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FABRICATION AND OPTICAL CHARACTERIZATION OF OLIVE OIL/AG THIN FILMS USING PLASMA POLYMERIZATION TECHNIQUE

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Abstract

To produce a polymeric material for use in electronic applications, traditional 'wet' methods of synthesis include chemical and electrochemical polymerization.. In addition, organic precursors that are unable to polymerize using conventional techniques have been found to undergo polymerization using this technique. Interest in the use of plasma polymerization originated due to its advantages, which include the ability to produce films that are of uniform thickness, pinhole-free, chemically inert and thermally stable The low cost of this fabrication technique is attributed to the associated low consumption of precursor material and the absence of any need for other chemicals and/or solvents, therefore making it ecologically friendly. The purpose of this work was to report the capability of converting Olive oil to a solid state thin film and study its optical properties.

The FTIR spectrum indicated the presence of hydroxyl groups ,methylene (—CH2) group , C —O ester group,and so on for the rest of the chemical groups, the entire range of spectra looks very similar for the Olive oil.Major optical properties are determined from analysis of absorption and emission spectra to both of pure Olive oil and prepared doped Ag sample.Absorption spectrum showed of pure olive oil has a strong two peak around wavelength at 411 nm and 690 nm, with three other weak peaks appears at wavelength around 463 nm.All these peaks are disappearing and heavily overlap one another. from absorption spectrum of doped Ag, in which it could see only wide absorption peak at 358nm.

Keywords: Olive Oil, Ag, Plasma Polymerization, FTIR, UV.VIS.

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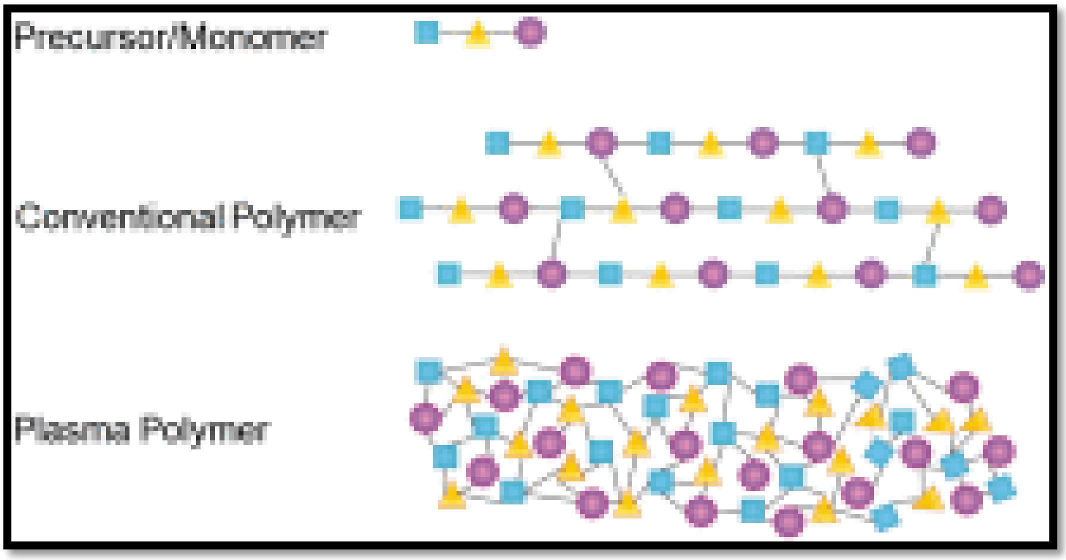
1. Introduction

Plant oils are very different and diverse uses in history, not just as food ingredients and contributed to sustainable development but also helped to address environmental problems, waste disposal, and non-renewable resource depletion. Since it became apparent that there was a need to find alternatives for replacing or reducing the consumption of petroleum, due to its non-renewable nature and dwindling reserves [1] In this context, vegetable oils are the ideal renewable resources and have increasingly been utilized in the spotlight of the chemical and polymer industries. These oils possess specific reliable characteristics including universal convenience, inherent biodegradability, low cost, and low eco-toxicity.The final disposal of products formulated with synthetic polymeric materials is also a significant concern that contributes to widening the use of bio resources beyond the narrow range to which they were confined during the second half of the last century [2,3]. The main sources of oil, namely palm trees, soybeans, rapeseed, cotton, sunflower, palm kernel, olive, and coconut, are being explored for beneficial improvements in research and development.It has become apparent that oils could contribute to replacing petroleum as a source for bio-oil derived polymers or composites that are widely applied to paints, coatings, adhesives, and biomedicine. In particular, Plants oilsare triglycerides containing long chain fatty acids such as oleic acid, linoleic acid, and linolenic acid that can be used to produce hydroxy fatty acids (HFAs). HFAs are known to have higher viscosity and reactivity than other fatty acids. Due to these features, HFAs have enormous potential in industrial applications including plastics, waxes, nylons, lubricants, cosmetics, and paint additives [4]. Olive oil is obtained from the fruit of the olive tree (the olive) that has an economically important product [5].This, in the Holy Quran has inspired the author to investigate the possibility of using Olive Oil industrially as an active dye laser material. Olive Oil which is classified as an organic compound, having good properties promote it to be used as an active dye laser material [6]for photonic applications [7]. It has a fine aroma, a pleasant taste and high nutritional and health value[5]. Olive Oil is an organic complex compound consists of Fatty acids, Glycerides, Sterols, Erythrodiol, Uvaol, Wax esters, Phenolic compounds, Aroma components, Tocopherols, Hydrocarbons (Vitamin E), Aromatic Hydrocarbons, Xenobiotics, Unsaponifiable matter, water soluble components and microscopic bits of olive [1, 8].

The preparing of Olive Oilthin film was achieved by applying the plasma jet polymerization technique. Plasma polymerization technique includes plasma (state) polymerization which is one of the most powerful methods for surface modification of polymeric materials.

Plasma polymerization is a new material preparation process. It refers to formation of polymeric materials under the influence of plasma, which is generated by some kind of electric discharge. Plasmapolymerization covers a wide interdisciplinary area of physics, chemistry, interfaces, and materials [9]. The well-recognized concept of polymerization today is based on the molecular processes by which the size of the molecules are increased. In contrast to such molecular processes, polymer formation in plasma has been recognized as an atomic (non-molecular) process [10]. In order to coat a certain substrate with a conventional polymer, several steps are required. In coating by plasma polymerization, in contrast, all these practical steps are replaced by an essentially one-step process to produce a good polymer coating. Initially when polymers are formed wider, the plasma condition is recognized as an insoluble deposit that provided the only difficulty in cleaning. The most two important characteristics of this undesirable deposit, which are the most sought later in modern technology of coatings are an excellent adhesion to substrate materials and strong resistance to the most chemicals. Plasma polymerization is a cost-effective tool for fabricating organic thin films. This technique results in homogeneous, highly cross-linked and thermally stable polymer thin films.[11]

Figure (1) represents a comparison of the structures of plasma polymers and conventional polymers.



Figure(1) Comparison between the plasma polymer and the conventional Polymer of the same monomer[12]

In this study, wereported the capability of converting Olive oil to a solid state thin film by aerosol assisted plasma jet polymerization at low temperature and characterizing its optical properties. The major optical properties are determined based on the analysis of the absorption and emission spectra to pure Olive oil and prepared doped Ag sample.

Some Application of Modified Plant Oil Based Additive in Polymer

1- Lubricant

Vegetable oil as a lubricant is preferred not only because they are renewable raw materials but also because they are biodegradable and non-toxic They also acquire most of the properties required for lubricants such as high index viscosity, low volatility and good lubricity and are also good solvents for fluid additives. However, vegetable oils have poor oxidative and thermal stability, which is due to the presence of unsaturation that restricts their use as a good lubricant[13]

2- Plasticizer

Nowadays, there is increasing interest in the use of natural-based plasticizers that are characterized by low toxicity and low migration. This group includes vegetable oils from soybean oil, linseed oil, castor-oil, sunflower oil, olive oil and fatty acid esters (FAEs)[14]

3- Composite

Composites based on environmentally degradable, eco-compatible synthetic and natural polymeric materials have great potential as advanced environmentally acceptable alternatives to petroleum-based materials. The last two decades have witnessed an exponential growth in the interest for using bio-derived products, which has been driven by the need for replacing petroleum based materials reducing the fuel consumption and, equally important, for producing materials with lower environmental impact. Vegetable oils constitute a rich source for many different polymers and polymer precursors and they are being considered for the production of ‘‘Greene composites’’[1,2]

4- Paints, Coatings and Adhesives

Vegetable oils have been used as binders or additives in paints and coatings for many centuries, dating back to the days of cave paintings Vegetable oil derivatives as value added polymers/monomers have found enhanced applications as environment friendly hyperbranched or waterborne coating materials that offer improved performance and reduction or elimination in the use of volatile organic solvents [1,15].

Experimental part

Thin films deposition

The films were deposited via a plasma jet. The plasma was generated downstream to the substrate(sizes of 10 × 10 mm), and then cleaned with acetone under ultrasonic condition prior to the plasma polymerization) which was positioned at fixed distance from the plasma torch end (0.75cm). The plasma torch system consists of a stainless steel tube with100mm long, 2.14 mm inner diameter and outer diameter of 2.98 mm, inserted inside the Teflon pipe, the stainless steel is connected to a high voltage power supply. The tolerance between the Teflon pipe and the stainless steel tube is filled with Teflon tape. The jet was generated, via Argon gas flow rate 2 L/min through a nebulizer which contained pure Olive oil. The Olive oil was converted into aerosol; the aerosol was guided by the Ar gas through the inlet pipe to the plasma jet and convert to solid thin films as shown in Figure 2. The plasma was ignited by using an electric source at fixed frequency 28.0 kHz and 10k volt peak to peak . The films deposition was carried out for 30 min under carrier gas flow rate.

Nano silver(Ag) dopingOlive oil

Nano silver (Ag) dopingOlive oil is carried out by in situ doping of nano Ag using aerosol assisted plasma jet polymerization techniques.The nano Ag powder is mixed with Olive oil by different weight mixing ratio 2, 4, andWt 9%. nano Ag and the monomer (Olive oil) were put into the nebulizer then Argon gas with constant flow rate 2L/min passes through the nebulizer which contains the mixture of nano Ag and the Olive oil . The mixture convert to aerosol, this aerosol was guided by the Ar gas to the plasma jet and convert to solid thin films .

Samples Characterization

Olive oil thin film was characterized with the UV-Vis and FTIR. UV-Vis Absorption spectra were measured at room temperature was recorded by a double-beam UV-VIS-NIR 210A. Spectrophotometer was used to measure the transmittance and absorption of Olive oil pure and doped Ag samples films deposited in the range of 200 to 1200 nm. The FT-IR spectra were recorded by using KBr and testing all samples by Shimadzu Co. FT-IR 8000 series Fourier transform, infrared spectrophotometer from wavelength range of 400 to 4000 cm-1 under identical conditions.

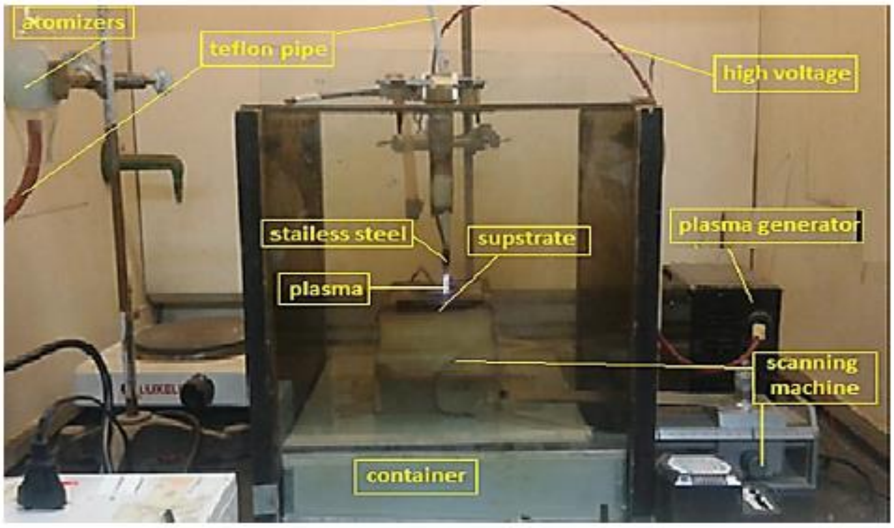


Figure 2: Schematic diagram for the non-equilibrium atmospheric pressure plasma nano Ag -doped Olive oil thin films

Results

Fourier transform infrared (FTIR) absorption spectra in the range of 4000 - 400 cm^{-1} were taken. The FTIR spectrum of pure Olive oil samples was illustrated in Figure 3

The FTIR spectrum indicated the presence of hydroxyl groups having a transmittance at 3337 cm-1

2924 cm-1 and 2852 cm-1 Asymmetrical and symmetrical stretching vibration of methylene (—CH2) group

1743 cm-1 Ester carbonyl functional group of the triglycerides

1465 cm-1 Bending vibrations of the CH2and CH3 aliphatic groupsassigned to the vibrations of deformation (C-H). This band can be used to determine the total unsaturation

1417 cm-1 Rocking vibrations of CH bonds of cis-disubstituted olefins

1377 cm-1Bending vibrations of CH2 groups

1236 cm-1 and 1160 cm-1 C—O stretching

1117 cm-1 and 1098 Stretching vibration of the C—O ester group

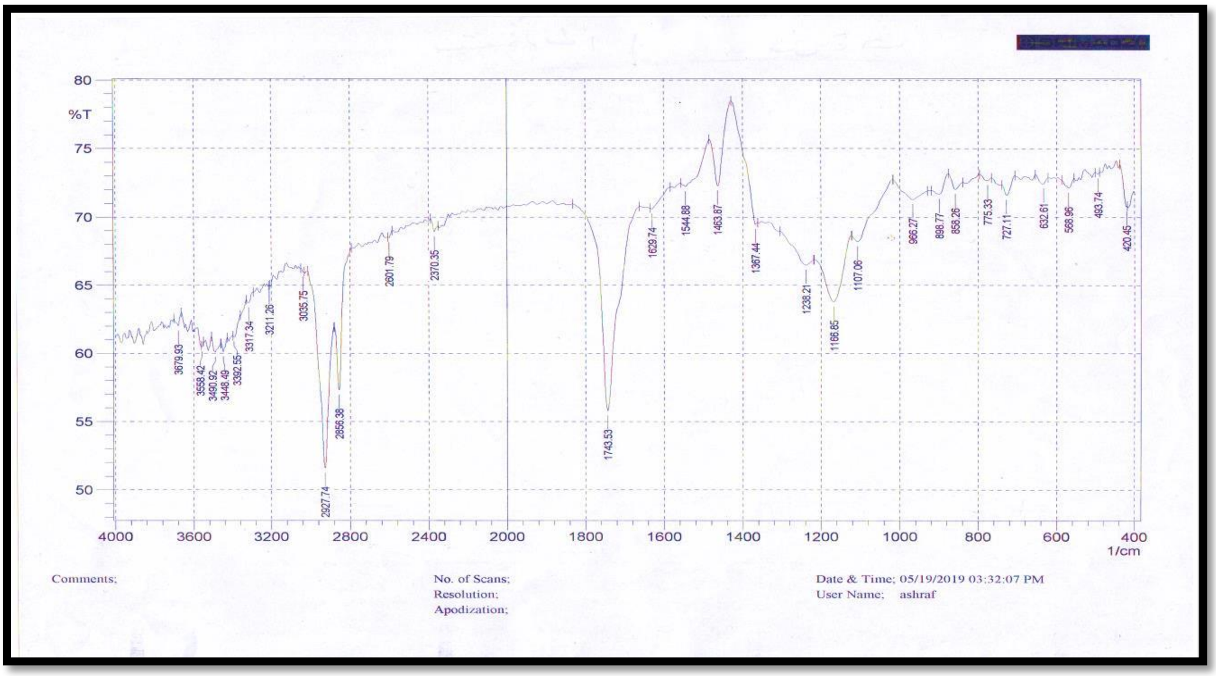
962 cm-1 Bending vibration of CH functional groups of isolated transolefin

850 cm-1 =CH2 wagging

721 cm-1 Overlapping of the methylene (–CH2) rocking vibrationand to the out of plane vibration of cis-disubstituted olefins

The entire range of spectra looks very similar for the Olive oil to the naked eyes. This is due to the similar chemical composition. While someslightly shifting in position was detected and observed, which might be due to different polymeric matrix of the synthesized Olive oil thin film. SO , these results are agreement in accordance with literature values [4, 16, 17].

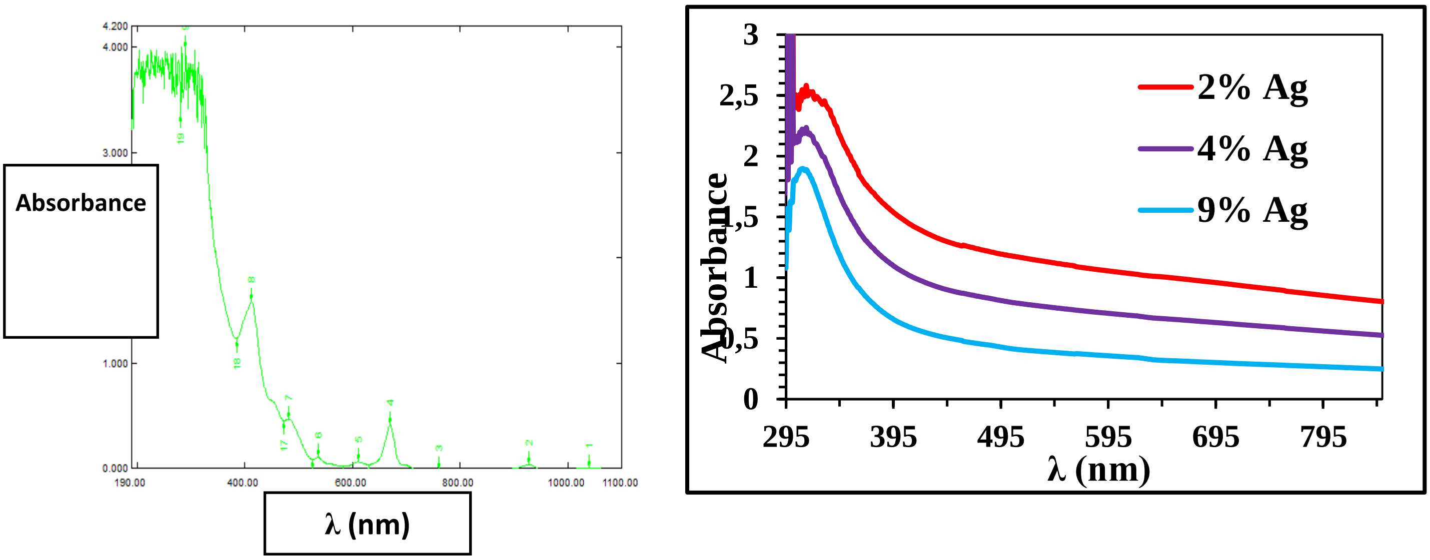
Figure 3 :FTIR transmission spectra of pure olive oil as a function of wave number



UV-Visible absorption spectra of pure olive oil and olive oil doped films with doping of nano Ag, for different ratio 2% , 4% , andWt 9%. With the monomer (Olive oil) Which operates in wavelength range of 200-1100 nm . Figure.4 (A,B)show the absorption spectrum at room temperature for pure olive oil. The absorbance peak appear at selected wavelengths 411nm, 463nm, 532nm, 625 nm and 690nm. Absorption spectrum showed of pure olive oil has a strong two peak around wavelength at 411 nm and 690 nm, with three other weak peaks appears at wavelength around 463 nm(related to conjugated hydroperoxides), one in- tense peak at 532 nm (due to Vitamin E) and another peak at 625 nm (due to chlorophylls). As well as the low intensity of the peak at 463nm is due to their large content on monounsaturated fatty acids and phenol- lic antioxidants, which provide more stability against oxidation. .These results are in agreement with reported by previous studies [6,8, 18]

Figure.4 show the absorption spectrum at room temperature for olive oil doped films with doping of nano Ag, for different ratio (2, 4, and 9%. With the monomer (Olive oil).

All these peaks are disappearing and heavily overlap one another. from absorption spectrum of doped Ag, in which it could see only wide absorption peak at 358nm. That’s mean Ag matrix effect on optical properties of Olive oil through changing of its absorption bands. results are agreement in accordance with literature values [6,18]



A B

Figure 4. Absorption spectrums for: (A) Pure Olive oil and (B) nano Silver doped with Olive oil.

Conclusions

Vegetable or vegetable oils represent a renewable resource that can be used as a reliable starting material for new products. Anesthetic olive oil with nano-fragment was successfully prepared by wet physical synthesis method. Label the thin film polymers of olive oil polymers prepared by UV-Vis, the absorption spectrum of pure olive oil showed two strong peaks around the wavelength at 411 nm and 690 nm which appear to be bound to (conjugated hydroperoxides), While all of these peaks disappear and strongly overlap with one another whene the doped Ag absorption spectrum, it can only be seen a wide absorption peak at 358 nm. FTIR spectroscopy of the pure olive oil samples showed that the spectrum range appears very similar to that of the olive oil. Plasma jet was found as an effective tool for plasma polymerization. This was an inexpensive and environmentally friendly one-step process, which could be a candidate as a new technology in polymer delivery for coating large substrate areas.

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