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The Effect of Doping Talha Gum Arabic with Iodine on the Absorption Coefficient and Energy Gap

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Abstract: *Five samples from Talha Gum Arabic were doped with iodine having concentrations (0.1, 0.2, 0.3, 0.4, 0.5 ppm).The energy gap were studied using ultraviolet spectrophotometer. The d-spacing and the crystal nano sizes were studied using X-ray diffraction device. Increasing iodine concentration decreases nano crystal size and d-spacing. The increase of iodine concentration decreases the energy gap to take the values (2.364, 2.356, 2.352, 2.345, and 2.339 eV).*

Keyword*: Gum Arabic ,Talha, Nano size, d-spacing, Energy gap, Absorption coefficient*

Introduction

The prefix *nano* in the word *nanotechnology* means a billionth (1×10^9) [1]. Nanotechnology deals with natural and artificial structures on the nanometer scale [2]. While the word *nanotechnology* is relatively new, the existence of functional devices and structures of nanometer dimensions is not new, and in fact such structures have existed on Earth as long as life itself [1]. Its infuse scientific branches from biology, chemistry, physics and engineering, hence called interdisciplinary subject opens new doors of applications[3]. It is important to distinguish here between 'nanoscience' and 'nanotechnology', nanoscience is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at larger scale ,while the nanotechnologies are the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale [4,5].

Nano materials/nano objects are materials that have one or more nano-sized external dimensions [2,6].The nano scale is the last step of the material before the atom. If all three dimensions of the material are less than 100 nm, such materials are called nano particles, quantum dots, nanoshells, nanorings and nanocapsules; if only two dimensions are less than 100 nm, they are called nanotube, nanowire and fiber; if only one dimension is less than 100 nm, it is called thin film, layer and coating. Optical, mechanical, electrical and color properties of the same material in macro/micro and nano size may be different or even the opposite of other scales[7].Some properties that do not occur in macro size may appear in nano size.The main reason for this is the increased surface area/volume ratio with decreased material size and the non-continuous dimensions in nano-scale compared to macro dimensions [8,9,10].As the surface area/volume ratio increases, materials with low molecular weight can be formed [9,10] .

Although a few scientists had done related work earlier, nanotechnology didn't really get going until the second half of the twentieth century[11].The concepts that seeded nanotechnology were first discussed in 1959 by renowned physicist Richard Feynman in his talk *There's Plenty of Room at the Bottom*, in which he described the possibility of synthesis via direct manipulation of atoms. In 1960, Egyptian engineer Mohamed Atalla and Korean engineer Dawon Kahng at Bell Labs fabricated the first MOSFET (metal–oxide–semiconductor field-effect transistor) with a gate oxide thickness of 100 nm, along with a gate length of 20 µm [12]. In 1962, Atalla and Kahng fabricated a nanolayer- Base metal- semiconductor junction (M-S junction) transistor that used gold(Au) thin films with a thickness of 10 nm[13]. The word "nanotechnology" was introduced for the first time into a scientific world by N. Taniguchi at the international conference on industrial production in Tokyo in 1974 in order to describe the superthin processing of materials with nanometer accuracy and the creation of nano-sized mechanisms [14].

Feynman put forward two other themes in his lecture. First, he had envisaged the possibility of making machines that could pick up and place single atoms to make chemical compounds. In 1981, Binnig and Rohrer, at IBM in Zurich, invented the scanning probe microscope. This uses a very sharp metal point scanned over a surface to 'see' the atoms in the surface. Eigler used the scanning probe microscope to 'nudge' atoms of xenon on a copper surface held at a temperature close to absolute zero to spell out the letters 'IBM'. Eigler and his group have done some remarkable work, mainly using the technique to explore basic physical and quantum mechanical phenomena. Gimzewski at IBM has used similar techniques, but at room temperature, to push single molecules around on surfaces. This kind of work with single atoms and molecules is called 'extreme nanotechnology'. Feynman's second vision in 1959 was of a factory in which billions of very small machine tools were drilling and stamping myriad tiny mechanical parts, which would then be assembled into larger products [4]. Ideas of nano technological strategy, which were put forward by Feynman, were developed by E. Drexler in his book "Vehicles of creation: the arrival of the nanotechnology era" published in 1986[14].

At the beginning of the 21st century, very important advances were made in the use of nanotechnology in fields such as medicine, biotechnology, and computer technology, aviation, energy use, space studies, materials and manufacturing [15].

In the future, as nanotechnology will play a major role in the discovery of new components and in the development of existing technologies, it is inevitable that the indispensable place of this technology loft will remain for many years [15].

Gum Arabic derived from exudates of Acacia Senegal and Acacia Sayal trees which are known to grow in the sub-Sahara region of the Sudan [16, 17]. The use of arabic gums dates back to the second millennium BC by Egyptians who used them as adhesives and ink stabilizers [18]. Today, the properties and features of GA have been widely explored and developed and it is being used in a wide range of industrial sectors such as textiles, ceramics, lithography, cosmetics and pharmaceuticals, encapsulation, food, etc. [19]. It is a complex polysaccharide, comprised mostly of glactose, arabinose, rhamnose and glucoronic acid, with ~2 % proteins as an integral part of its structure [20].

Iodine is a very special element. It is the heaviest non-radioactive element in the Periodic Table classified as a non-metal and it is the largest, the least electronegative and the most polarizable of the halogens [21], atomic weight is 126.9045 grams, and atomic radius is 133.3 pm[22]. The isotope of iodine in the environment that is most abundant naturally is iodine-127, but radioactive isotopes also occur naturally in the environment. Iodine-129 is produced naturally in the upper atmosphere when cosmic rays from the solar system hit the element xenon .Xenon degrades into this radioactive iodine and beta particles and gamma radiation [23]. Iodine is used in various fields of science and technology including medicine [24]. Physicochemical Properties of Iodine as a solid, which is its normal form (at 25 ˚C and 1 atm), the color in its gaseous state is violet. If heated under the proper conditions, iodine can be made to melt at 113.7°C and to boil at 184°C. Starch is a common indicator for the presence of iodine to change color [22]. Iodine single crystals were semiconducting, it have photoconductivity properties [25] and accept electrons from the solvent molecule into its lowest unoccupied molecular orbital (LUMO) [26]. Iodine dissolved in organic solvents [22]. However, its slightly soluble in water can be increased by the addition of sodium or potassium iodide it produces solutions having a variety of colors [26]. In this work the change of Absorption Coefficient and Energy Gap was studied when Talha is doped by iodine having different concentrations. This is done in sections 3 section 2 is devoted for materials and methods while sections 4 and 5 are concerned with discussion and conclusion.

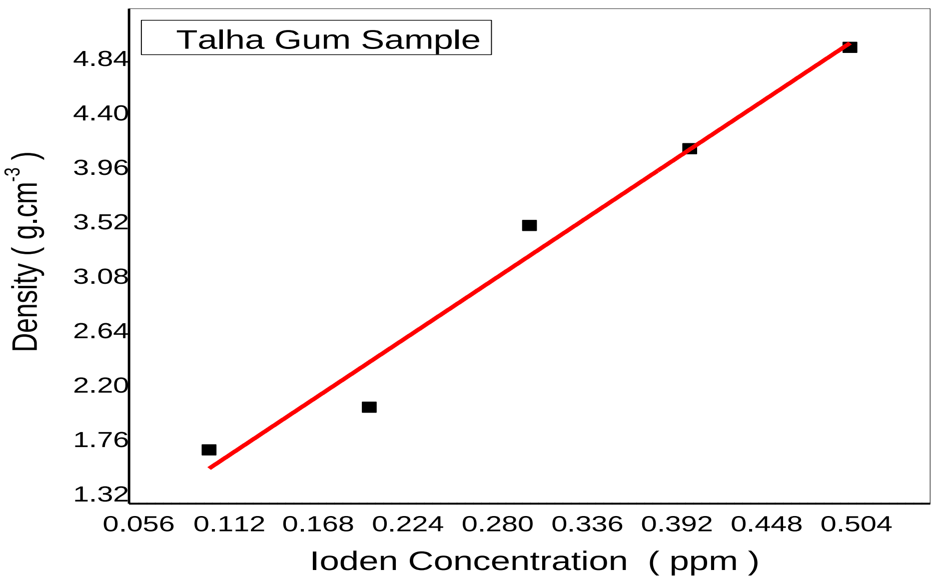
Material and Method

Five sample of Talha Gum Arabic were doped by Iodine in different concentration (0.1, 0.2, 0.3, 0.4 and 0.5)ppm. The preparing process started by preparing Talha Gum Arabic solution by thermo chemical method where 100 mL of methanol (Pour analysis 99%) with 50 mL (H_2SO_4) on the magnetic stiller were added to 5g of Talha Gum Arabic. The resulting material was to doped by Iodine in different concentration by chemical in ice bath for 60 min to made five samples, using an intermediate test tube for the simple. Then the annealed sample was grinded to get the powdered nanoparticles. The crystal structure of all samples were characterized at room temperature using a Philips PW1700 X-ray diffractometer (operated at 40 kV and current of 30 mA). The Energy gap and Absorption coefficient were found at room temperature using min 1240 UV- Spectroscopy.

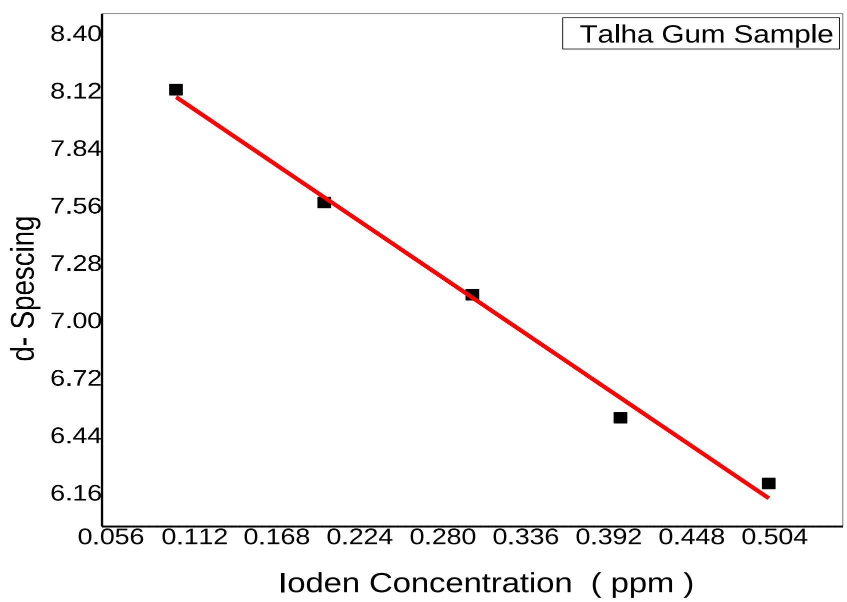
Result

Table (1) some crystallite lattice parameter (**Nano crystal size $X_S(nm)$ and d-spacing) Energy gap E_g and Absorption coefficient α**

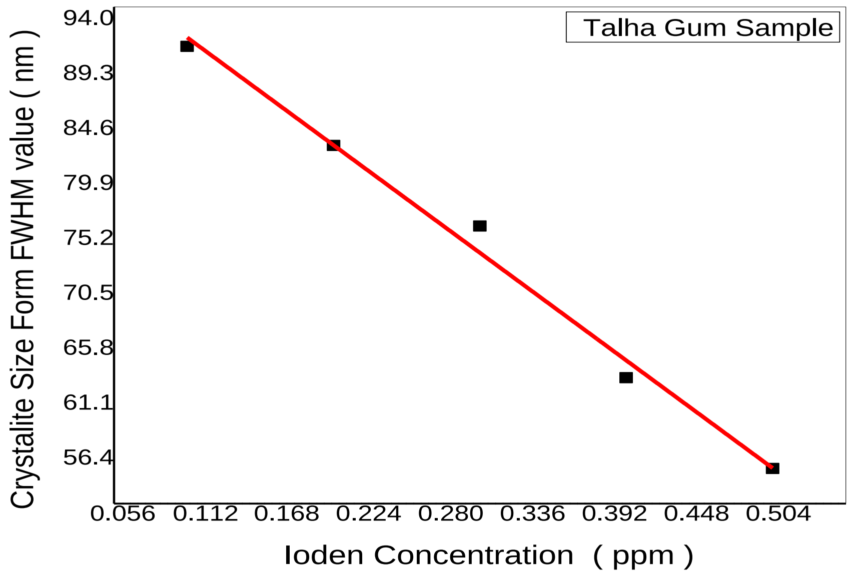
Iodine concentration (ppm)	Density g/ cm^3	Nano crystal size $X_S(nm)$	d-spacing	Energy gap $E_g eV$	Absorption coefficient $\alpha\ (cm^{-1})$
0.1	1.6838	91.62	8.13	2.364	3.604×10^3
0.2	2.029	83.14	7.58	2.356	4.165×10^3
0.3	3.4979	76.25	7.13	2.352	4.699×10^3
0.4	4.1179	63.27	6.53	2.345	5.313×10^3
0.5	4.937	55.51	6.21	2.339	6.113×10^3



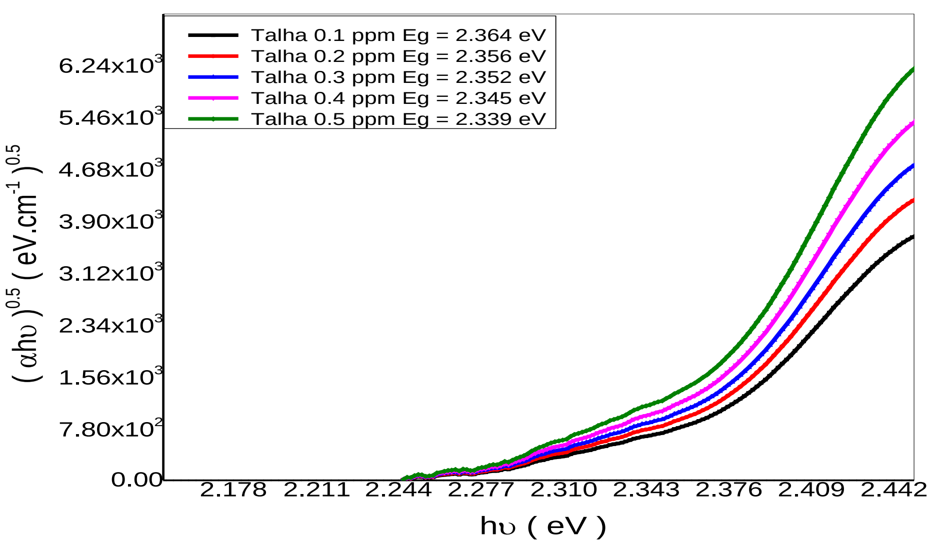
Fig(1)Dependence of the density of Talha Gum Arbic samples on iodine concentration



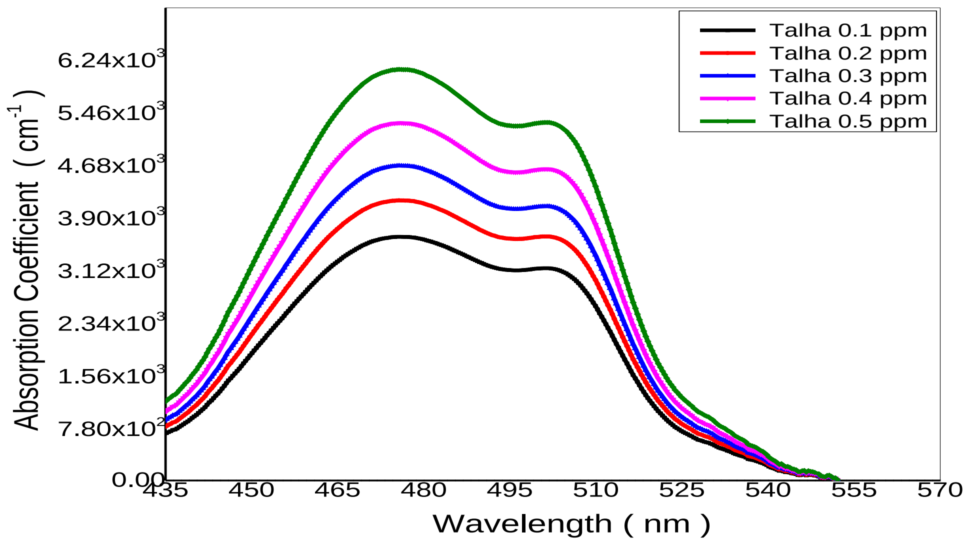
Fig(2)Dependence of the d- spacing of Talha Gum Arbic samples on iodine concenteration



Fig(3)Dependence of the crystallites growth of Talha Gum Arbic samples on iodine concenteration



Fig(4) plots the optical energy band gap of Talha Gum doping by Ioden in different concentrations



Fig(5) plots the relation of wavelengths vrs absorption coefficient of Talha Gum Arabic doped by

Ioden in different concentrations

Discussion

For talha the increase of iodine concentrations increases density as shown in fig(1) .This conforms with fact that the crystal spacing between successive planes and unit cells decreases also as shown in fig(2).Because this shrinking cause atoms to be more close together and as a result the density increases. The decrease of the nano crystal size x_s upon increasing iodine concentration [see figure (3)] also conforms with the fact that the distance between adjacent atoms decrease due to the decrease of d-spacing.

The absorption coefficients for Talha shown in figure (5), indicates increase of absorption coefficient upon increasing iodine concentration. This may be attributed to the fact that increase of iodine concentration increases gum density, which increases the number of atoms that absorb photons, which in turn increases absorption coefficient. The increase of iodine concentration decreases the energy gap for talha see figure (4) to be (2.364, 2.356, 2.352, 2.345, and 2.339 eV).This may be due to the fact that increasing concentration increases atomic density which increases the number of states in both conduction and valance band which causes the energy gap to be narrow.

Conclusion

The doping of Talha gum Arabic with iodine decreases crystal spacing and nano crystal size.It increases absorption coefficient also. The energy gap decreases upon increasing iodine concentration.

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