The Effect of X- rays in some Optical Properties of the Thin Film Polystyrene (PS) Dissolved in Phenyl Methane (Toluene)

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Abstract

This research includes a study of some optical properties of (ps) before and after x-ray irradiation in doses 8010 rad with average (267 rad/min) for (30 min) ,the x-ray application where done in 4 steps, 7.5 mints for each step. The study of optical properties had included measurement of absorbance, transmission, refractive index has been measured for all concentration before and after irradiation, as well as the reflectivity, and absorption coefficient has been measured. The results shown that the value of absorbance and reflectivity, are increases as the solution concentration increased before and after irradiation. Then we seen the value of transmission are decreases as the solution concentration increased before and after irradiation while the refractive index value is increases as the solution concentration increased before increases as the solution concentration increased before and after irradiation and decrease after irradiation finally the value of absorption coefficient are decreased when the solution concentration increased before irradiation and increase after irradiation. All measurements are calculated at a constant temperature approximately to (25oC). The reason for the change at value of properties may be due to cross linking of polymer chains and then increased the average viscosity molecular weight for material (PS) that used in this research.

Key Words: X-ray, Ps, Optical Properties, Absorbance, Reflectivity, Transmission, Refractive Index, Absorption Coefficient.

DOI Number: 10.14704/nq.2020.18.6.NQ20178 **NeuroQuantology 2020; 18(6):21-26**

Introduction

Polymer is a Latin word consisting of two parts, poly which means (multi) and Mer that means (parts), so any word polymer means multipart [(1)]. The polymer is a large molecule that composed of building frequently small chemical molecules called (Monomers), which are linked with each chemical bonds forming the polymer. Polymerization is the operations that convert the molecules of low molecular weight to the material of high molecular weight. The scientists Flory and Carthelrs classified the operations of polymerization into two groups: The first group is called intensification polymerization (Polymerization of Condensation) or growth steps interactions which is defined as a common correlation of all the particles found in the vicinity of interaction such small monomers and polymers[(2)]. The second group called addition polymerization or sequential growth interactions. Sequential growth interaction known as successive commitments for the monomer molecules with a high molecular weight[(3)]. Polystyrenes (C8H8)n, which is a class of polymers, as evidenced by its name. As is well known, polystyrene is considered one of the most important technologies circulating globally in the packaging, packaging and thermal insulation of buildings.

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 02 May 2020 **Accepted:** 30 May 2020

This material is produced from the polymerization of raw styrene, which is an organic compound of its petrochemical species. Polystyrene is classified from the first class insulators globally [4]. One of the most important characteristics of polystyrene is that it is a good heat insulator due to its cellular composition, which works to expel heat and lack of soil, and all this according to its density, as it is considered an acoustic insulator, due to its absorption of shocks and leads to a decrease in the sound strength of refraction. As for use in packing, polystyrene is considered a lightweight material that is easy to carry and transport as it is a material that can bear the compressive strength, and scientists have proven that the higher the density, the greater its strength and the greater its compressive strength[5]. As for insulation in buildings, it maintains the building from several natural and chemical phenomena. Polymers are generally defined as materials that can be easily formed, and their origin is chemical compounds obtained from oil. These compounds have long chains, and they are arranged in a specific format and this arrangement gives plastics several advantages. The polymer, in chemistry, is a Latin word consisting of two syllables: poly and multiple meaning and the phrase «mir» means a molecule or the base ring or the repeating unit or monomer and means in Greek one part [6].

The expanded granular polystyrene material is manufactured in a three-stage production process, namely [7]:

1. The first stage of the granulation.
2. The maturation stage of the extended granules (partial replacement of air instead of gas).
3. The molding stage, in which the final production molds are filled with expanded granules, then the closed molds are injected with water vapor, which serves to expand the granules and dilute their surfaces, leading to their fusion.

Toluene, otherwise called Toulon is a sweet-smelling hydrocarbon. It is a dismal, water-insoluble fluid with the smell related with acetones. It is a mono-subbed benzene subsidiary, comprising of a CH3 bunch appended to a phenyl gathering. In that capacity, its IUPAC efficient name is methylbenzene. Toluene is prevalently utilized as a mechanical feedstock and a solvent. As the dissolvable in certain sorts of acetone, indelible markers, contact concrete and specific kinds of paste, toluene is some of the time utilized as a recreational inhalant [7] and has the capability of causing extreme neurological harm[8,9] .

Toluene Properties	
Chemical formula	C_7H_8
Density	0.87 g/mL (20 °C)[2]
Melting point	−95 °C (−139 °F; 178 K)[2]
Molar mass	92.141 g·mol^{-1}
Appearance	Colorless liquid[2]
Refractive index (n_D)	1.497 (20 °C)
Viscosity	0.590 cP (20 °C)
Boiling point	111 °C (232 °F; 384 K)[2]

Effect of Radiation on Polymers

The ionizing radiation prompts the occasions of huge changes in the qualities of polymers because of an assortment of physical and compound changes in the material when punctured by ionizing radiation as ionizing radiation adjusts the course of action of particles and atoms in the establishment of material which prompting an adjustment in the properties of the material. When would you be able to change the force of the episode radiation to change the properties of polymers it was changed into a circumstance where non-solvent or be combination, and identified with the idea of the progressions occurring affected by ionizing radiation polymer type or nature of the radiation [10].

1. Change of Chemical Properties

The chemical properties of polymers change when irradiated a result of the occurrence of one of the following two processes [2, 11]:

a. Degradation

The debasement procedure known as parting rot procedure and crushing the synthetic bonds in the fundamental chain of the polymer because of ionization and excitation forms during the radioactive rot [11].

b. The Cross Linking

Tangles or unintentional relationship process is characterized as those responses that lead to the connecting of polymer chains side crossing bonds bring about the end structures of work lead to the rise of complex mixes non-combination and futile prepared [8,12].

Change of Physical Properties

At the point when the polymers introduction to radiation, some physical properties has been change exhibited tentatively. The polymer shading during light will change, that relies upon the temperature through illumination and type radiation that utilized and the radiation portion and time of the light which shows the adjustment in the optical properties [12]. The electrical properties change because of the electrons disturbance in the polymer and the age free electrons through light which prompting an adjustment in the electrical conductivity for the polymer relying upon the vitality and transition of illumination. The expansion in normal atomic load of the polymer happen through the procedure of cross-connection and increment its hardness and less vulnerability dissolving as you get an expansion in Youthful's modulus [13]. The advancement of new applications for changes brought about by the attributes radiation of polymeric materials in innovative ventures, for example, hardware and clinical purifying and the Van Allen Belts space cause yearnings to examine the impact of radiation on polymers [10, 14-16].

The Practical Side

In this study, the substance used PS, which is a white color powder, numerical average molecular weight is ($\overline{Mw}$ = 104.15 g/mol) which made by Synthetic compounds Ltd Poole Britain (BDH Organization). The virtue refined Toluene additionally been utilized to planning research facility condenser dissipation approach to liquefying PS material, Table (2) shows the Concoction and Physical Properties of PS [6].

Table 2. Physical properties of polystyrene

Molecular weight g/mol	Transition temperature	Heat capacity	Melting point	Solubility
104.15 g/mol	373 K	0.04737 KJ/smK	0.0153 - 0.0168 KJ/mol	15.6-21.1 MPa

Crush and Illumination Layouts

A specific measure of polystyrene PS has been fertilizing the soil by repairman cylinder in the tablets structure that equivalent in mass, size and the mass of each disc is (1g), (0.85cm) width and (0.6cm) thickness after presentation to the weight of (12 ton/cm2) on the layouts with the end goal of simplicity of light procedure.

The application of x-ray delivered by (Siemens X-ray) machine that gives (160KV). All discs put in area (24x20) cm^2, the x-ray is (267 rad/min) for (30min) at four steps, i.e. (7.5min) for each step, so the total dose equal to (8010rad).

Preparation Models

The arrangement of the diverse weight groupings of the polymer extending from (0.1-0.6%), an expansion 0.1% for each once by breaks down specific loads of polymer material (PS) in a given volume of the dissolvable (refined water) and arranged these focuses weight of the material illuminated and non-lighted and utilized the relationship the accompanying to remove the weight fixations (2):

$$\text{The weight concentration} = \frac{\text{Solute mass (g)}}{\text{Solute mass (g)} + \text{mass of solvent (g)}} \times 100\%$$

While the Molarity Concentration calculating by the following relationship:

$$\text{The Molarity Concentration} = \frac{\text{Material mass (g)}}{\text{The molecular weight of the material} \times \text{volume of solution (lit)}}$$

Results and Calculations

Measurement

a. Absorbance and transmittance:

The absorbance and transmittance was estimated by the framework (CARY 100Conc) which works inside the scope of bright and noticeable districts where the frequencies running between [(190-1000) nm], and the customized consequently to complete a study all things considered and show the frequency that gets most extreme absorption.The absorbance and transmittance has been estimated for different convergences of the arrangement when light and placed the outcomes in tables (2,3), individually, and afterward painted a realistic connection between the absorbance when illumination with fixations as appeared in Figure (1) and furthermore painted a realistic connection between porousness when light with focuses as appeared in figure (2).

Table 2. The absorbance values of the solutions before and after irradiation at room temperature (25°C) and various concentrations.

Concentration (C %)	Absorbance (A) before Irradiation	Absorbance (A) after Irradiation
0.1	1.466	1.582
0.2	1.814	1.994
0.3	2.085	2.295
0.4	2.248	2.396
0.5	2.3	2.453
0.6	2.367	2.497

NeuroQuantology | June 2020 | Volume 18 | Issue 6 | Page 21-26 | doi: 10.14704/nq.2020.18.6.NQ20178

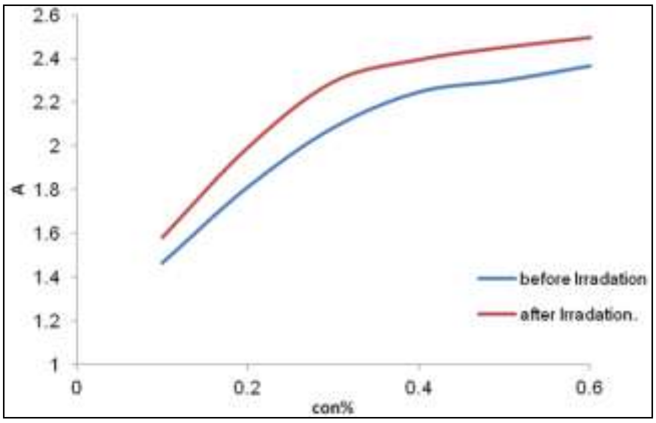

Fig. 1. Absorbance change with the concentration before and after irradiation

Table 3. Transmittance values of the solutions before and after irradiation at room temperature (25°C) and various concentrations.

Concentration (C %)	Transmittance (T) Before irradiation.	Transmittance (T) After irradiation.
0.1	6.499	3.799
0.2	3.495	2.099
0.3	1.715	1.236
0.4	1.210	0.809
0.5	0.755	0.387
0.6	0.493	0.266

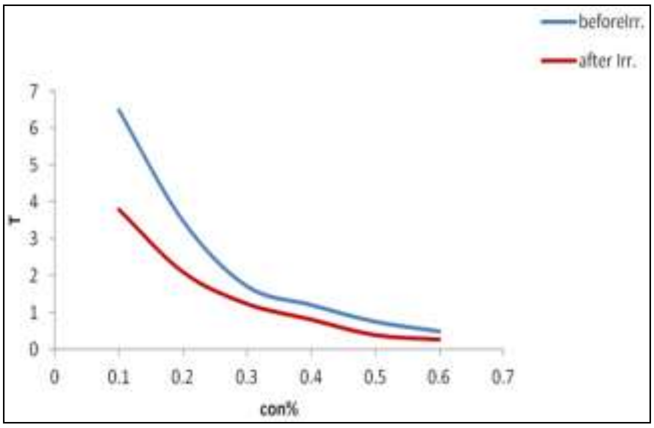

Fig. 2. Transmittance change with concentration before and after irradiation

Concentration (C) %	refractive index before irradiation (n)	refractive index after irradiation (n)
0.1	1.3326	1.3318
0.2	1.3331	1.3324
0.3	1.3335	1.3328
0.4	1.3338	1.3331
0.5	1.3342	1.3334
0.6	1.3346	1.3337

b. Refractive Index

To quantify the refractive index of the polymer arrangements coefficient, it was utilized gadget (Abbe's Refractometer) which quantifies the refraction of reality arrangements coefficient inside the range (1.3 - 1.77). The gadget is set with the goal that it can peruse the refractive file of the frequency (589nm) (sodium range line) on the scale instrument. The refractive list was estimated for various groupings of the arrangement coefficient esteems when illumination and placed the outcomes in the table (4) and afterward painted a realistic connection between the refractive record when light with fixations as in Figure (3).

Table 4. The refractive index values for solutions before and after irradiation

Concentration C %	K\` before irradiation cm^{-1}	K\` after irradiation cm^{-1}
0.1	12.252	15.22
0.2	8.867	11.32
0.3	6.287	9.07
0.4	4.724	7.239
0.5	3.605	5.406
0.6	2.901	4.574

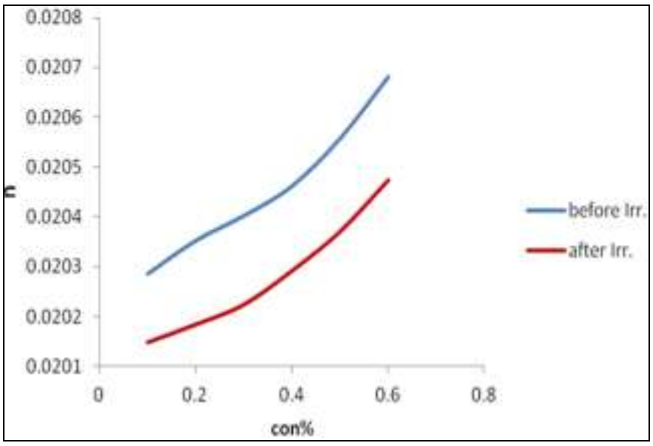

Fig. 3. The change of refractive index with concentrations of samples before and after irradiation

Calculation

a. The absorption coefficient:

Subsequent to estimating the absorbance by utilizing the spectroscopy framework for all convergences of the arrangement when light to know the length of the optical way, it has been utilized a relationship (1) to discover a coefficient of ingestion subsidence for all fixations esteems when illumination (1) and put the outcomes in Table (5). Figure (4) shows the connection between the assimilation coefficient esteems when illumination with fixations graphically.

$$A = K'CL \qquad (1)$$

K'= The Coefficient of Absorption Subsidence,C=

eISSN 1303-5150

Concentrations of the solution.
L= Optical path length through the solution = (1 cm), which is width of a cell spectroscopy system.

Table 5. The Coefficient of Absorption Subsidence values before and after irradiation of different concentrations solutions at room temperature (25°C)

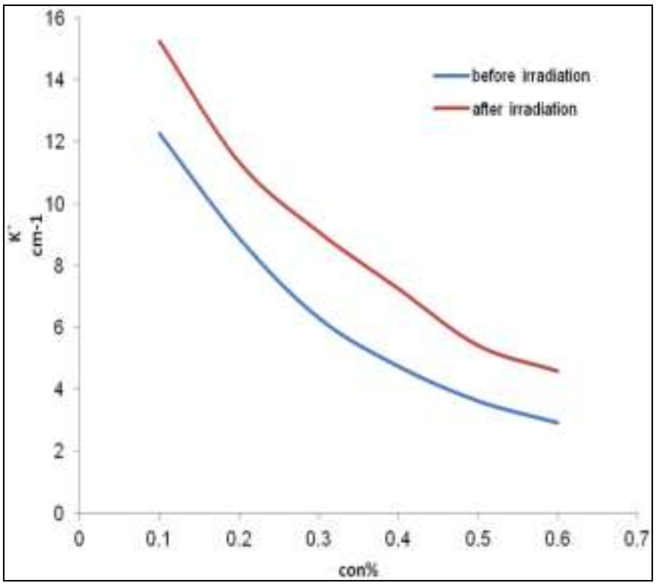

Fig. 4. The Coefficient of Absorption Subsidence changed with the samples concentration before and after irradiation

b. Reflectivity

In the wake of estimating the refractive index for all groupings of the arrangement when light, there found the reflectivity esteems when illumination utilizing the relationship (2) (1) and put the outcomes in Table (6). Figure (5) shows the connection between the reflectivity when illumination with focuses.

$$Re = (1-n /1+n)^2 \qquad (2)$$

Where: Re: Reflectivity and n: Refractive index.

Table 6. Reflectivity values before and after Irradiation of different Concentrations Solutions at Room Temperature (25°C).

Concentration C %	Re (Before irradiation)	Re (After irradiation)
0.1	0.020148	0.020285
0.2	0.020184	0.020352
0.3	0.020224	0.020402
0.4	0.020292	0.020462
0.5	0.020371	0.020558
0.6	0.020474	0.020682

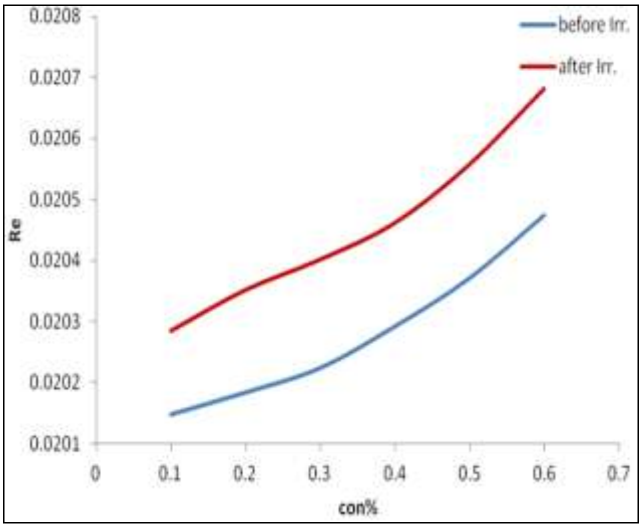

Fig. 5. Reflectivity changed with the Samples Concentration before and after irradiation

Conclusion

From the results and graphs for optical properties that obtained we can conclude the following:

1. The absorbance (A) and reflectivity (Re) increases with increasing concentrations of the solution before and after irradiation, as shown in the graphs (1, 5).
2. The Transmittance (A) decrease with increasing concentrations of the solution before and after irradiation, as shown in the graphs (2). 25
3. The Refractive index (n) increase with increasing concentrations of the solution before irradiation and decrease after irradiation, as shown in the graphs (3).
4. The coefficient of Absorption (K) decrease with increasing concentrations of the solution before irradiation and increase after irradiation, as shown in the graphs (4).

The adjustment in the physical optical properties is because of the expansion of the arrangement focus, which prompts expanded consistency, which builds the quantity of polymer atoms bonds with water particles.
The expansion in the quantity of atoms adding to the increment in the quantity of polymer anchors that add to the assimilation of wave vitality. Or on the other hand it might be expected to be disgusting circumstance in the arrangement with the nearness of polymeric atoms separately in arrangement and while expanding ceaselessly expanding association of inward focus , and the fixation will keep on expanding prompting a deviation in a basic direct relationship and may prompt complex collaborations.

The Large particles of polymer are influenced by the powers interior polymer chain, just as one atom of this polymer in a roundabout way impact on another atom by methods for a common inward collaboration. The inward communication which causes the merger between the polymer particles and water might be answerable for a reduction in assimilation coefficient at increment the convergence of solvents in light of the fact that the polymer atoms moving toward the dissolvable particles and leaving an exceptionally thin space between them.

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