, then green to light yellow on lowering the pH due to the protonation of the molecule.¹ But the color change reverses in the same sequence on