PYRYLIUM FERROCHLORIDE AS A DYE LASER

S. MORADIAN
Polymer and colour engineering
Department of Amirkabir University of Technology

M. RABIE, A. SABBAGH ALVANI
Colour reproduction and colour control
Department of the Iranian Colour Research Center

In the present study the preparation of 2,6 –di (4-methil-phenyl) – 4- (3- chlor – phenyl) pyrylium ferrochloride and its application as a dye laser were investigated. The pyrylium ferrochloride salt was prepared, purified by recrystallisation and characterized by FTIR, DSC and elemental analysis techniques. The purified product was dissolved in a suitable solvent in order to give it rigidity (i. e decreased rotational mobility) and hence increased lasing efficiency. The measured fluorescence and lasing efficiency carried out at the laser division of the Iranian Atomic energy organization showed suitable fluorescence and good laser efficiency.

Keywords: pyrylium ferrochloride, dye laser, fluorescence, lasing efficiency, characterization.

INTRODUCTION

Pyrylium salts belong to a very important class of cationic compounds with a trivalent oxygen atom and $6^{-}\Pi$ electrons in a six membered ring system.

The pyrylium cation as a moiety having the deficiency of one electron will have an electron accepting character [1].

Molecules in this group of compounds i. e the group of doner-acceptor chromogenic dyes manifest strong fluorescence which can be increased in suitable solvents giving them increased rigidity and decreased mobility.

Observation of the laser emission from some pyrylium dyes were first reported by the Schafer's group [2].

From 1991 on wards the Tomasz Kotowsky group, reported the laser effects of a large group of pyrylium dyes. It is worth to mention that many of the pyrylium dyes in suitable solvents or in combinations with polymers will manifest excellent lasing properties in the visible spectral range [1,2].

EXPERIMENTAL

Pyrylium ferrochloride salt was prepared by the modification of the standard method described by Dilthey [3] as follows. In a 200 ml round bottomed flask 17 cc of acetic anhydride was placed. 0,08 moles of 4-methyl acetophenone and 0,03 moles of 3-chloro benzaldenyde were added and the mixture was slowly stirred for 5 minutes. Then a total of 5 grams of ferric chloride were added slowly to the mixture the temperature of the reaction being kept between 0-5 degrees centigrades. The reaction was continued for one and a half hours at the same temperature. The temperature was then raised to 80°C and kept at this temperature for a further two hours.

The product was filtered, washed ten times with acetic acid and was then recrystallised from acetone [4].

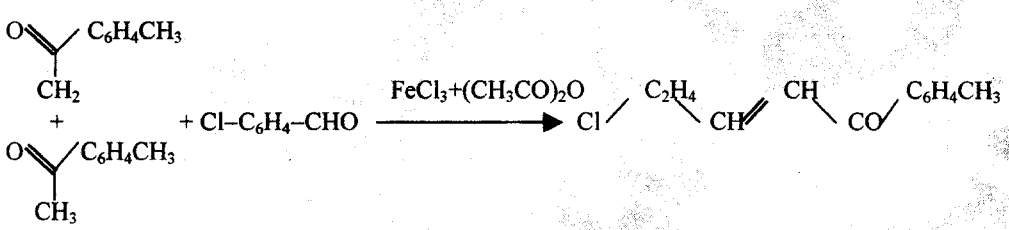
The mechanism of the reaction is as follows [5]:

1: Condensation of 3 chloro benzaldenyde with 4-methyl acetophenone.

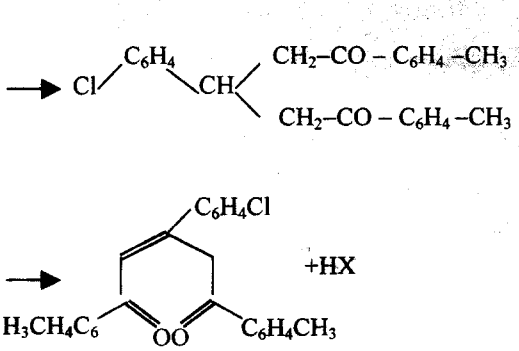
2: Condensation with 4-methylacetophenone.

3: Ring formation.

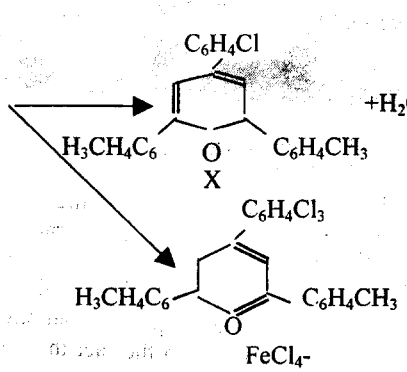
1)



2)



3)



The dye was then characterized using FTIR, DSC and elemental analysis techniques and its fluorescence and lasing action was investigated by the use of a fluorimeter and a nitrogen laser respectively.

RESULTS AND DISCUSSION

The FTIR and DSC of the prepared dye laser are shown in figure 1 and 2 respectively. The results from the elemental analysis is tabulated in table 1.

Table 1.

Element analysis of the prepared pyrylium ferrochloride

Molecular Formula	Element analysis					
	calculated			Found		
	C	H	N	C	H	N
$C_{25}H_{20}OFeCl_5$	52.77	3.55	<0.1	52.1	3.8	<0.1

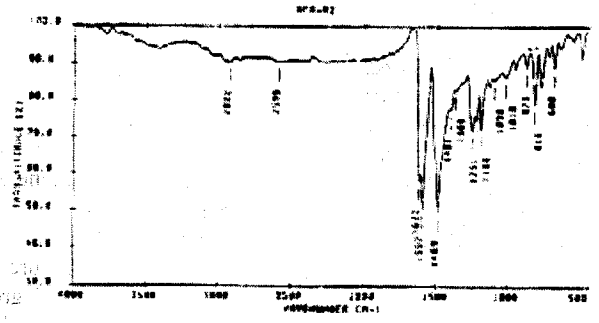


Fig.1. FTIR spectrum of the prepared pyrylium ferrochloride.

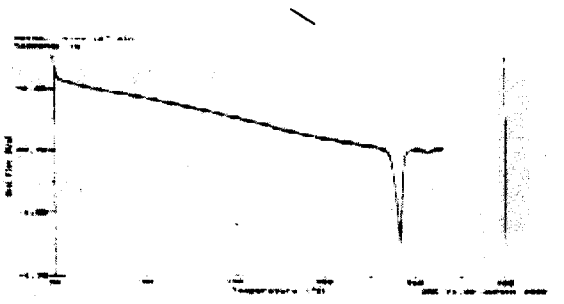


Fig.2. DSC of the prepared pyrylium ferrochloride.

The absorbtion and fluorescence properties and the corresponding lasing of the prepared dye are shown in figures 3 and 4 respectively.

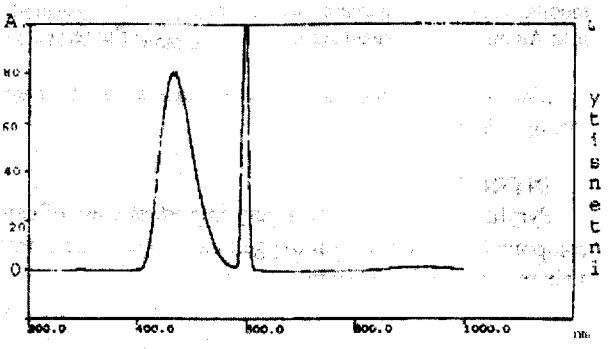


Fig.3. Absorption spectrum (484 nm) and Fluorescence spectrum (596 nm) for a 0.01 mol concentration of pyrylium dye in acetone.

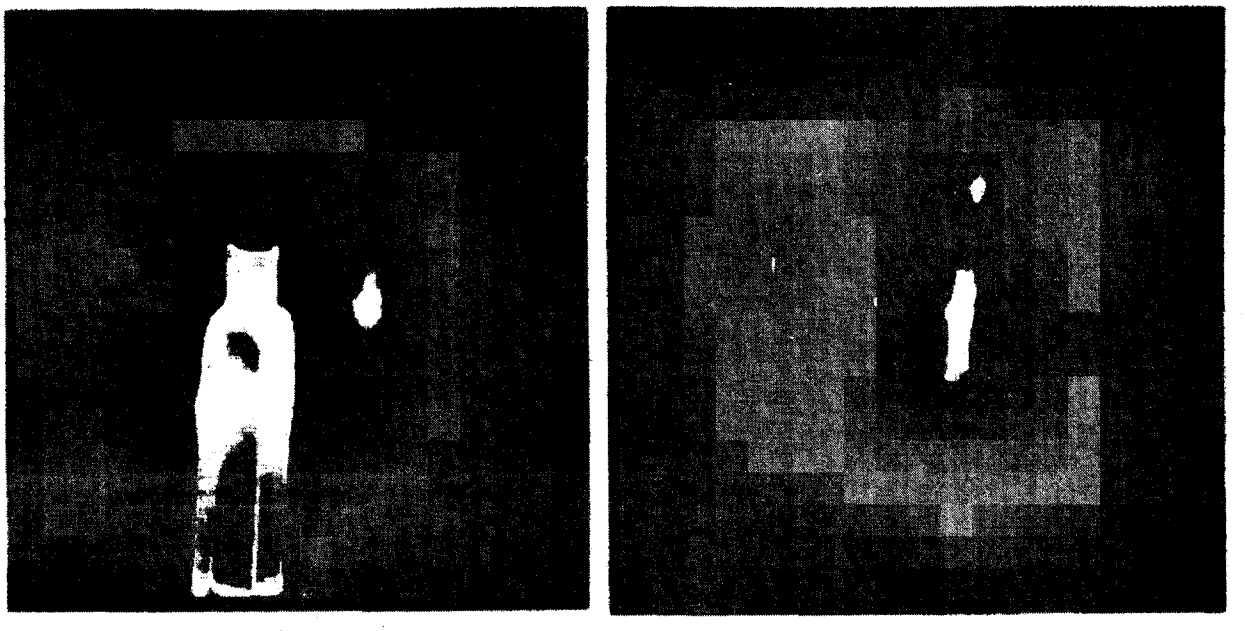


Fig.4. Lasing action of the prepared dye by nitrogen laser.

Dilthey observed a rather poor fluorescence for the three phenyl pyrylium dye under his investigation [3]. Contrary to his results results, we achived the laser emission for the prepared pyrylium dye. This can be attributed to the higher purity of our compound (it is known that impurities can have an adverse effect of quenching) and also to the fact that the choice of a suitable solvent causes the rigidification of the molecule increasing its fluorescence and laser efficiency [6,7].

CONCLUSION

The following conclusions can be summerised:

1 – Three phenyl pyrylium percholorate was prepared with hogh purity which was confirned by instrumental characterization techniques.

2 – The lasing properties of the product increased by the use of acetone as solvent.

[1] *Tomaz Kotovski.* Journal of luminescence, 1991, 50, p.39-45.
[2] J.opt. Soc. Am. B, 1985, vol. 2, № 7.
[3] *Dlthy.* J. pr. Chem., 1916, 94, 53.
[4] *Balaban and Nenitzescu* Annalen, 1961, 696, 97
[5] *Rene Lombard, Paul Stephan.* Societe chimique france Bulletin, 1958, p.1458.
[6] Encyclopedia of chemical technology. 1978, v. 14, p.42, p.554.
[7] *Hecht.* J., "versatility keeps dye lasers alive" laser focus world, 1992, 28 (7), p. 59-74.

S. Moradian, M. Rabie, A. Sabbagh Alvani

PERİLİUM FERROXLORİD BOYA ƏSASINDA LAZER KİMİ

Işdə 2,6 di-(4-metil-fenil) – 4 – (3xlor-fenil) perilium ferroxlorid duzunun alınması metodu və onun boya əssında lazer kimi işlədilməsi araşdırılmışdır.

С. Морадян, М. Рабие, А. Саббах Алвани

ПЕРИЛИУМ ФЕРРОХЛОРИД КАК ЛАЗЕР НА КРАСИТЕЛЯХ

В данной статье исследован метод получения соли 2,6 – ди-(4-метил-фенил) – 4-(3-хлор-фенил) перилиум феррохлорид и ее использование в качестве основы лазера на красителях.

Received:24.07.01