

Laser Characteristics from a Chalcone in Solution

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Abstract: *We have studied the laser spectra from conjugated chalcone in a few organic solutions. The laser of the chalcone appears to arise from its monomeric state. Chalcone in solutions of acetone or tetrahydrofuran (THF) was pumped by the third harmonics of an Nd: YAG (355 nm) for different concentrations and pump-pulse energies.*

Keywords: laser, chalcone, solvent effect

1. Introduction

A dye laser is a laser which uses an organic dye as the lasing medium, usually as a liquid solution. Compared to gases and most solid state lasing media, a dye can usually be used for a much wider range of wavelengths. The wide bandwidth makes them particularly suitable for tunable lasers and pulsed lasers. Moreover, the dye can be replaced by another type in order to generate different wavelengths with the same [1]. The development of the dye laser has been intimately tied to the systematic search for organic dye structure and dye media in which stimulated emission is observed. An array of photophysical properties such as absorptive, emission (fluorescence) yield, Stokes shift, and triplet formation influence the threshold and peak power lasing characteristics. The tailoring of dyes must also be contend with variables having to do with photochemical reactions which degrade dye and produce competitively absorbing product, thus influencing dye service life as other parameters. In the first comprehensive review of laser-dye structures and properties, Drexhage, compiled a table of about three hundred dyes that had been found to laser reasonably [2]. In a later survey covering reports on laser dyes through 1980, it has been identified that 546 dyes from various classes of structure work well with the advent of powerful laser or flash lamp pump sources and needs for high output and repetition rate, the requirements for photochemical stability of lasing media are extreme. For pulsed lasers, projections as high as 100W power, pulse frequency at 500Hz and 200mJ/pulse have been made [3, 4]. In a review of advances in laser-dye development notes that, the barrier to wider industrial use of the dye laser is due association with dye instability (photo degradation). The service life of a typical rhodamine dye in alcohol on excitation with the unfiltered light of a bank of flash lamps is limited to a few flashes [4].

Laser activity of chalcones

The literature survey has been shown that the laser activity of chalcones is very limited, a crystal of chalcone with two donor auxochromes at para position of ring A and ring B has been studied. It was found that the chalcone is chemically stable and the cutoff wavelength was found to be at 430 nm [5]. Sun et al, 2012 have also reported that the compound with such feature has shown a highly fluorescence properties. The heteroaryl chalcones in different solvents has studies and it was showed large red

shift in both absorption and emission spectra in polar solvents, the fluorescence quantum yield is mainly depend on the solvents properties [6]. The both of pyrimidine and pyrazole have a lone pair not involved in the π system, this lead to addition electron transfer to that of π system, known as $n \rightarrow \pi^*$ which also occur at longer wavelength. Pyrimidine is an electron-deficient ring leads to adsorption at shorter wavelengths while pyrazole is a rich one with an opposite properties [7].

The quantum yield to the photoproducts of pyrimidine has been investigated and it was found to be depend on the base auxochromes and phosphate group, phosphate group was shown negative effect, the quantum yield of 0.21 and 0.03 have also reported. The fluorescence of 2-amino-6-hydroxy-4-(3,4-dimethoxyphenyl)-pyrimidine-5-carbonitrile have been studied and shown the quantum yield ranged 0.0073 to 0.0893 [8].

The complexes of pyrimidine bearing β -ketoiminate ligands have also studied and have shown fluorescence quantum yield higher in solid state than in solution. The reported quantum yield were ranged from 0.55- 0.07 [9]. Whereas the fluorescence properties of biaryl pyrimidine nucleosides were shown quantum yield between 0.152 - 0.001 [10]. Samy A. El-Daly et. al (2013) had been measured the photophysical parameters such as absorption, molar absorptive, oscillator strength, dipole moment, fluorescence spectra, and fluorescence quantum yield of 3-(4-dimethylamino-phenyl)-1-(2,5-dimethyl-furan-3-yl)-propenone (DDFP) in different solvents. They showed that DDFP dye exhibited an essentially larger redshift of the emission spectra than the absorption one as solvent polarity increases. This fact indicates that the dipole moment of the DDFP dye is higher in singlet excited state than that in the ground one [11]. M. Gaberet. al (2009) were studied the spectral properties of 3-[40-dimethylaminophenyl]-1-(2-pyridyl) prop-2-en-1-one (DMAPP). Cu (II) complexes of were prepared and characterized by elemental analysis as well as spectral studies (IR and UV-vis), ESR, magnetic susceptibilities and thermal studies. The effect of different alcoholic solvents as well as the temperature on the complex formation is studied. The effect of Cu (II) ion on the emission spectrum of the free chalcone is also assigned. The stoichiometry, stability constant, absorption maximum and molar absorptive of the metal complexes as well as the effect of pH, temperature on complex formation are determined spectra photo metrically.

Adherence to Beer's law and Ringbom optimum concentration ranges are determined[12].

The spectral and photo physical properties of two chalcones containing electron donating and accepting groups with intermolecular charge transfer characteristics were synthesized and characterized using ^1H NMR, ^{13}C NMR and X-ray crystallography by MehboobaliPannipara et. Al (2015). Both compounds showed very strong solvent polarity dependent changes in their photophysical characteristics, namely, remarkable red shift in the emission spectra with increasing solvent polarity, large change in Stokes shift, significant reduction in the fluorescence quantum yield; indicating that the fluorescence states of these compounds were of intermolecular charge transfer (ICT) character. The solvent effect on the photophysical parameters such as singlet absorption, molar absorptivity, oscillator strength, dipole moment, fluorescence spectra, and fluorescence quantum yield of both compounds have been investigated comprehensively for both dyes. Anthony synthesized pyrene-containing chalcone derivatives and studied their optical properties in solution and in solid-state. The molecules showed a zero dipole moment at the ground state in contrast to the excited state that exhibited high polar property. The study also revealed that all the molecules were having emission activities that varied according to the substituents appended on the aryl group connected to the carbonyl function of the chalcone. In particular the methoxy functional group greatly contributed to the enhancement of the emission quantum yield in solid-state as compared to the solution [13]. Novel chloroquinoline based chalcones and their derivatives containing 1,2,3-triazole moiety were synthesized and characterized by spectral data and single crystal X-ray crystallography. Their absorbance and emission spectra were investigated and it was observed that compounds having electron withdrawing or halogen substituents on phenyl ring did not show emission. The ground state and excited state dipole moments of compound were determined using solvate chromic methods. The ground state dipole moment was found to be 1.081 D, while excited state dipole moment was calculated to be in the range of 11.969–3.801 D. Thermal stability was also investigated using thermo gravimetric analysis [14]

2. Results and Discussions

2.1 Amplified Spontaneous Emission (ASE) measurements of MEH-PPV

The ASE spectrum of chalcone in tetrahydrofuran (THF) at 1mM was obtained when this solution was excited by the third harmonic of the Nd: YAG (355 nm) The ASE peak was at 450 nm with a narrow spectral bandwidth 6 nm (FWHM). This peak coincided with the maximum of the fluorescence emission spectrum at this concentration as shown in Fig 1. One can immediately see that laser action was produced from the excimericstate.

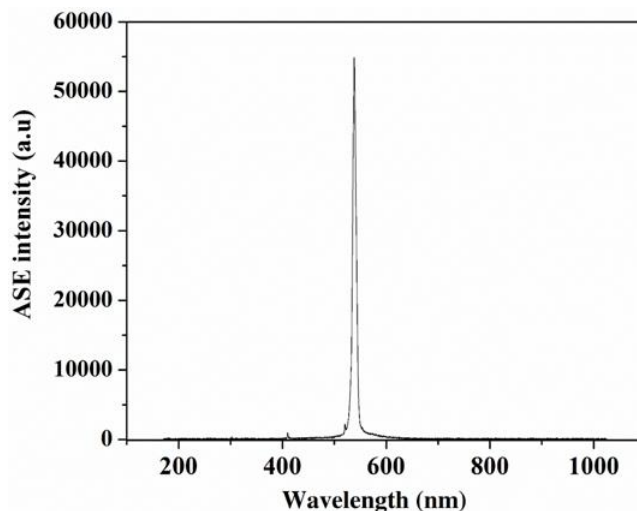


Figure 1: ASE spectrum of chalcone in THF at 1 mM

The variations of ASE intensities of chalcone as a function of pump pulse energy were recorded. The concentration was varied from 0.1 mM with steps of 1 mM the pump power was varied from 6mJ to 12mJ, the solvent in this case was acetone. It is seen in Fig 2 that as the pump power increased, the intensity of the ASE increased linearly for the acetone as shown Fig 2

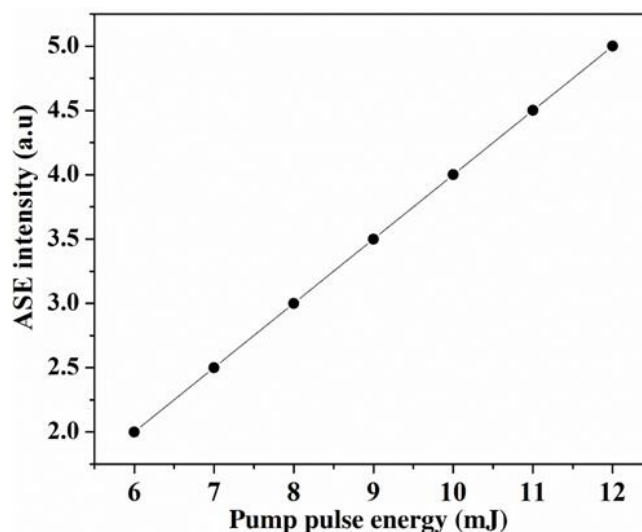


Figure 2: The pump pulse energy dependence of ASE intensity of chalcone in benzene at different concentrations.

Fig 3 shows the ASE intensity of chalcone dissolved in (THF) at different concentrations, where the pump pulse energy being kept at 9mJ. When the concentration increased the intensity of ASE increased until saturation almost sets in at 1 mM.

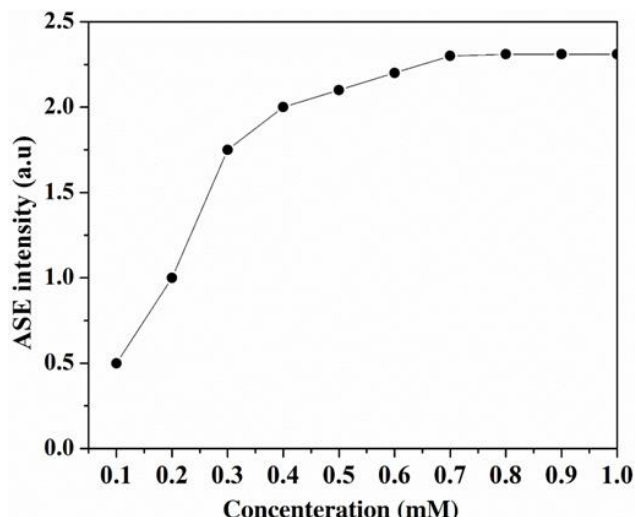


Figure 3: The pump pulse energy dependence of ASE intensity of chalcone in benzene at different concentrations.

3. Conclusion

In conclusion, the excited state dynamic of chalcone molecules was studied in this paper from the measurement of laser spectra. Our results show that the chalcone was capable of to produce high intense laser. This study reveals that these kinds of compounds (amino chalcones) will be promising laser materials in the future.

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