THE RELATIVE QUANTUM EFFICIENCY OF ANTHRACENE SOLUTION AS A FUNCTION OF LIGHT EXPOSURE DURATION

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Abstract

In this paper the effect of light exposure duration on Anthracene solution in chloroform is studied. It is found that: the Anthracene solution change its color when it is exposed to light, and that its relative quantum efficiency, Φ, decreases as the light exposure duration, t, increases and this govern by following empirical equation:-

$$\Phi = 0.7918 - 0.0762 \ln(t)$$

الكفاءه الكميه النسبيه لمحلول الانثراسين كداله لفترة تعرضه للضوء

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الخلاصة

لقد تم في هذا البحث دراسة تاثير فترة تعرض محلول الانثراسين للضوء. وقد وجد ان لون محلول الانثراسين يتغير عند تعرضه للضوء، في حين ان كفاءته الكميه النسبيه Φ تقل بزيادة فترة التعرض للضوء t وفقا للمعادله التجريبيه الاتيه:–

$$\Phi = 0.7918 - 0.0762 \ln(t)$$

1. Introduction

Anhtracene was discovered in 1832 a constituent of the Anthracene oil fraction of coal tar; and it is still today obtained from it. Pure Anthracene forms are colorless leaflets, which exhibit an intense blue-violet fluorescence in UV-light. The Anthracene molecule consists of three linear orthofused benzene rings, Figure1, and there are 14π- electrons associated with 16 bonds as a result, the aromatic character of Anthracene is weaker than that of naphthalene whose molecule consists of two benzene rings with 10π electrons associated with 11 bonds, the resonance energy of Anthracene is 86K cal/ mole.
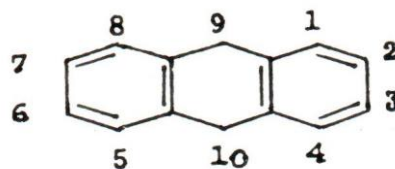

Figure 1: Anthracene Molecule

It is expected that, the large interatomic distance between mesocarbon atoms 9 and 10 does not, however allow the existence of a meso-bond. Later, Armstrong and Hinsberg [1] suggested the generally accepted structure of Anthracene, Figure 2. In this structure the meso-carbon atoms 9 and 10 being the terminal atoms of two conjugated double bonds.
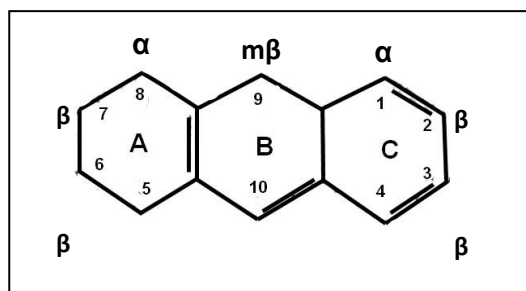
Figure 2: The Meso-Carbon Atoms

Addition at the 9, 10 positions, which are regarded as the terminal atoms of a diene system, occur readily and result in the formation of two fully aromatic end-rings. For instance, irradiation of strong UV-light of an Anthracene solution in the presence of oxygen yield Anthracene peroxide, Figure 3.
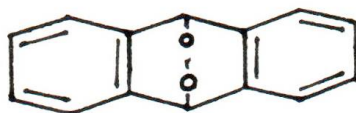
Figure 3: Anthracene Peroxide

The addition of chlorine or bromine gives 9, 10 dichloro or 9, 10 dibromo-Anthracene, respectively [1].

The relative quantum efficiency is defined by [2].

$$\Phi_2/\Phi_1 = area\ 2\ /\ area\ 1$$

Where Φ_1 and Φ_2 are the absolute fluorescence efficiencies for the substances 1, and, 2; area 1, and, area 2 are the areas under their fluorescence spectra. If the absolute fluorescence efficiency of one of the substances is known that of the other is then simply calculated. For clearance the absolute fluorescence efficiency is defined as the number of emitted photons per the number of absorbed photons [3].

2. EXPERIMENTAL PART

1. A chloroform is used as a solvent for Anthracene molecule to get a solution with concentration of 0.15 mole / liter.
2. Two species of this solution are used, one of them is exposed to UV-light and the other is not exposed.
3. The fluorescence measuring system, which is used to determine the fluorescence spectrum, is illustrated in Figure 4, and is described in ref. [4]
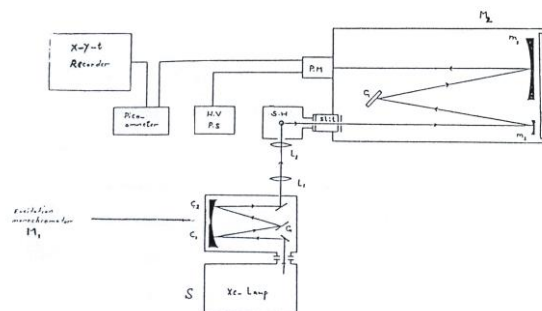


Figure 4: The Fluorescence Measuring System

4. The fluorescence spectrum of Anthracene solutions is measured using the cell, which is shown in Figure 5, and fully described in ref. [4].
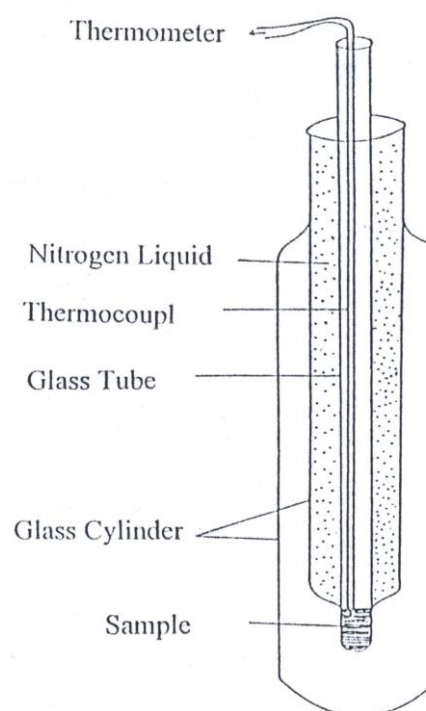
Figure 5: the Cell which is used to Measure the Spectrum of Solutions

3. Results And Discussion

1. It is found that Anthracene solution changes its color when it is exposed to UV-light.
2. The emission spectra of the colored solutions were found to be board spectra and displaced toward longer wave length. The broadening and displacement of each spectrum depend on the light exposure duration, and reach constant values when the exposure duration exceeds a week, Figure 6.
3. The intensity of the emission spectrum, which is related to the quantum efficiency, decreases as the light exposure duration increases, Figure 6.
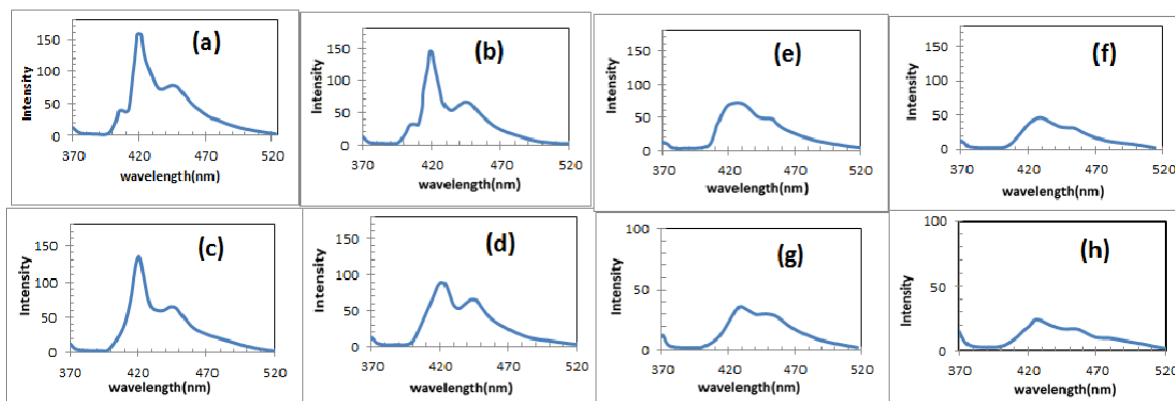
(---) the spectrum which is measured in the first day.
(-.-.-.) the spectrum which is measured in the second day.
(*-*-*) the spectrum which is measured in the third day.
(-..-) the spectrum which is measured in the fourth day.

(…) the spectrum which is measured after seven day.
(xxx) the spectrum which is measured after ten day.
(ooo) the spectrum which is measured after month.
(***) the spectrum which is measured after three months.

Figure 6: The Emission Spectrum of Anthracene Solution

4. As a result, the quantum efficiency, Φ, decreases with increasing the light exposure duration, t, as shown in Figure 7, according to the following empirical equation

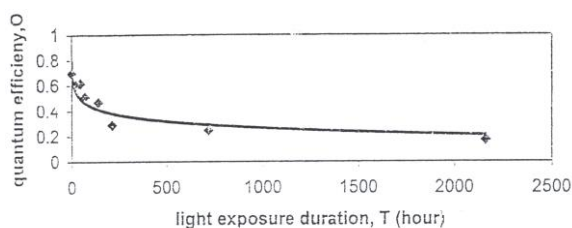$$\Phi = 0.7918 - 0.0762 \ln (t)$$

Figure 7: Quantum efficiency as a function of light exposure duration

These results can be interpreted as follows:-
The change of the Anthracene solution color, when it is exposed to UV- light, is attributed to the strong chemical bonding of Anthracene with oxygen, which is presented in the air, and with chlorine, which is existing in chloroform. Their product is characterized by separation of the halogen and the production of a radical when it is exposed to light.
Consequently photodimer, dianthracene, and different long polymer molecules, depending on the wavelength of the light and its duration, are produced. Of course, the color of polymer molecule will represent the Anthracene solution color.
The decrement of the quantum efficiency as the light exposure duration increases is due to the increment of the concentration of these products (photodimer, dianthracene, and polymer) and the same interpretation can be used to explain the emission spectrum shift. These results are in good agreement with those of others [4-11].

REFRENCES

1. Hans. Beyer, **1963.** *Organic Chemistry;* Germany.
2. Parker, C. A. **1968.** Photoluminescence of Solutions; Ph. D.; D. Sc.; F.R.M.S.; F.R.I.C.; Amsterdam – London – New York.
3. Birks, J. B. **1970.** *Photo physics of Aromatic Molecules;* Wiley- London.
4. Al-Tememee, N. A. **1989.** Spectral Study of Complex Formations of Some Aromatic Molecules; M.Sc. Thesis; Baghdad University.
5. Chandross, E. A. **1965.** Photolytic Discussion of Dianthracene; *J. Chem. Phys*, **43**:4175.
6. Chandross, E.A. and Ferguson, J. **1966**. Absorption and Fluorescence of Sandwich Dimers *J. Chem. Phys*.; **45**:397.
7. Mataga, N.; Torihash, Y. and Ota Y. **1967**. Studies on the Fluorescence Decay Times of Anthracene and Perylene Excimers in Rgid Matrices at Low Temperatures in Relation to the Structures of Excimers; *Chem. Phys. Lett*. **1**:385.
8. Chakrabartn, S. K. **1970**. Research Notes Anomalous Isotropic Luminscence from Anthracene Sandwich Dimers; *Mole. Phys.;* **18**:275.
9. Morris, J.M.. Intermolecular Forces Between Large Molecules: The Structure of Anthracene Stable Dimers; *Mole. Phys*. **28**(5):1167.

10. Kilmova, L. A.; Nersesova, C. N. and Glyadkovskii, V. I. **1976**. Evidence of Local State of Impurity Aggregates in Polycrystalline Solutions; *Opt. Spectrosc*. **40**:284.

11. Klimova, L.A.; Nersesova, C. N. and Glyadkovskii, V.I. **1968**. Short Communications on the Nature of Anthracene Aggregation in Solution; *Opt. Spectrose*; **25**:153.