Journal of the Serbian Chemical Society
JSCS@tmf.bg.ac.yu • www.shd.org.yu/JSCS

J. Serb. Chem. Soc. 72 (11) 1039–1044 (2007)
JSCS–3637

UDC 547.633.6+547.484:542.913
Original scientific paper

Synthesis and characterization of heterocyclic substituted fluoran compounds

SACHIN V. PATEL, MANISH P. PATEL* and RANJAN G. PATEL

Department of Chemistry, Sardar Patel University, Vallabh Vidyanagar–388 120, Gujarat, India

(Received 5 September 2005, revised 1 February 2006)

Abstract: New quinazolinone-substituted fluoran compounds were synthesized by reaction of keto acid, 2'-carboxy-2-hydroxy-4-*N*-pyrrolidinylbenzophenone with different quinazolinone derivatives in the presence of conc. sulphuric acid. All the synthesized fluoran compounds were characterized by spectroscopic methods (IR, ^{1}H-NMR and UV–visible spectroscopy) and elemental analysis. The fluoran compounds are colourless or nearly colourless and develop colour on contact with electron-accepting compounds.

Keywords: fluoran, keto acid, synthesis, quinazolinone.

INTRODUCTION

Spiro[isobenzofuran-1(3*H*),9'-xanthen]-3-one,[1] commonly known as fluoran, is a parent compound of a class of leuco dyes. Fluoran compounds are substantially colourless or nearly colourless and produce colouration when they are brought into intimate contact with electron-accepting substances, such as acid clays, activated clays, phenol formaldehyde resins, bisphenol, *etc*. Fluoran compounds containing various heterocycles, such as pyrrole,[2] pyridine,[3] morpholine,[4] benzothiazole[5] and piperazine,[6] have been reported earlier. Fluoran compounds are widely used in a variety of fields, such as pressure sensitive adhesive tap,[7] paint and toys,[8] thermochromic polymers,[9] thermochromic printing inks,[10] carbonless copying papers,[11] *etc*. In the present paper, the synthesis and characterization of nearly colourless pyrrolidinyl fluoran compounds prepared from various substituted quinazolinones are described.

EXPERIMENTAL

All the used raw materials were of commercial grade and were further purified by recrystallization and redistillation before use. All melting points (m.p.) are uncorrected and expressed in °C. The IR spectra of all compounds were recorded on a Nicolet Impact-400D FTIR spectrophotometer using the KBr pellet technique. The ^{1}H-NMR spectra were recorded on a Hitachi R-1500 instrument (60 MHz) using TMS as the internal standard. Chemical shifts are given in δ (ppm). The ab-

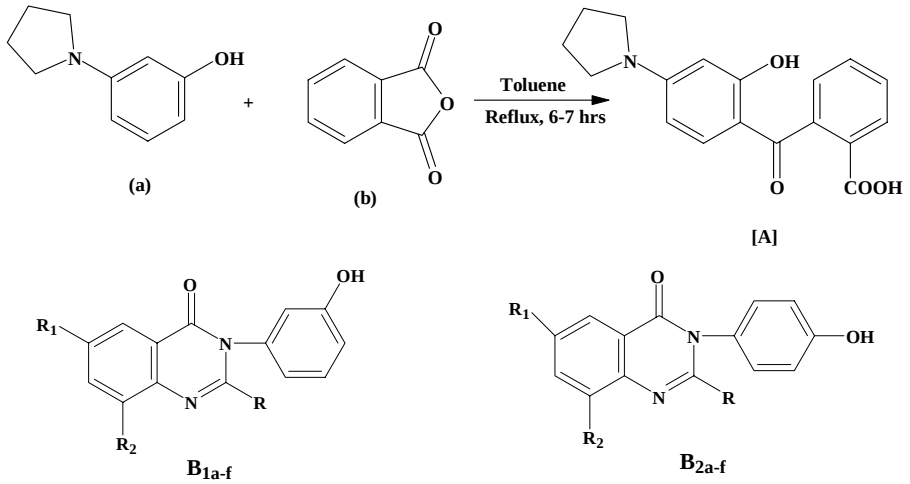
* Corresponding author. E-mail: patelmanish1069@yahoo.com
doi: 10.2298/JSC0711039P

sorption spectra (λ_{max}) of the compounds in chloroform and 95 % acetic acid were recorded on a Shimadzu UV-240 instrument.

General procedure for the preparation of ***A*** *and* $\boldsymbol{B_{1a\text{-}f}}$ *and* $\boldsymbol{B_{2a\text{-}f}}$

A mixture of 81.5 g 1-(3-hydroxyphenyl)pyrrolidine (**a**), 74 g phthalic anhydride (**b**) and 350 ml toluene were stirred at reflux for 6–7 h under dry conditions. The reaction mixture was cooled to room temperature and the precipitate was filtered off through a funnel, washed with methanol to obtain yellow coloured 2'-carboxy-2-hydroxy-4-*N*-pyrrolidinylbenzophenone (**A**),[12] m.p. 196–8 °C (Scheme 1).

Various quinazolinone derivatives $\mathbf{B_{1a\text{-}f}}$ and $\mathbf{B_{2a\text{-}f}}$ were prepared as reported in the literature.[13,14]



Scheme 1. 2'-Carboxy-2-hydroxy-4-*N*-pyrrolidinylbenzophenone [A]; quinazolinones $\mathbf{B_{1a\text{-}f}}$ and $\mathbf{B_{2a\text{-}f}}$; R = CH_3, C_6H_5; R_1 and R_2 = H, Br.

Preparation of fluoran compounds $\boldsymbol{C_{1a\text{-}f}}$ *and* $\boldsymbol{C_{2a\text{-}f}}$

2'-Carboxy-2-hydroxy-4-*N*-pyrrolidinylbenzophenone (**A**) (0.01 mol) and the corresponding quinazolinone $\mathbf{B_{1a\text{-}f}}$ or $\mathbf{B_{2a\text{-}f}}$ (0.01 mol) were dissolved in conc. H_2SO_4 (10 ml) and stirred at 80–85 °C for 56 h. After the completion of the reaction, the reaction mixture was poured into ice-cold water. The precipitate was filtered and washed with water. The acid-free compound was charged into water and the pH was made alkaline (pH 9–10) using aqueous NaOH to obtain the corresponding light coloured fluoran compound (Scheme 2, Table I). The product was filtered and washed with water until neutral. TLC showed a purple-coloured single spot in the solvent system toluene:ethyl acetate 7:3 (v/v).

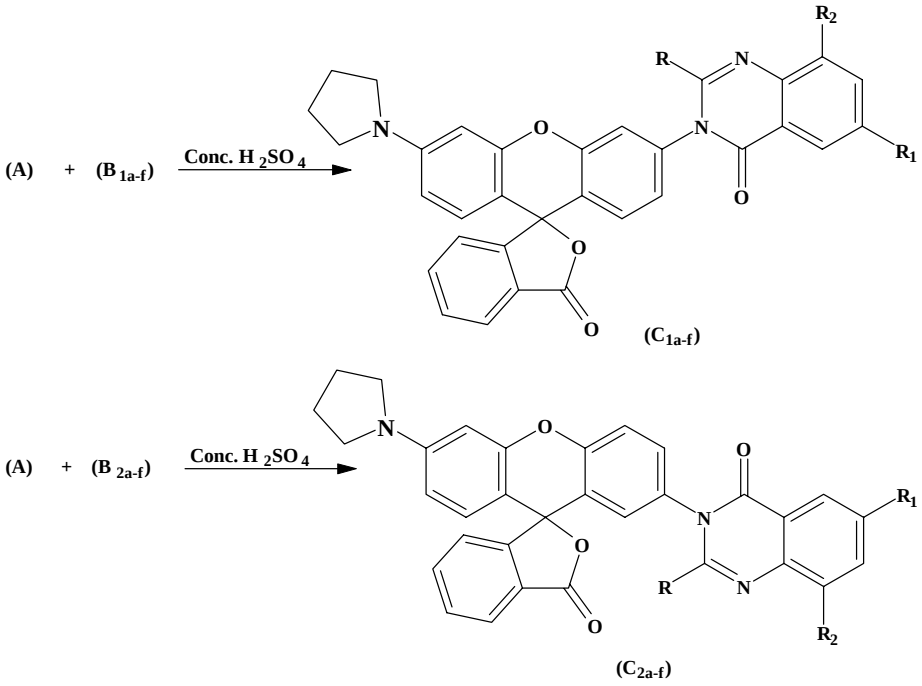
RESULTS AND DISCUSSION

The results of the chemical and spectroscopic analyses of the prepared compounds are given below.

*2-Methyl-3-(3-oxo-6'-*N*-pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen-3'-yl]-4(3*H*)-quinazolinone* (**C_{1a}**): Anal. calcd. for $C_{33}H_{25}N_3O_4$: C, 75.12; H, 4.77; N, 7.96. Found: C, 75.42; H, 4.45; N, 7.79. IR (KBr, cm^{-1}): 3070, 2858, 1441, 1355 (Ar-CH_3); 1775 (C=O group of lactone ring); 1660 (−C=O group of quinazolinone); 1595 (C=N); 1332 (C−N stretching of phenyl pyrrolidine). ^{1}H-NMR ($CDCl_3$, δ, ppm): 7.0–7.7 (*m*, 14H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 2.2 (*s*, 3H, $ArCH_3$), 1.9 (*m*, 4H, NCH_2CH_2).

3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen]-3'-yl]--4(3*H*)-quinazolinone* (**C$_{1b}$**): Anal. calcd. for $C_{38}H_{27}N_3O_4$: C, 77.40; H, 4.61; N, 7.12. Found: C, 77.35; H, 4.22; N, 7.03. IR (KBr, cm^{-1}): 1770 (C=O group of lactone ring); 1650 (C=O group of quinazolinone); 1595 (C=N); 1330 (C−N stretching of phenyl pyrrolidine). ^{1}H-NMR ($CDCl_3$, δ, ppm): 6.5–7.8 (*m*, 19H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 1.9 (*m*, 4H, NCH_2CH_2).

6-Bromo-2-methyl-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'--[9*H*]xanthen]-3'-yl]-4(3*H*)-quinazolinone* (**C$_{1c}$**): Anal. calcd. for $C_{33}H_{24}BrN_3O_4$: C, 65.35; H, 3.98; N, 6.92. Found: C, 65.78; H, 3.79; N, 6.53. IR (KBr, cm^{-1}): 3080, 2910, 1465, 1356 ($ArCH_3$); 1760 (C=O group of lactone ring); 1680 (C=O group of quinazolinone); 1605 (C=N); 1336 (C–N stretching of phenyl pyrrolidine); 565 (C−Br). ^{1}H-NMR ($CDCl_3$, δ, ppm): 7.0–8.1 (*m*, 13H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 2.2 (*s*, 3H, $ArCH_3$), 1.9 (*m*, 4H, NCH_2CH_2).



Scheme 2. Fluorans **C$_{1a-f}$** and **C$_{2a-f}$**.

6-Bromo-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen]-3'-yl]-2-phenyl-4(3*H*)-quinazolinone* (**C$_{1d}$**): Anal. calcd. for $C_{38}H_{26}BrN_3O_4$: C, 68.27; H, 3.92; N, 6.28. Found: C, 68.42; H, 3.89; N, 6.42. IR (KBr, cm^{-1}): 1760 (C=O group of lactone ring); 1670 (C=O group of quinazolinone); 1600 (C=N); 1332 (C−N stretching of phenyl pyrrolidine); 545 (C−Br). ^{1}H-NMR ($CDCl_3$, δ, ppm): 7.0–8.3 (*m*, 18H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 1.9 (*m*, 4H, NCH_2CH_2).

6,8-Dibromo-2-methyl-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),-9'-[9*H*]xanthen]-3'-yl]-4(3*H*)-quinazolinone* (**C_{1e}**): Anal. calcd. for $C_{33}H_{23}Br_2N_3O_4$: C, 57.83; H, 3.38; N, 6.13. Found: C, 57.62; H, 3.12; N, 6.34. IR (KBr, cm^{-1}): 3010, 2880, 1445, 1350 ($ArCH_3$); 1765 (C=O group of lactone ring); 1650 (C=O group of quinazolinone); 1594 (C=N); 1310 (C−N stretching of phenyl pyrrolidine); 532 (C−Br). ^{1}H-NMR ($CDCl_3$, δ, ppm): 6.9–7.4 (*m*, 12H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 2.2 (*s*, 3H, $ArCH_3$), 1.9 (*m*, 4H, NCH_2CH_2).

6,8-Dibromo-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen]-3'-yl]-2-phenyl-4(3*H*)-quinazolinone* (**C_{1f}**): Anal. calcd. for $C_{38}H_{25}Br_2N_3O_4$: C, 61.06; H, 3.37; N, 5.62. Found: C, 61.27; H, 3.28; N, 5.71. IR (KBr, cm^{-1}): 1775 (C=O group of lactone ring); 1650 (C=O group of quinazolinone); 1595 (C=N); 1320 (C−N stretching of phenyl pyrrolidine); 587 (C−Br). ^{1}H-NMR: ($CDCl_3$, δ, ppm): 7.0–7.3 (*m*, 17H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 1.9 (*m*, 4H, NCH_2CH_2).

2-Methyl-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen--2'-yl]-4(3*H*)-quinazolinone* (**C_{2a}**): Anal. calcd. for $C_{33}H_{25}N_3O_4$: C, 75.12; H, 4.77; N, 7.96. Found: C, 75.37; H, 4.84; N, 7.84. IR (KBr, cm^{-1}): 3052, 2880, 1472, 1362 ($ArCH_3$); 1760 (C=O group of lactone ring); 1680 (C=O group of quinazolinone); 1590 (C=N); 1330 (C−N stretching of phenyl pyrrolidine). ^{1}H-NMR ($CDCl_3$, δ, ppm): 7.0–8.1 (*m*, 14H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 2.2 (*s*, 3H, $ArCH_3$), 1.9 (*m*, 4H, NCH_2CH_2).

3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen]-2'-yl]--4(3*H*)-quinazolinone* (**C_{2b}**): Anal. calcd. for $C_{38}H_{27}N_3O_4$: C, 77.40; H, 4.61; N, 7.12. Found: C, 77.58; H, 4.23; N, 7.29. IR (KBr, cm^{-1}): 1760 (C=O group of lactone ring); 1660 (C=O group of quinazolinone); 1600 (C=N); 1333 (C−N stretching of phenyl pyrrolidine). ^{1}H-NMR ($CDCl_3$, δ, ppm): 7.5–8.3 (*m*, 19H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 1.9 (*m*, 4H, NCH_2CH_2).

6-Bromo-2-methyl-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'--[9*H*]xanthen]-2'-yl]-4(3*H*)-quinazolinone* (**C_{2c}**): Anal. calcd. for $C_{33}H_{24}BrN_3O_4$: C, 65.35; H, 3.98; N, 6.92. Found: C, 65.69; H, 3.76; N, 6.84. IR (KBr, cm^{-1}): 3060, 2852, 1492, 1362 ($ArCH_3$); 1755 (C=O group of lactone ring); 1650 (C=O group of quinazolinone); 1600 (C=N); 1325 (C−N stretching of phenyl pyrrolidine); 590 (C−Br). ^{1}H-NMR ($CDCl_3$, δ, ppm): 6.5–8.2 (*m*, 13H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 2.17 (*s*, 3H, $ArCH_3$), 1.9 (*m*, 4H, NCH_2CH_2).

6-Bromo-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen]-2'-yl]-2-phenyl-4(3*H*)-quinazolinone* (**C_{2d}**): Anal. calcd. for $C_{38}H_{26}BrN_3O_4$: C, 68.27; H, 3.92; N, 6.28. Found: C, 68.32; H, 3.88; N, 6.47. IR (KBr, cm^{-1}): 1765 (C=O group of lactone ring); 1660 (C=O group of quinazolinone); 1595 (C=N); 1325 (C−N stretching of phenyl pyrrolidine); 582 (C−Br). ^{1}H-NMR ($CDCl_3$, δ, ppm): 6.9–8.3 (*m*, 18H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 1.9 (*m*, 4H, NCH_2CH_2).

6,8-Dibromo-2-methyl-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),-9'-[9*H*]xanthen]-2'-yl]-4(3*H*)-quinazolinone* (**C_{2e}**): Anal. calcd. for $C_{33}H_{23}Br_2N_3O_4$:

C, 57.83; H, 3.38; N, 6.13. Found: 57.71; H, 3.14; N, 6.24. IR (KBr, cm^{-1}): 3045, 2895, 1425, 1350 ($ArCH_3$); 1770 (C=O group of lactone ring); 1645 (C=O group of quinazolinone); 1590 (C=N); 1310 (C−N stretching of phenyl pyrrolidine); 562 (C−Br). ^{1}H-NMR ($CDCl_3$, δ, ppm): 7.3–8.1 (*m*, 12H, ArH), 3.3 (*t*, 4H, NCH_2CH_2), 2.2 (*s*, 3H, $ArCH_3$), 1.9 (*m*, 4H, NCH_2CH_2).

6,8-Dibromo-3-(3-oxo-6'-N-*pyrrolidinylspiro[isobenzofuran-1(3*H*),9'-[9*H*]xanthen]-3'-yl]-2-phenyl-4(3*H*)-quinazolinone* (**C$_{2f}$**): Anal. calcd. for $C_{38}H_{25}Br_2N_3O_4$: C, 61.06; H, 3.37; N, 5.62. Found: C, 61.37; H, 3.59; N, 5.79. IR (KBr, cm^{-1}): 1765 (C=O group of lactone ring); 1670 (C=O group of quinazolinone); 1600 (C=N); 1320 (C−N stretching of phenyl pyrrolidine); 555 (C−Br). ^{1}H-NMR ($CDCl_3$, δ, ppm): 6.3–8.1 (*m*, 17H, ArH), 3.2 (*t*, 4H, NCH_2CH_2), 1.9 (*m*, 4H, NCH_2CH_2).

TABLE I. Physical data of fluorans **C$_{1a-f}$** and **C$_{2a-f}$**

Comp. No.	Compound C			Yield, %	M. p., °C	λ_{max} / nm		Colour on silica gel
	R	R_1	R_2			In 95 % acetic acid	In chloroform	
C$_{1a}$	CH_3	H	H	67	268	528, 369, 275	267	Purple
C$_{1b}$	C_6H_5	H	H	62	223	535, 318, 281	284	Purple
C$_{1c}$	CH_3	Br	H	60	250	532, 316, 284	280	Purple
C$_{1d}$	C_6H_5	Br	H	63	294	547, 316, 289	290	Purple
C$_{1e}$	CH_3	Br	Br	58	262	500, 379, 273	273	Purple
C$_{1f}$	C_6H_5	Br	Br	69	208	530, 367, 276	252	Purple
C$_{2a}$	CH_3	H	H	66	234	536, 380, 278	252	Purple
C$_{2b}$	C_6H_5	H	H	62	182	546, 378, 282	249	Purple
C$_{2c}$	CH_3	Br	H	61	225	549, 366, 279	247	Purple
C$_{2d}$	C_6H_5	Br	H	68	252	534, 355, 280	249	Purple
C$_{2e}$	CH_3	Br	Br	60	308	502, 365, 280	249	Purple
C$_{2f}$	C_6H_5	Br	Br	68	321	532, 372, 280	254	Purple

The IR spectra of all the synthesised fluoran compounds showed the disappearance of the characteristic absorption band of the OH group of quinazolinone and the appearance of C–N stretching of the phenyl pyrrolidine group and also appearance of the C=O group of the lactone ring at 1745−1790 cm^{-1} and at 1640−1700 cm^{-1} for the C=O group of quinazolinone and other characteristic absorption bands for the rest of the molecules.

Absorption spectra (λ_{max}) of the compounds in chloroform and 95 % acetic acid showed a single peak in chloroform due to the lactone ring and three peaks in 95 % acetic acid due to the quinone, zwitterion and lactone forms.[15,16]

CONCLUSIONS

The chromogenic fluoran compounds of the present investigation are soluble in organic solvent without colouration and show spontaneous colour formation in aqueous solution and acidic colour-activating substances.

И З В О Д

ДОБИЈАЊЕ И КАРАКТЕРИЗАЦИЈА ФЛУОРАНА СУПСТИТУИСАНИХ ХЕТЕРОЦИКЛИМА

SACHIN V. PATEL, MANISH P. PATEL и RANJAN G. PATEL

Department of Chemistry, Sardar Patel University, Vallabh Vidyanagar–388 120, Gujarat, India

Нова једињења флуорана уз супституцију киназолиноном добијена су реакцијом кето киселине, 2'-карбокси-2-хидрокси-4-*N*-пиролидинил бензофенона и различитих деривата киназолинона у присуству концентроване сумпорне киселине. Добијена једињења флуорана окарактерисана су спектроскопским методама (IR, ^{1}H-NMR и UV-vis спектроскопијом) и елементалном анализом. Једињењења флуорана су безбојна или слабо обојена, док у додиру са електрон-акцептор једињењима постају обојена.

(Примљено 5. септембра 2005, ревидирано 1. фебруара 2006)

REFERENCES

1. R.Muthyalal, *Chemistry and Applications of Leuco dyes*, Plenum Press, New York, 1997, p.159
2. S. Spatz, US 3,989,716 [*C.A.***86**/1977 44769n]
3. A. Takashi, K. Kohichi, K. Makoto, M. Makoto, I. Hiroshi (Sumitomo Chemical Co., Ltd.), JP 73 00,168 [*C.A.***80**/1974 28468j]
4. L. F. Dixon, (Holliday Dyes & Chemical Ltd.), GB 2,097,013 [*C.A.***98**/1983 73839p]
5. P. Theodor, R. Rolf, S. Ernst (Farbwerke Hoechst A.–G.), Ger.Offen. 2,036,817 [*C.A.***76**/1972 155606v]
6. Yamamoto Synthetic Chemical Co. Ltd., Brit. 1,336,955 [*C.A.***80**/1974 122413j]
7. N. Sakai, Jpn. Kokai Tokkyo Koho, JP 2004 91,769 [*C.A.***140**/2004 272003x]
8. M. Ito, Jpn. Kokai Tokkyo Koho, JP 2004 136, 477. [*C.A.***140**/2004 397413n]
9. N. Nakasuji, T. Kataoka, H. Inagaki, S. Nakashima (Pilot Ink Co., Ltd.), U.S. 4,028,118 (1977)
10. Y. Shibahashi, N. Nakasuji, T. Kataoka, H. Inagaki, U.S. 4,425,161 (1984)
11. V. G. Atkinson (Carrs Paper Ltd.), US 6071852 (2000)
12. G. Robert, P. Jean C. (Ciba–Geigy A.G.), U.S. 4,007,195 [*C.A.***86**/1977 173071c]
13. R. G. Patel, M. P.Patel, R. G. Patel, *J. Serb. Chem. Soc.* **69** (2004) 327
14. S. V. Patel, M. P. Patel, R. G. Patel, *J. Iran Chem. Soc.* **2** (2005) 220
15. A. V. Despande, E. B. Namdas, *J. Photochem. Photobiol., A* **110** (1997) 177
16. S. Kimura, T. Kodayashi, S. Ishige, Fuji Photo Film Co. Ltd., Japan, JP 71 12,312 (1968).