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# Improving of Paraffin Wax Properties by Adding of Low Density Polyethylene (LDPE)

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**Abstract**

Petroleum wax is a polymer completely similar to ethylene with a high degree of crystalline and linearity. The method of mixing polymer with wax is one of the most common methods used in the field of improving the specifications of polymeric materials and making them widely used in various industrial fields. By mixing wax with different proportions of the polymer, to obtain better specifications in terms of solubility, hardness, thermal stability, and chemical resistance. Thus, it can be used in the electrical industries. This study examines some characteristics of the prepared wax such hardness, melting point, ash percentage, and electrical conductivity.

The process of mixing with different percentages of wax, polyethylene and nano silver led to a clear increase in the electrical conductivity property, as the increase in the proportion of nano silver led to an increase in electrical conductivity. The polymer worked to prevent silver nanoparticles from clumping and making them cover the surface of the polymer, and thus an electrical circuit was made without metal wires.

**Keywords:** Paraffin wax, Polyethylene high & low density, Nano silver, electrical conductivity

الخلاصة : شمع البترول عبارة عن بوليمر مشابه تماًما لإليثيلين بدرجة عالية من البلورة والخطية, تعتبر طريقة خلط البوليمر مع الشمع من أكثر الطرق شيوعا في مجال تحسين مواصفات المواد البوليمرية وجعلها مستخدمة على نطاق واسع في مختلفً المجاالت الصناعية. عن طريق خلط الشمع بنسب مختلفة من البوليمر للحصول على مواصفات أفضل من حيث الذوبان والصالبة والثبات الحراري والمقاومة الكيميائية. وبالتالي ، يمكن استخدامه في الصناعات الكهربائية. تبحث هذه الدراسة في بعض خصائص الشمع المحضر مثل الصالبة ودرجة االنصهار ونسبة الرماد والتوصيل الكهربائي .أدت عملية المزج بنسب مختلفة من الشمع والبولي إيثيلين ونانو الفضة إلى زيادة واضحة في خاصية التوصيل الكهربائي ، حيث أدت الزيادة في نسبة الفضة النانوية إلى زيادة التوصيل الكهربائي. عمل البوليمر على منع جسيمات الفضة النانوية من التكتل وجعلها تغطي سطح البوليمر ، وبالتالي تم صنع دائرة كهربائية بدون أسالك معدنية.

## 1.INTRODUCTION

Tarvin wax is one of the most important materials that has been used in various places since the beginning of humanity [1]. Paraffin wax is a petroleum product that contains mainly straight chain hydrocarbons, so the melting point and inherent density of paraffin wax increases with the number of carbon atoms [2]. Paraffin and microcrystalline waxes are types of waxes derived from petroleum. They can be easily recovered and provide a wide range of physical properties that can often be improved through refining processes. Wax is commonly used in paper coatings, glass cleaning products, biodegradable mulches, lubricants, acid bottle caps, and electrical insulation [Hussien et al., 2016]. Polyethylene has low strength, hardness and hardness, but high flexibility, impact resistance and low friction. It shows strong creep under continuous force, which can be reduced by adding short fibers. Polyethylene (PE) is a low-cost, commercially available polymer with excellent physical and

mechanical properties. There are different types of polyethylene: high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE). The main difference between them is the degree of branching they exhibit at the microstructural level. Lowest degree of branching. Linear low-density polyethylene consists of short-chain branches at regular intervals, and low-density polyethylene consists of short, long, irregularly spaced branches. Changes in the microstructure and degree of branching lead to numerous changes in properties such as degree of crystallinity, morphology, and lamella thickness [3]. Candles are used as food packaging materials because they have good moisture barrier properties. It can also protect dry foods from ambient moisture or reduce food moisture loss [4]. In addition, the wax coating can protect food during transportation and handling. However, there are concerns that wax and other ingredients can transfer into food, especially if they are part of the food contact layer. A study conducted by Varner et al. It has been shown that it is possible to measure benzophenone in paraffin waxes used in food contact materials, but so far only studies on leaching are available [5]. The wax/polymer blend can be used in many applications, such as hot areas Adhesives, coatings and phase change materials. The most commonly used matrix for mixing paraffin candles is polyethylene. This is due to the chemical and structural similarity between polyethylene and paraffin wax, ensuring good compatibility between the two components. Paraffin candles are a mixture of saturated hydrocarbons. It can be mixed with small molecules to adjust the melting points. The properties of added polymer blends depend on the structure and degree of branching of the polymer, as well as on whether wax is added to the polyethylene; Crystallization plays an important role [6]. This study was conducted on the basis of blending paraffin wax as a base material with polyethylene (low-density polyethylene, LDPE) to improve the physical properties of the wax and make it more suitable for use in many fields. Industrial applications such as covering metal surfaces for food preservation, electrical circuits and appliances. It is known that the waxy substance in its pure state has no industrial or economic importance due to its fragility and low melting point. Therefore, the wax is mixed with the polymer to increase its hardness. And the melting point [7.8].

# 2. EXPERIMENTAL PART

## 2.1 Materials and apparatuses

In this research use high and low-density polyethylene in the form which brought from local markets. The paraffin wax used in this research was obtained from Al-Doura refinery as reinforcement material, the properties of paraffin wax, high and low density polyethylene are illustrated in tables (1, 2).

Table 1 Physical properties of oil wax

| Property | Value |
|---|---|
| Viscosity at 100 ° C | 4.2-7.4 cst |
| Melting Rang °C | 46-68 |
| Refractive Index | 1.34 – 1.43 |
| Density gm/cm$^3$ | 0.896-0.925 |
| Dielectric Constant w/m ° C | 2-2.5 |

Table 2 Physical Properties of Low & LDPE Density polyethylene

| Property Value | |
|---|---|
| HDPE | |
| Melting point | 120-140°C |
| Density | 0.93 to 0.97 g/cm3 |
| LDPE | |
| Melting point | 105 to 115°C |
| Density | 0.910–0.940 g/cm$^3$ |

Nano silver (prepared by the Department Materials Research). Powder grinder model silver crest / Germany, heat plat with magnetic stirrer / Germany, Balance. Melting points (m.p) were recorded using hot stage Gallenkamp / Germany, melting point / Germany. Electrical conductivity (Packaging Centre) and Penetration for wax model NPN TECH / France.

## 2.1.1. Preparation of crystalline nano silver powder

An aqueous solution of tri-sodium citrate 18 g/100 mL water was added to an aqueous solution of silver nitrate (5 g/50 mL water), to maintain a ratio of at least 2:1. The drop-wise addition under continuous stirring at room temperature afforded a white precipitate. After the complete addition of tri-sodium citrate, stirring was continued for an additional (15 min). To this, drop-wise addition of required amount of aqueous sodium formaldehyde sulphoxylate (~5.0 g/50 mL water) afforded a dark grey precipitate, which was filtered off, washed with methanol and dried (Iara J. Fernandes, 2020).

Table 3 properties of Nano silver

| Property Value |
|---|
| Particle size 30 – 40nm |
| colour Light yellow |
| shape spherical |

## 2.1.2. Preparation of Polyethylene

Poly ethylene grinding to fine powder at a particle size of (0.29-1.58) µm by using a special polymeric grinder, at the Packaging Centre / Ministry of Industry and Minerals (A Grover, et al 2015).

**Fig.1** Preparation of Polyethylene

## 2.1.3. Preparation of wax

- 5g of paraffin wax is melted at (40-45) C° in glass beaker

- Add polyethylene gradually with certain weights. After, raise the temperature gradually with continuous stirring at a degree of (100-110) °C to completely melt the polymer until homogeneous with the wax.

- When complete, gradually reduce the temperature to 40°C, and slowly add nano silver with continuous stirring for a period of 3 hours, all proportions used in the work are shown in Table (4).

Table 4 Proportion used in the work

| **Oil wax** gm | **Polyethylene** gm | **Nano silver** gm |
|---|---|---|
| 5 | 5 | 0.2 |
| 5 | 7 | 0.4 |
| 5 | 9 | 0.6 |
| 5 | 11 | 0.8 |
| 5 | 13 | 1.0 |

| | | |
|---|---|---|
| 5 | 15 | 1.2 |
| 5 | 17 | 1.4 |
| 5 | 19 | 1.6 |
| 5 | 21 | 1.8 |
| 5 | 23 | 2.0 |

Two types of metal (carbon steel and aluminium) aluminium type (2024) composition shown in composition (Table 5) were coated with prepared wax.

Table 5 Percentage nominal composition of Al 2024

| **Element Symbol** | **Al** | **Si Fe Mn** | **Cr** | **Zn** | **Ti** | **others** |
|---|---|---|---|---|---|---|
| **% Composition (2024)** | 92.45 | 0.5 0.5 3.8-4.9 | 0.10 | 0.25 | 0.15 | 0.15 |

## 3. RESULTS AND DISCUSSION

The process of mixing with different percentages of wax, polyethylene, and nano silver led to a clear increase in the electrical conductivity property, and from the results it was clear that an increase in the percentage of nano silver leads to an increase in the electrical conductivity value. The work of the polymer was to prevent silver nanoparticles from agglomerating and to make them coat the surface of the polymer, and thus an electrical circuit was made without metal wires (M. P. Molaba. et al. 2015). Tables (6, 7, 8) show the results of electrical conductivity in the presence and absence of silver nanoparticles.

Waxes can be enhance physical properties in order to many industrial purposes such as food packaging for protection as coating material for metallic surfaces and food cans as well as electrical wires. The enhancement of wax is carried out by mixing with different presenting of polyethylene.

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Table 6 Electric Conductivity for oil wax and nano silver without polyethylene

| Conductivity Um | Nano silver gm | Oil wax gm | No |
|---|---|---|---|
| 0.025 | 0.1 | 5 | 1 |
| 0.040 | 0.2 | 5 | 2 |
| 0.090 | 0.3 | 5 | 3 |
| 0.120 | 0.4 | 5 | 4 |
| 0.200 | 0.5 | 5 | 5 |
| 0.230 | 0.6 | 5 | 6 |
| 0.310 | 0.7 | 5 | 7 |
| 0.411 | 0.8 | 5 | 8 |
| 0.45 | 0.9 | 5 | 9 |
| 0.499 | 1.0 | 5 | 10 |

Table 7 Electric Conductivity for oil wax and polyethylene with nano silver

| Conductivity Um | Nano silver gm | Polyethylene gm | Oil wax gm | No |
|---|---|---|---|---|
| 0.081 | | 5 | | |
| 0.085 | 0.2 | 7 | 5 | 1 |
| | 0.4 | | 5 | 2 |
| 0.09 | 0.6 | 9 | 5 | 3 |
| 0.1 | 0.8 | 11 | 5 | 4 |

| | | | | |
|---|---|---|---|---|
| 0.4 | 1.0 | 13 | 5 | 5 |
| 0.7 | 1.2 | 15 | 5 | 6 |
| 1.9 | 1.4 | 17 | 5 | 7 |
| 2.5 | 1.6 | 19 | 5 | 8 |
| 3.4 | 1.8 | 21 | 5 | 9 |
| 4.2 | 2.0 | 23 | 5 | 10 |

Table 8 Electric Conductivity for oil wax and polyethylene without nano silver

| **Conductivity Um** | **Polyethylene gm** | **Oil wax gm** | **No** |
|---|---|---|---|
| 0.0114 | 5 | 5 | 1 |
| 0.115 | 5 | 7.5 | 2 |
| 0.161 | 5 | 10 | 3 |
| 0.162 | 5 | 12.5 | 4 |
| 0.170 | 5 | 15 | 5 |

## 4. CONCLUSIONS

1. The process of mixing with different percentages of wax, polyethylene, and nano silver led to a clear increase in the electrical conductivity property.
2. It's clear the increase in the percentage of nano silver leads to an increase in the electrical conductivity value.
3. Waxes can be enhance physical properties in order to many industrial purposes such as food packaging for protection as coating material for metallic surfaces and food cans as well as electrical wires.

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