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Use of Nano Chemical Additives to Improve the Properties of Industrial Used Paraffin Wax

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Abstract

In this study the melting point and hardness of the paraffin wax was improved by mixing it with 1:1 ratio of micro crystalline wax then adding weight percentage wt% of locally produced nano particles (CuO,ZnO,AI_2O_3 and bentonite) for each addition to the wax mixture. The results showed an increase in the melting point and hardness values of the prepared samples by increasing the weight percentage of each nano particles additives. . It was found that the addition of nano bentonite to the wax mixture gave high melting point values (122.5°C)and hardness (81.2)followed by melting point value (97°C)and hardness(68.2)resulting from the addition of CuO nano particles to the wax mixture compared to other used nano particles**.**

Key words: paraffin wax, Meltingpoint, Hardness, bentonite nano particles.

استخدام إضافات كيمياوية نانوية لتحسين خصائص الشمع البرافيني المستخدم صناعيا

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الخلاصة

تم في هذا البحث تحسين خاصيتي نقطة الانصهار والصلادة لشمع البرافين وذلك بمزجه مع الشمع البلوري الدقيق وبنسبة مزج (1:1) لكل منهما ثم اضافة نسب مئوية وزنية (3%,7.5%,15%) من المواد الكيميائية النانوية (اوكسيد النحاس و اوكسيد الزنك و الالومينا و البنتونايت) المحضرة مختبريا الى مزيج الشمع .وقد اظهرت النتائج زيادة قيم درجة الانصهار والصلادة للنماذج المحضرة بزيادة النسبة المئوية الوزنية لكل اضافة من الاضافات النانوية .وقد وجد ان اضافة النانو بنتونايت الى مزيج الشمع قد أعطى قيم عالية من درجة الانصهار (122,5° م) والصلادة (81,2) تليها قيم درجة الانصهار(97 °م) والصلادة (68,2) للنماذج الناتجة من اضافة اوكسيد النحاس النانوي الى مزيج الشمع مقارنة مع بقية الاضافات النانوية الاخرى

Introduction

The phase change material is utilized for storage thermal energy in applications of solar energy. Variables phase change materials (PCM) have high latent heat storage capacities at the stage of phase change interval from a solid to a liquid state, or from the liquid to the solid state. During this process, this material can store about (5 to 14) times the energy / unit volume, contrasted to the reasonable heat storage materials, like water, stone masonry, or rock. Its low thermal conductivity describes paraffin wax as other PCMS. This character limits the absorption and energy release rate. Many researchers have used different additives with high melting point to improve the effective melting point of the phase change material. Fukai used ceramic powder fillers and graphitic carbon fiber [1], Pincemin used graphite particles [2], while Kim and Drzal used peeled graphite in their work [3],

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and Elgafy employed carbon nano-fibers [4]. Nano-materials showed changing in physical and chemical properties contradictory essentially when compared with base mass structure [5].The generation of different sorts of nanoparticles has an end less demands as a result of the fast progress in nanotechnology [6], mechanical and electronic building, and current procedures [7,8]. The higher melting point of the nanomaterials made from metals or metal oxides can be used with low conductivity materials as PCMs to improve its melting point [9]. A higher melting point can be taind at smaller nano materials size. The improvement of the melting point of PCMS is a result of the advancements in its thermal capacities [10]. figured out how to include nano-materials for paraffin wax without inflictinشg any surface strain. The outcomes look ift the expansion of nano-materials in paraffin wax bring on modification in the thermal limit of the phase change material. Melting point of the wax expanded clearly [11]. studied the effect of different amount of carbon nano-fillers on the courier and energy storage and on thermal properties of materials using paraffin (PCMS). The thermal quantity of the formed material was less with the nano-fillers addition; however, it has no effect on the temperature of the phase change. The results showed that the melting point of the PCM nano-composite increments with the expansion of the extent of fillers. Likewise, the relative change in the melting point relies upon the size and state of the added nano particles material [12]. Chaichan added two types of nano materials to the paraffin wax in variable mass fractions. Al2O3 and TiO2 were used to improve the melting point of the used PCM. The results indicated that the melting point improved with increasing the nano-fillers mass fraction, t.The results revealed significant enhancement in the wax's charging and discharging period which was reduced with the addition of nano-fillers [Chaichan et al 2017].The use of nano materials-paraffin wax composite gets wider interest in different applications, especially those related to the uses of solar thermal applications [13]. The essential objective of this study is to assess the best proportion of nanoparticles that can be added to Iraqi paraffin wax to improve its melting point and hardness.

Material and Methods

Chemical Materials

1-Waxes

In this research two types of wax (from the Ministry of oil \Al-Dura refinery.)were under study in this work.

Paraffin wax is a mixture of saturated hydrocarbon that forms alkanes,.It consists of hadrocarbon chains of (26-30) carbon atoms.It has high molecular weight.

Table 1-Some physical properties of paraffin wax

property	
Penetration at25°c	34
Oil content wt%(max)	1.5
Melting point around° c	38
Color(SAYBOLT)(min)	20

b-Microcrystalline wax is a thermoplastic material that differs from paraffin wax in that it has a higher melting point.

some physical properties of microcrystalline wax shown in Table-2.

Table 2-Some physical properties of microcrystalline wax

property	
Penetration 25°c	18
Oil content %wt(max)	2.0
Melting point °c	71.75
Color(ASTM-1500)(Max)	4.0

2-Nano particles Materials:

The chemical additives that were used in this work are nano copper oxide (black to brown powder , size granular 71 nm), nano zinc oxide (solid, white, odorless powder size granular78 nm),nano alumina(white color powder with 65nm particle size)and nano bentonite (it is found as aqueous aluminum silicate and granular size 24 nm.)., All are locally produced.

Experimental procedure:

1-preparation of wax\ nano particles Mixture:

prepared by mixing 1:1 ratio of paraffin wax and microcrystalline wax at 50ºC for 40 minutes, then adding the nanoparticles (nano copper oxide,nano zinc oxide, nano alumina and nano bentonite) to the molten waxes in different percentage of weight (0,3,7.5 and 15)% for each nano materials,. tThese nano particles were dispersed in the liquid for 40 minute with stirring

Results and Discussion

The results of the melting point and hardness tests of the prepared samples showed that the nano particles (copper oxide, zinc oxide, alumina or bentonite) in different weight percentage (3%, 7.5% and 15%) with wax mixture increased with increasing weight percentage of the nano materials under testing. The relationship between the melting point and weight percentage of each nano particles with wax mixture are shown in Figure-1.

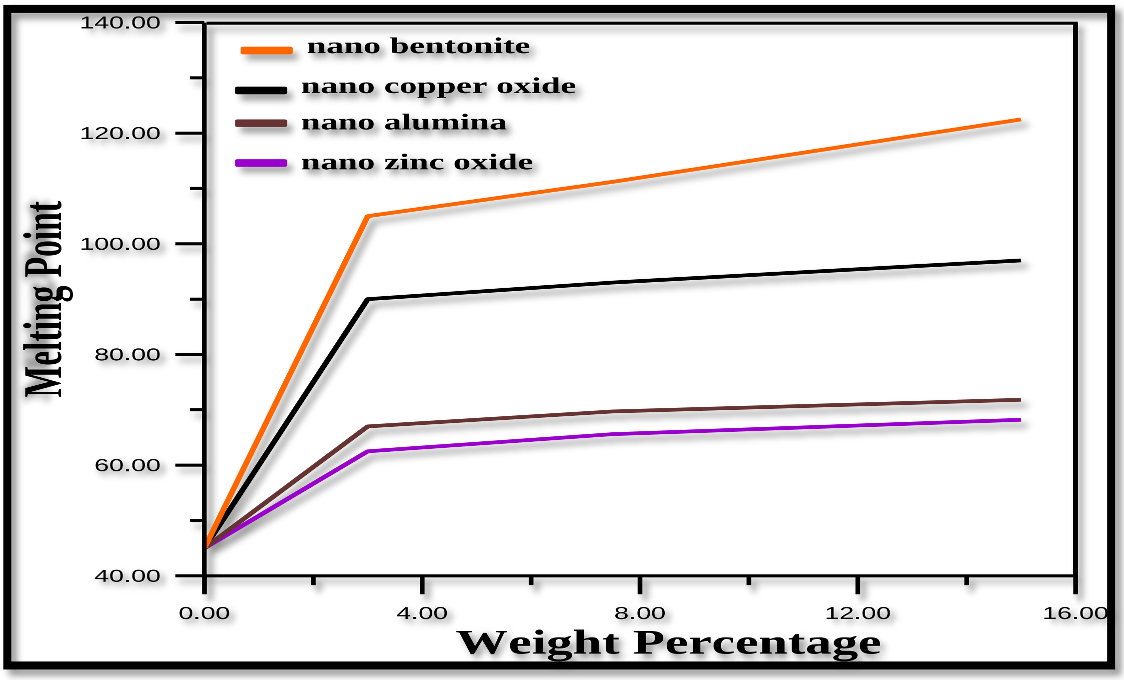

Figure 1-The relationship between the melting point and weight percentage of the nano materials under testing.

Hardness was also plotted against the weight percentage for each nano structure addition with wax mixture as shown in Figure-2.

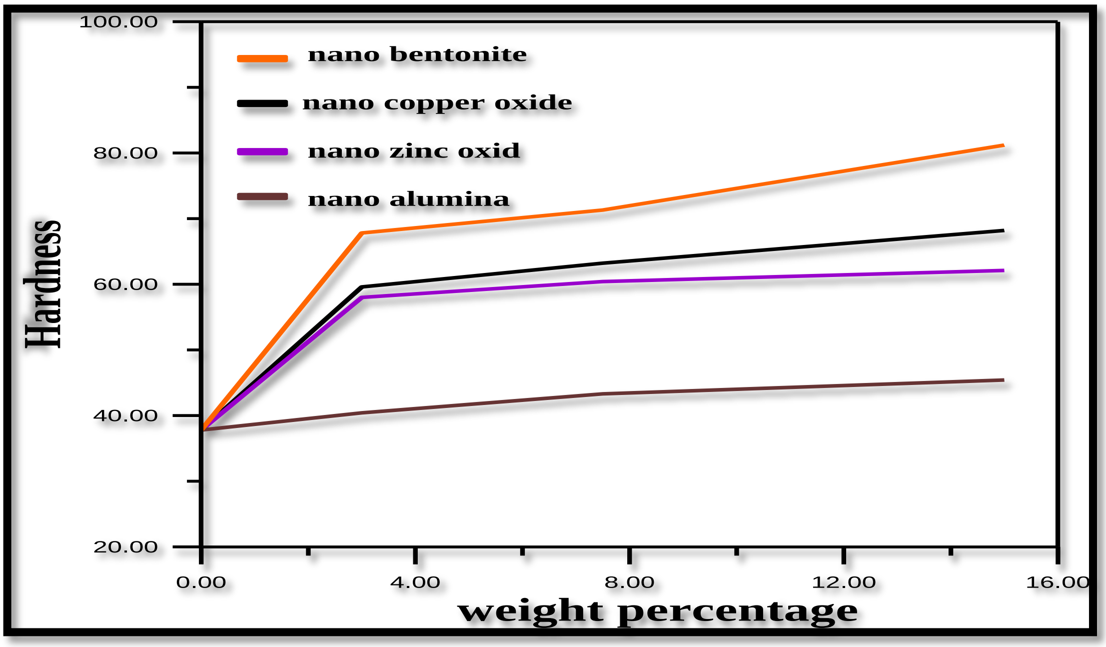

Figure 2-The relationship between the hardness and weight percentage of the nano materials under testing.

The observed increase in the melting point and hardness showed a strong interaction between the nano particles additives and the wax. The hardness increases as the weight of the reinforcement material increases because the reinforcing particles lead to the impedance of the movement of the dislocations and the possibility of the particles on the participation of the base phase in carrying the forces and stresses placed on it [14]. The results were listed in Tables-(3, 4)

Table 3-Melting point results of wax mixture with (3, 7.5, 15) % nano additives

Wt%	CuO	ZnO	Al_2O_3	bentonite
0	45	45	45	45
3	90	62.5	67	105
7.5	93	65.6	69.7	111.2
15	97	68.2	71.8	122.5

Table 4-Hardness results of wax mixture with (3, 7.5, 15) % nano additives

Wt%	CuO	ZnO	Al_2O_3	bentonite
0	37.8	37.8	37.8	37.8
3	59.6	58	40.4	67.8
7.5	63.2	60.4	43.3	71.3
15	68.2	6201	45.4	81.2

The results showed that at the weight percentage (15%), for all the additions of nano particles with the wax mixture , achieved the highest values of melting point and hardness were obtained. The results also indicated that bentonite nano particles gave the a values of melting point (122ºC) and hardness (81.2) See note 1. The properties of bentonite are derived from the crystal structure of the smectite group, which is an octahedral alumina sheet between two tetrahedral silica sheets. Silica as an inorganic filler effectively played important role in the increasing of wax mixture hardness [15].

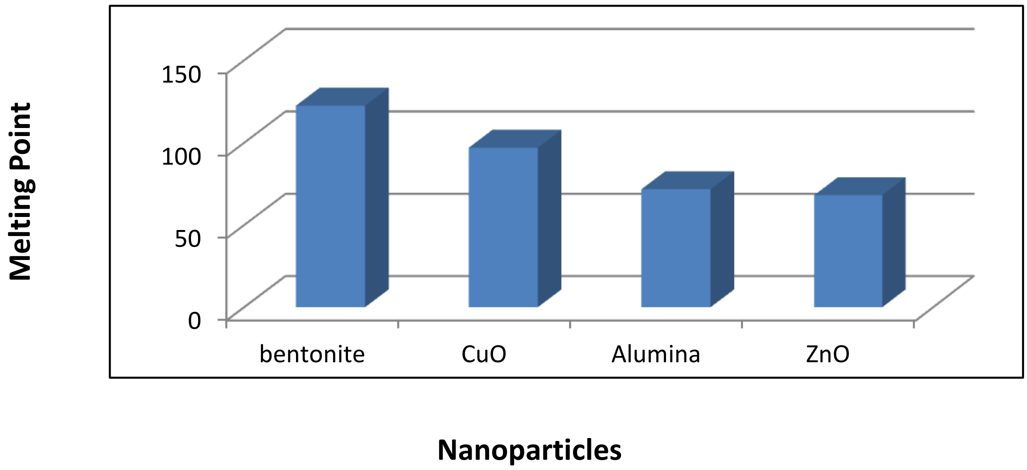

Figure 3-Comparison of melting point results for wax mixture with nano additives at 15% wt.

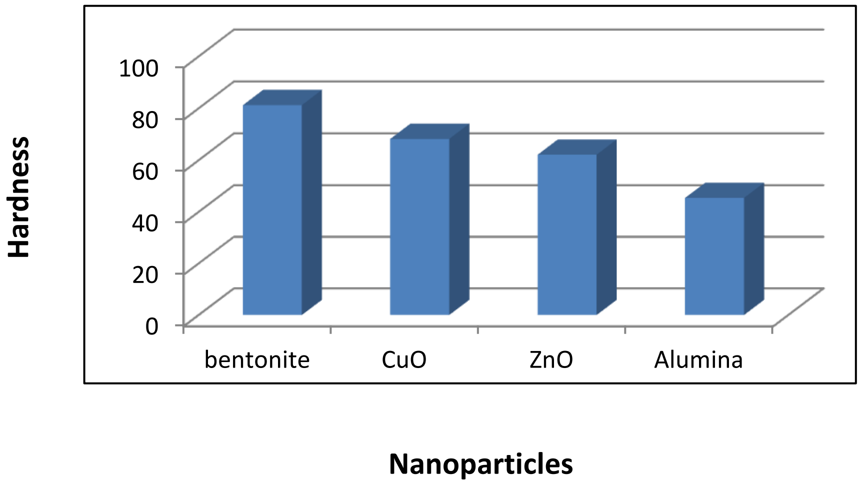

Figure 4- Comparison of hardness results for wax mixture with nano additives at 15% wt.

Conclusions

1-The addition of nano chemicals to the wax mixture improved the melting point and hardness properties of the paraffin wax.

2-The melting point and hardness values of the prepared samples increased by increasing the weight percentage of nano particles additives

3-The addition of bentonite nano particles to the wax mixture achieved a higher improvement to the melting point and hardness compared with the other nano particles.

4-The importance of this research is that the improved sample is a successful alternative to the vegetable wax which has high hardness and melting point and is one of the important components in car wax and other polishes. The improved sample is distinguished as composed of paraffin wax, which is locally available and cheap oil derivatives, while vegetable waxes are expensive and are not available.

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