

# Fluorescence Study of Acridone in W/O Microemulsions Perturbed by the Addition of Water-Soluble Polymers

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**Using steady state and time resolved fluorescence techniques, the photophysical parameters of acridone in w/o microemulsions of aerosol OT/isooctane were obtained. The results point to the existence of two species of acridone in equilibrium. In this equilibrium some water molecules are involved. The acridone species were localized at the micellar interface and in the water pool, respectively. The pseudo-equilibrium constant of the displacement process and the number of water molecules needed to displace acridone from the organic interface to the water pool were determined. In the presence of two different molecular weight polyvinyl pyrrolidone polymers the two species of acridone were also detected. The pseudo-equilibrium constant and the water molecules involved in the distribution equilibrium have also been determined and were compared with those obtained in nonperturbed microemulsions. Their differences are related with the average droplet occupancy and with changes on the water pool polarity induced by the addition of water soluble polymers.** © 1997 Academic Press

**Key Words:** w/o microemulsions; polyvinyl pyrrolidone; acridone; fluorescence techniques.

## INTRODUCTION

Water-in-oil (w/o) microemulsions generally consist of small water droplets surrounded by surfactant molecules and dispersed in an organic apolar solvent. The properties of the water droplets (size, viscosity, or polarity) are intimately related to the water content, given as the water–surfactant molar ratio,  $w_0 = [\text{water}]/[\text{surfactant}]$ .

The water droplets can solubilize several additives, electrolytes, enzymes, alcohols, and synthetic polymers. In this case the microemulsions are used in technological problems as separations and solubilization processes (1), oil recovery (2), or as microreactors in microparticle synthesis (3). The correct use of these microemulsions requires the knowledge of their size and their structural properties.

Recent work in this field has centered upon the effect of

additives on the size (4–6), on electrical percolation processes (7–9), or on the formation of microemulsion gels (10–12).

Fluorescence probing is one of the most extensively used methods to obtain structural properties of several kinds of micellar aggregates and of a great number of macromolecules (13). Using fluorescence probing and electrical conductivity measurements, the effect of two different water soluble polyvinyl pyrrolidone polymers, PVP K15 (MW = 10000) and PVP K25 (MW = 24000), on microemulsion properties is examined in this work. The microemulsion was composed of bis(2-ethylhexyl)sodium sulfosuccinate (aerosol OT, AOT), dissolved in isooctane with variable water contents and acridone was used as a fluorescence probe.

Acridone is a fluorescent molecule soluble in water and practically insoluble in isooctane which can be bound at the negatively charged interfaces (14). Thus, this probe can be distributed between two different regions of the microemulsion and may be used to obtain information on them. In particular, photophysical properties (emission spectra, fluorescence quantum yields, and fluorescence lifetimes) of acridone in w/o microemulsions of AOT solubilized in isooctane, with and without the water-soluble polymers, were determined.

The main objectives of the work were: (a) to test the ability of the acridone molecule to be used as a fluorescence probe in these w/o microemulsions; (b) to derive information on different regions of the microemulsions from the photophysical parameters of acridone; and (c) from the comparative analysis of results in the absence and in presence of polymers, to obtain information on the effect of the addition of PVP K15 and PVP K25 on the acridone distribution process and on the properties of filled microemulsions.

On the other hand, attractive interactions between w/o microemulsion droplets have recently been detected. In general, the presence of water-soluble polymers decreases the attractive interactions between droplets (15, 16), whereas the oil-soluble polymers increase them (15). However, some exceptions have been observed, i.e., the addition of the wa-

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ter-soluble polymer, polyoxyethylene glycol, to microemulsions of SDS increases the attractive interactions between droplets (17, 18). It is known that the electrical conductivity can be used to predict qualitatively the interaction between droplets in w/o microemulsions and for detecting percolation threshold (19). Therefore, in order to determine the effect of the addition of PVP K15 and PVP K25 on the interactions between droplets, electrical conductivities of all w/o microemulsions were determined.

## EXPERIMENTAL

### Materials

Bis(2-ethylhexyl)sodium sulfosuccinate (aerosol OT, AOT) was purchased from Fluka. It was purified by adding 30 g to 60 mL of warm methanol. The mixture was cooled in ice, centrifuged, and filtered to eliminate the sediment. The supernatant was stirred overnight with 3 g of activated charcoal. This was separated by filtration and the surfactant was recovered by removing the solvent with a rotatory evaporator. The residue was dried over  $P_2O_5$  for 12 h in an evacuated desiccator (20).

After drying, some water molecules remain bound to the surfactant. The analysis of the water concentration of the stock solution of AOT in isooctane with a Karl–Fisher titrator revealed the presence of 0.25–0.27 mol of residual water per mole of surfactant. This water content was considered as part of the total water concentration. Isooctane, spectroscopic grade from Fluka, was stored in sodium. Water was treated with a Milli-Q system from Millipore.

Polyvinyl pyrrolidone fractions were used as received from Fluka. The molecular weights provided by the manufacturer are 10,000 and 24,000 g/mol. Acridone is from Aldrich Chemical Co. and was purified by recrystallization in ethanol.

### Preparation of the Sample Solutions

The w/o microemulsions were prepared by adding the appropriate amount of water to stock solutions of AOT in isooctane and stirring until the solution became transparent. In the presence of polymers, microemulsions were prepared by adding the appropriate volume of a concentrated aqueous polymer solution to a steady w/o microemulsion and stirring until all the polymer was incorporated to the water core and the solution became transparent.

The incorporation of acridone in microemulsions was carried out by solubilization of the appropriate residue of the probe in microemulsions. This residue was obtained by solubilization of acridone in methanol and evaporation of the solvent by slow passage of  $N_2$ . The probe concentration was kept at 0.01 mM. The surfactant concentrations were 0.08 and 0.1 M. To study the effect of the composition on the

structure of the microemulsion, the water content was systematically modified between  $w_0 = 0.25–0.27$  and  $w_0 = 45$ . The polymer content, given as weight percentage of the polymer to water fraction, was kept constant at a value of 0.7% of PVP K15 and 1% of PVP K25. All measurements were performed at 25°C.

### Instrumentation

The electrical conductivity was measured using a CDM 83 (Radiometer, Copenhagen) conductivity cell and a low-conductivity cell. The cell constant was calibrated with solutions of KCl of known concentration (21).

Absorption spectra were recorded with a Perkin–Elmer Lambda 5 spectrophotometer. Steady state emission spectra were recorded with a Perkin–Elmer MPF-3 spectrofluorimeter. The fluorimeter analogic output was coupled to an interface and the digitized data were stored in a computer. The instrumental response, intensity at each wavelength, was corrected by means of a curve obtained through fluorescence standards. The excitation wavelength was 372 nm.

The fluorescence quantum yield of acridone was measured using acridone in aerated ethanol,  $\Phi = 0.62$  (22) as a standard. Appropriate corrections for changes in the refractive index were carried out (23).

Fluorescence decays were measured by the time-correlated single photon counting method using a Photon Technology International LS 100 apparatus. The excitation source was a gated lamp filled with hydrogen at a pressure of 17 psi,<sup>2</sup> with an electrode gap of 2 mm.

The decay data were analyzed by an iterative deconvolution procedure based on the Marquardt algorithm (24). The reduced  $\chi^2$  was used to test the quality of fit during the analysis procedure.

## RESULTS AND DISCUSSION

### Electrical Conductivity Measurements

Figure 1 shows values of the electrical conductivity,  $\kappa$ , of empty and filled microemulsions with different water contents.

In the absence of polymers, the conductivity increases until a water concentration of 1.5 M. At a greater water content the conductivity remains constant. No attractive interactions between droplets were detected in these microemulsions. No significant differences between conductivity values corresponding to microemulsions with different surfactant concentrations (0.08 and 0.10 M) were observed. This fact may indicate that there are no changes in the water droplet size of these microemulsions.

In the presence of PVP K15 similar values were obtained,

<sup>2</sup> 1 psi = 6894.757 Pa.

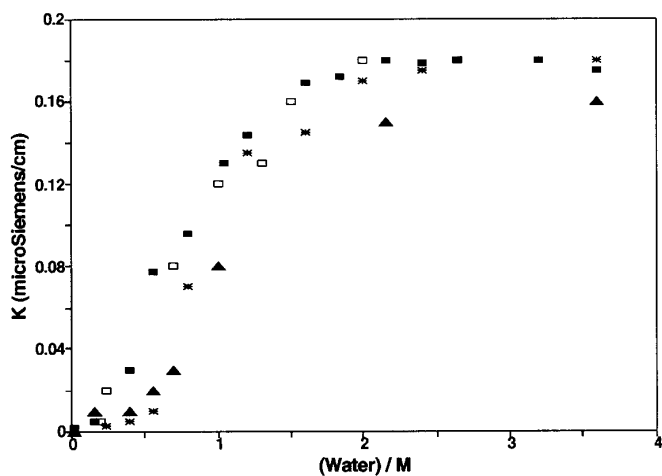


FIG. 1. Variation of the electrical conductivity of w/o microemulsions of: ■, (AOT) 0.08 M; □, (AOT) 0.10 M; \*, (AOT) 0.08 M and PVP K15; ▲, (AOT) 0.08 M and PVP K25.

whereas in PVP K25 filled microemulsions the conductivity decreased, in relation to the values corresponding to empty microemulsions. The decrease in the electrical conductivity may be due to a decrease in the droplet size when PVP K25 is added to microemulsions. Apparent hydrodynamic radii obtained by using dynamic light scattering confirm this assumption (25).

In any case attractive interactions between droplets were detected in the range of the water and polymer contents studied.

### Fluorescence Measurements

*Nonperturbed w/o microemulsions.* The absorption and emission spectra of acridone were recorded in water and in anionic micelles of AOT in isooctane with different water contents. Some of these spectra are shown in Figs. 2 and 3.

In 0.08 M AOT microemulsions with the lowest water content,  $w_0 = 0.25$ , and due to the insolubility of acridone in isooctane, the probe can be localized at the micellar interface. When the water content increases, spectral red shifts are observed and, at high  $w_0$  values, both the absorption and the emission spectra are similar to those of acridone in water. Thus, water displaces the fluorescent probe to the water pool. Isosbestic points in the absorption and emission spectra are centered around 372 and 400 nm, respectively.

Small differences between spectra of acridone dissolved in water and solubilized in microemulsions with high water content were detected and could be due to the different structure and physical properties of water molecules confined inside microemulsions. These results are consistent with those observed by other authors (26–28).

These results support the existence of two spectroscopically different species in the ground state, the one associated

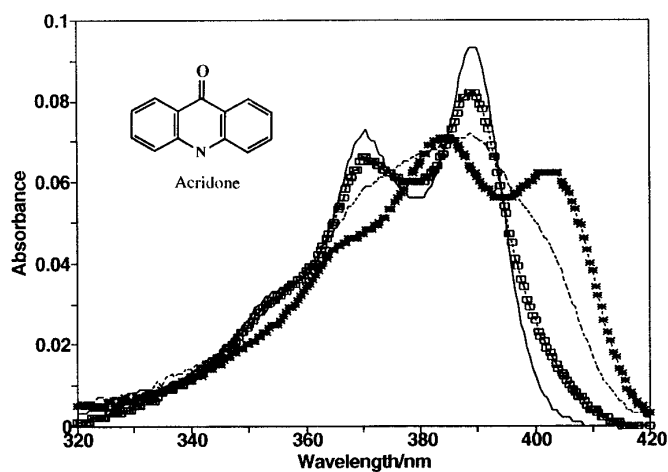
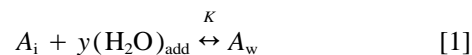


FIG. 2. Absorption spectra of acridone in: - \* -, water; —, AOT (0.08 M)/isooctane/ $w_0 = 0.25$ ; - □ -, AOT (0.08 M)/isooctane/ $w_0 = 5$ ; - · - ·, AOT (0.08 M)/isooctane/ $w_0 = 25$ .

to the interface, with emission bands centered around 400 and 424 nm, and the other ascribed to the acridone solubilized in the water pool, with two emission bands centered at 414 and 439 nm and a shoulder at 465 nm. The displacement process of the probe from the interface to the water pool can be expressed by



where  $A_i$  and  $A_w$  stand for acridone associated to the interface and solubilized in the water pool, respectively, and  $y$  is the number of water molecules needed to displace the acridone toward the water pool. We suppose that the distribution pro-

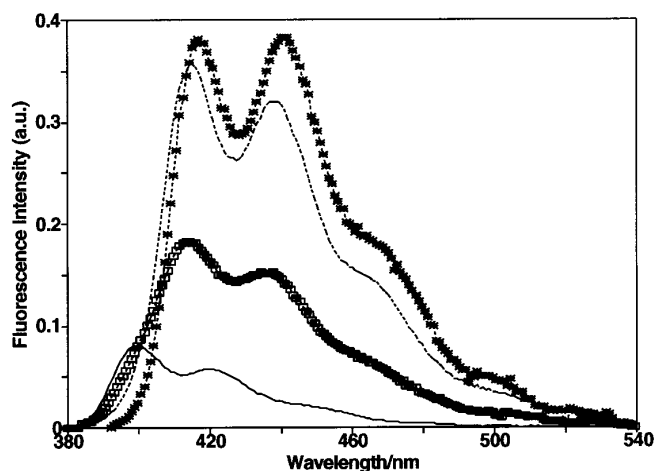


FIG. 3. Corrected emission spectra of acridone at excitation wavelength of 372 nm in: - \* -, water; —, AOT (0.08 M)/isooctane/ $w_0 = 0.25$ ; □, AOT (0.08 M)/isooctane/ $w_0 = 5$ ; - · - ·, AOT (0.08 M)/isooctane/ $w_0 = 25$ .

cess is related with the w/o microemulsion structure and as consequence could vary with the water content,  $w_0$ . Thus, we consider the parameter  $K$ ,  $K = (A_w)/(A_i)(H_2O)^y$ , as a pseudo-equilibrium constant for the transfer of the probe in the water pool.

From the quantum yield of fluorescence of acridone in w/o microemulsions of AOT in isooctane at different water contents,  $w_0$ , it is possible to determine the pseudo-equilibrium constant,  $K$ , and the  $y$  value. The fitting procedure is based on the following methodology (29): the fluorescence emission intensity, at a given wavelength, is the sum of the contribution of the acridone associated to the interface,  $I_i$ , and solubilized in the water pool,  $I_w$ :

$$I = I_i + I_w. \quad [2]$$

If it is considered that the fluorescence intensity is related with the quantum yield,  $\Phi$ , by  $I = \Phi \epsilon l C F_0$ , where  $\epsilon$  is the molar absorptivity at the excitation wavelength,  $l$  and  $C$  are pathlength (1.00 cm) and the probe concentration, respectively, and  $F_0$  is the intensity at the excitation wavelength. Taking into account that excitation was done at the wavelength of the isosbestic point, where  $\epsilon_i = \epsilon_w$ , Eq. [2] becomes

$$\Phi = \Phi_i(A)_i/(A)_0 + \Phi_w(A)_w/(A)_0, \quad [3]$$

where  $(A)_i$ ,  $(A)_w$ , and  $(A)_0$ , are, respectively, the concentration of acridone at the interface, in the water pool, and the total, and  $\Phi$  is the experimental quantum yield.

From the mass balance and the equilibrium conditions, the following equation for the experimental quantum yield can be obtained:

$$\Phi = \frac{\Phi_i + \Phi_w K (H_2O)^y}{1 + K (H_2O)^y}. \quad [4]$$

A correlation of  $\Phi$  vs water concentration allows, by fitting of Eq. [4], the evaluation of parameters  $K$ ,  $y$ ,  $\Phi_i$ , and  $\Phi_w$ . A suitable nonlinear least squares fitting procedure, based on a search in parameter space and minimizing the  $\chi^2$  value, was applied. The uncertainty in each parameter was established according to the curvature of the  $\chi^2$  hypersurface near the minimum (30). The results obtained in the microemulsions composed of AOT 0.08 and 0.10 M, have all been subjected to the same fitting procedure.

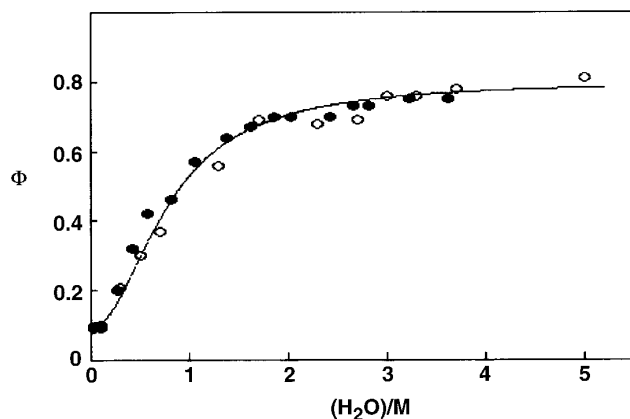
The best fitting parameters of the experimental data to Eq. [4] are the following:

$$\Phi_i = 0.095 \pm 0.0005$$

$$\Phi_w = 0.800 \pm 0.001$$

$$K = (1.6 \pm 0.1) M^{-1}$$

$$y = 2.0 \pm 0.06.$$



**FIG. 4.** Effect of the water content on the fluorescence quantum yield of acridone at different surfactant concentrations of aerosol OT solubilized in isooctane: Circles (AOT) = 0.08 M. Open circles (AOT) = 0.10 M. The curve is calculated according Eq. [4].

Figure 4 shows that there is excellent agreement between the experimental quantum yield and Eq. [4] using the above fitting parameters.

An important consideration is derived from the fact that Eq. [4] can interpret simultaneously all the results obtained in microemulsions made with different surfactant concentrations. As expected from the electrical conductivity data, no significant differences on the structural properties were detected when the surfactant concentration changes from 0.08 to 0.1 M. Conversely, in microemulsions of AOT dissolved in toluene at a fixed water concentration, the quantum yield of acridone changes when the surfactant concentration is modified between these values (31). This different behavior can be related to changes on the microemulsion structure caused by the solvent. These different structures have also been detected by other techniques (27).

Fitting parameters show that  $K$  remains constant in the whole range of  $w_0$  values studied. This fact indicates that, in these microemulsions, the probe distribution process is not a function of the water content and, as consequence, does not depend on the structural changes induced by the addition of water to the microemulsions.

On the other hand, examination of the fitting parameters shows that the quantum yield of acridone in the water pool is in a good agreement with that of the acridone dissolved in water,  $\Phi = 0.81$ . This fact supports the location of this acridone species inside the water pool. The fluorescence quantum yield of acridone decreases when the solvent dielectric constant decreases; i.e., the corresponding value of acridone in toluene is 0.062 (31). Thus the value obtained of acridone associated to the interface shows a relatively hydrophobic microenvironment corresponding to the organic interface. Finally, the parameter  $y$  can be related with the water molecules needed to hydrate the fluorescence probe.

TABLE 1

**Analysis<sup>a</sup> of Fluorescence Decays of Acridone in W/O Microemulsions of AOT/Isooctane (AOT) = 0.08 M, with Different Water Concentrations**

$w_0$	$A_1$	$\tau_1/\text{ns}$	$A_2$	$\tau_1/\text{ns}$	$\chi^2$
0.25	0.886	1.45	0.114	9.19	1.07
1	0.842	1.62	0.158	9.83	1.03
3	0.548	1.51	0.452	9.93	1.27
5	0.368	1.002	0.632	10.2	1.2
7	0.596	1.93	0.404	10.4	1.63
10	0.213	0.60	0.787	11.0	1.09
13	—	—	1	11.6	1.45
15	—	—	1	11.4	1.08
17	—	—	1	11.4	1.59
20	—	—	1	11.3	1.07
23	—	—	1	11.4	1.69
25	—	—	1	11.5	1.19
30	—	—	1	11.6	1.5
33	—	—	1	11.7	1.5
35	—	—	1	11.6	1.19
40	—	—	1	11.7	1.37
45	—	—	1	11.8	1.28

<sup>a</sup> Fit to function  $I(t) = A_1 \exp(-t/\tau_1) + A_2 \exp(-t/\tau_2)$ .

This value is in good agreement with those obtained for other fluorescence probes (29).

Fluorescence decays of acridone in water and w/o microemulsions of AOT solubilized in isooctane at different  $w_0$  values have been obtained. Acridone in aqueous solution decays with a single exponential ( $\tau_f = 14.9$  ns), but in microemulsions with low water contents the fluorescence decays exhibit a biexponential curve. Table 1 shows the parameters obtained for fitting experimental results to a biexponential function for microemulsions without polymers. The longer component has a lifetime close to that in aqueous solutions and is ascribed to acridone solubilized in the water pool. The shorter component has been ascribed to acridone associated to the organic interface. Examination of values presented in Table 1 shows that at a relatively high water content,  $w_0 \geq 13$ , acridone solubilized in the water core is predominant whereas at low water contents,  $w_0 < 13$ , two species are present in different percentages, as a function of the water concentration. Similar results have been obtained for microemulsions with higher surfactant concentration, 0.10 M. The data are presented in Table 2.

All the results presented above may indicate the existence of two spectroscopically different species of acridone in microemulsions of AOT dissolved in isooctane. The species are localized at the micellar interface and in the water pool, respectively. The two species have different photophysical properties and can be used to obtain information on the effect of polymer inclusion on the microemulsion properties.

*W/o microemulsions perturbed by the addition of water-soluble polymers.* In the presence of water-soluble poly-

mers, the w/o microemulsions were made with 0.08 M AOT dissolved in isooctane, different water contents, and 0.7% PVP K15 and 1% PVP K25, respectively.

The absorption and emission spectra of acridone in microemulsions containing PVP K15 and PVP K25 are represented in Figs. 5 and 6, respectively. The position of the maxima and the variation with the water content are similar to those in nonperturbed microemulsions; i.e., at a given polymer content, a red shift on the spectra is observed as the water content increases. The isosbestic points in the absorption and in the emission spectra appear around 372 and 400 nm, respectively. These values agree with the values in the absence of polymers. All these results involve the existence of the distribution process described by Eq. [1].

Figure 7 shows the effect of water content on the fluorescence quantum yield of acridone solubilized in microemulsions perturbed by the addition of polymers. Two different behaviors have been observed. In microemulsions with PVP K15, a larger water content is necessary to displace the probe from the interface to the water pool than in microemulsions with PVP K25, while microemulsions containing PVP K25 show similar behavior to the nonperturbed microemulsions.

To obtain the pseudo-equilibrium constant between two species of acridone in these new microemulsions, the experimental values of quantum yield vs water content have been fitted to Eq. [4] using the above mentioned nonlinear least squares fitting procedure. The best fitting parameters are summarized in Table 3. For comparative purposes the fitting parameters corresponding to the acridone displacement process in empty microemulsions are also included in the table. Figure 7 shows the excellent agreement between experimental results and the results calculated from Eq. [4] using the fitting parameters of Table 3.

Examination of the fitting parameters shows the following: (i) the addition of water-soluble polymers to micro-

TABLE 2

**Analysis<sup>a</sup> of Fluorescence Decays of Acridone in W/O Microemulsions of AOT/Isooctane (AOT) = 0.10 M, with Different Water Concentrations**

$w_0$	$A_1$	$\tau_1/\text{ns}$	$A_2$	$\tau_2/\text{ns}$	$\chi^2$
0.27	0.949	1.54	0.051	9.40	1.51
3	0.773	1.76	0.228	10.1	1.02
7	0.552	1.64	0.448	10.8	1.11
13	—	—	1	10.9	1.23
17	—	—	1	11.1	1.18
23	—	—	1	11.5	1.28
27	—	—	1	11.5	1.26
33	—	—	1	11.9	1.21
37	—	—	1	12.0	1.19
50	—	—	1	12.0	1.48

<sup>a</sup> Fit to function  $I(t) = A_1 \exp(-t/\tau_1) + A_2 \exp(-t/\tau_2)$ .

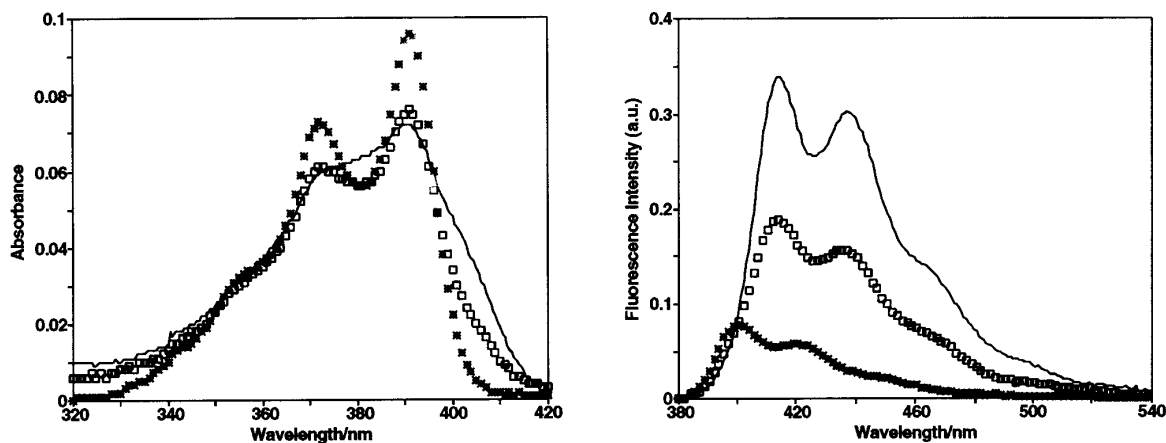


FIG. 5. Absorption and corrected emission spectra of acridone in isoctane in the presence of PVP K15: \*, AOT/isoctane/ $w_0 = 3$ ;  $\square$ , AOT/isoctane/ $w_0 = 10$ ; —, AOT/isoctane/ $w_0 = 35$ .

emulsions decreases the quantum yield of the two species of acridone as compared to the nonperturbed ones. This fact indicates that the presence of these polymers provides a certain hydrophobic nature to microemulsions and this effect is more pronounced in PVP K15 than in PVP K25. (ii) When comparing the number of the water molecules,  $y$ , involved in the distribution process with and without polymers, two different results were obtained. In the presence of PVP K25 the  $y$  value is the same as that in nonperturbed microemulsions, whereas in microemulsions with PVPK15,  $y$  increases drastically. (iii) The pseudo-equilibrium constant decreases when water-soluble polymers are added to microemulsions. The decrease of these constants can be due to changes in the dielectric constant induced by the presence of polymers.

An equation to describe the dependence of the pseudo-equilibrium constant with the dielectric constant of the reac-

tion medium was derived. In this expression  $K$  is related to the change in the standard free energy with the transfer of acridone from the interface to the water pool. To describe the change in the standard free energy with the transfer of a molecule of dipole moment  $\mu$ , from a medium of dielectric constant unity to one of dielectric constant  $D$ , we used the model proposed by Kirwood (32). According to this model, the variation of  $K$  with the dielectric constants of the interface,  $i$ , and of the water pool,  $w$ , is

$$\ln K = \frac{\mu^2}{r^3 RT} \left\{ \frac{D_w - 1}{2D_w + 1} - \frac{D_i - 1}{2D_i + 1} \right\}, \quad [5]$$

in which  $r$  is the radius of the molecule treated as a sphere and  $R$  is the gas constant.

In view of the fluorescence quantum yield of acridone at

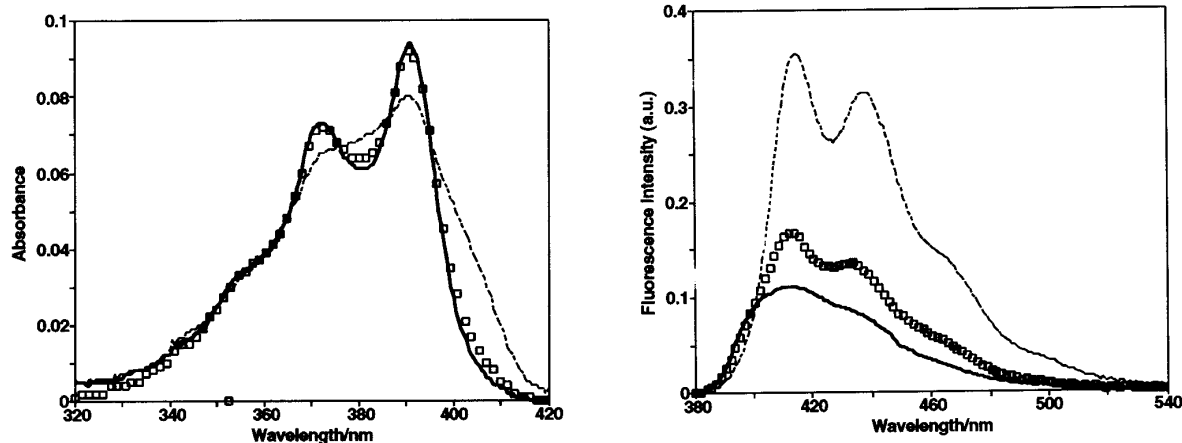


FIG. 6. Absorption and corrected emission spectra of acridone in isoctane in the presence of PVP K25: —, AOT/isoctane/ $w_0 = 3$ ;  $\square$ , AOT/isoctane/ $w_0 = 5$ ; ---, AOT/isoctane/ $w_0 = 40$ .

**TABLE 3**  
**Fitting Parameters of the Distribution Process Described by Eq. [1], for Acridone**  
**in W/O Microemulsions without and with Polymers**

Additive	$\phi_i$	$\phi_{wp}$	$K/\text{dm}^3 \text{ mol}^{-1}$	$y$
Water	$0.095 \pm 0.0005$	$0.800 \pm 0.001$	$1.6 \pm 0.1$	$2.0 \pm 0.06$
PVP K15 (0.7% w:w)	$0.069 \pm 0.0005$	$0.495 \pm 0.001$	$0.40 \pm 0.02$	$7.3 \pm 0.1$
PVP K25 (1% w:w)	$0.063 \pm 0.0005$	$0.590 \pm 0.001$	$0.95 \pm 0.06$	$1.8 \pm 0.05$

the interface, Table 3, we assume that the addition of polymers does not change the dielectric constant of the organic interface,  $D_i$ . From that and according to Eq. [5], a decrease in  $D_w$  induced by the presence of the polymer in the medium gives a decrease in the pseudo-equilibrium constant. The effect is more pronounced in the most hydrophobic water pool, i.e., with PVP K15.

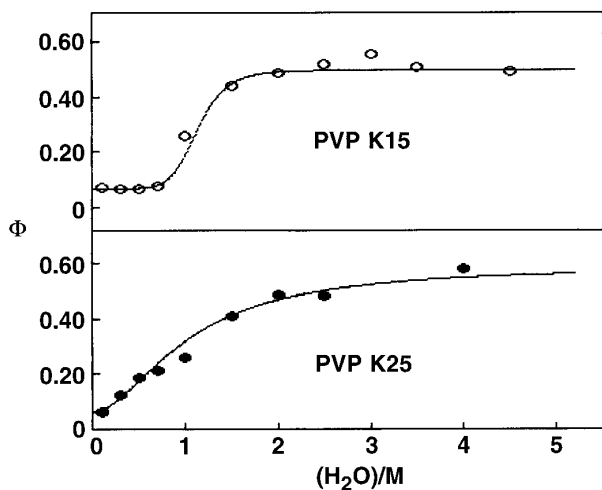
The comparative analysis of the distribution process parameters in microemulsions with and without polymers shows that the most significant changes are always detected in aggregates containing PVP K15. This fact cannot be explained in terms of microemulsion structural properties because the hydrodynamic radii of droplets containing 0.7% PVP K15 are similar to those found for empty microemulsions, while microemulsions filled with 1% PVP K25 have smaller hydrodynamic radii than the empty microemulsions (25). Nevertheless we make a naive interpretation in terms of the average droplet occupancy. By using the Poisson distribution we calculated an average droplet occupancy of 1 in the case of 1% PVP K25, while in the case of 0.7% PVP K15 the droplet occupancy is 2 (25). From that we can conclude that the double occupancy can be responsible for

the major changes detected on the acridone distribution process in PVP K15 filled microemulsions compared to empty or PVP K25 filled microemulsions.

The fluorescence decays of acridone in the w/o microemulsions perturbed by the addition of PVP K15 and PVP K25 with different  $w_0$  values were also obtained. In agreement with the steady state fluorescence results, at low water contents the fluorescence decay exhibits a biexponential curve. Lifetimes of these components are close to those in the absence of polymers and have been ascribed to acridone associated to the interface and solubilized in the water pool, respectively. At high water contents, only the component ascribed to acridone in the water pool is observed. The values of lifetimes of these species are presented in Table 4. The main difference with respect to the results obtained in the nonperturbed microemulsion is that the acridone species sol-

**TABLE 4**  
**Analysis<sup>a</sup> of Fluorescence Decays of Acridone in AOT/Isooctane**  
**Microemulsion Containing Different Water Concentrations and**  
**PVP K15 and PVP K25 Polymers**

$w_0$	$A_1$	$\tau_1/\text{ns}$	$A_2$	$\tau_2/\text{ns}$	$\chi^2$
PVP K15					
1	0.857	1.53	0.143	8.66	1.72
3	0.879	1.39	0.121	8.57	1.57
5	0.811	1.53	0.189	8.77	1.24
7	0.871	1.50	0.129	8.60	1.65
10	0.280	1.60	0.720	10.9	1.09
15	—	—	1	11.0	1.46
20	—	—	1	11.2	1.38
25	—	—	1	11.2	1.37
30	—	—	1	11.5	1.27
35	—	—	1	11.3	1.28
45	—	—	1	11.4	1.29
PVP K25					
1	0.879	1.58	0.121	8.73	1.04
3	0.579	1.96	0.421	9.67	1.19
5	0.363	1.93	0.637	10.3	1.25
7	0.342	1.87	0.676	10.42	1.22
15	—	—	1	11.0	1.29
20	—	—	1	11.0	1.21
25	—	—	1	11.6	1.17
40	—	—	1	11.3	1.21



**FIG. 7.** Effect of the water content on the fluorescence quantum yield of 0.08 M acridone in isooctane in the presence of polymers. Open circles represent values of PVP K15 and circles of PVP K25. Curves are calculated according Eq. [4] and parameters of Table 3.

<sup>a</sup> Fit to function  $I(t) = A_1 \exp(-t/\tau_1) + A_2 \exp(-t/\tau_2)$ .

ubilized in the water pool become predominant at high water concentrations, as one might expect from a low pseudo-equilibrium constant.

### SUMMARY

The fluorescence properties of acridone in w/o microemulsions of AOT/isooctane with different water contents support the existence of two spectroscopically different probe species, formed by incorporation of water into the microemulsions. The species are localized at the micellar interface and in the water pool, respectively. The pseudo-equilibrium constant obtained from the fluorescence techniques was 1.6 and the number of water molecules involved in this equilibrium was 2. Fluorescence decays confirm the existence of these species. The acridone species have different photophysical properties and were used to obtain information of the effect of the addition of water soluble polymers, PVP K15 and PVP K25, on the microemulsion properties.

In the presence of two different molecular weight polyvinyl pyrrolidone polymers, two acridone species were also detected. The pseudo-equilibrium constant, the water molecules involved in the equilibrium, and the quantum yield of the species in these new microemulsions were determined. Changes observed in these parameters relative to values in empty microemulsions are related to the average droplet occupancy and with the water pool dielectric constant.

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