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Preparation of A New Gamma Irradiated PVC-Olive Oil Cake Plastic Composite Material

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تحضيرتوليفة بلاستيكية جديدة من كلوريد عديد الفينيل (PVC) ومخلفات عصر الزيتون بإستخدام أشعة جاما

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Abstract

This paper dealt with the investigation on preparing new plastic composite material, utilizing polyvinyl chloride polymer (a commercial product in Abu-kammash chemical complex) and olive oil cake (a waste of many olive oil production factories) , followed by gamma irradiation (26.3 Kgry) to induce crosslinking of the polymer. The new material possess good, electrical and mechanical properties as compared to plastic products of (PVC plastic pipe factory), and which could be used as new construction anticorrosive material, such as special roofing and partitioning or household goods.

خلاصـــــة

تعرض هذه الورقة دراسة تحضير توليفة بلاستيكية جديدة مكونة مـن كلوريـد عديـد الفينـــيل (PVC المصنع محلياً بمجمع أبي كماش الكيميـائي) وعجينـة عصـر الزيتـون (مخلفات معامل إنتاج زيت الزيتون). تم تشعيع هذه التوليفة بواسطة أشعة جاما بجرعة إشـعاعية

مقدارها 26.3 كيلو غري من مصدر مشع كوبالت - 60 لغرض حث تكوين الروابط العبورية. تم دراسة الخواص الفيزيائية للمادة البلاستيكية الجديدة، وقد وجد أنها أكتسبت خواص كهربائيـــة وميكانيكية جيدة مقارنة بمنتجات مصنع الأنابيب البلاستكية. هذه المادة يمكن استخدامها كمادة بناء مقاومة للتآكل في عدة أغراض مثل، الأسقف والفواصل الخاصة أو بعض الأغراض المنزلية.

Introduction

Composite materials have been extensively developed and they are continuously growing. They are produced by various processes from different component substances of different states, shapes and sizes, and in which new physio-chemical structure matrix is initiated. They can be classified into systems according to the combinations of the component substances, e.g. metal-metal, metal-inorganic, metal-organic, inorganic-inorganic, inorganic-organic and organic-organic [1]. Each composite material consists of a certain matrix system including the formation of an interfacial structure confirmation. Many composed processing methods are known which include mixing, lamination, impregnation, special heat treatment and diversified combination of them. The properties of the composite material depend strongly on the composite structure, which is initiated by the component substances and the composite processing. Although, much theoretical and experimental work has been carried out, many aspects of the process mechanism is still remaining imperfectly understood [1]. However, possessing various peculiar characteristics such as good thermal and dimensional stability, excellent mechanical strength, anti-corrosion, good electrical properties and others are considered to be of utmost important.

Fibrous materials such as wood, bagasse (a crushed fibrous residue of sugarcane plant), saw dust (waste of timber factories), cellulose paper were used with polymers to manufacture plastic

composite materials [1,2,3]. Majorities of these plastic composite materials are manufactured by mixing or impregnating processing followed by catalytic heating chemical process or radiation process or both. Radiation processing is an easy operation of polymer crosslinking in high yield at room temperature with a reasonable cost. Radiation induced crosslinking of polymers is a well known process for improving the chemical, physical and mechanical properties to great extent [1-6]. Basically, high-energy photons break molecular bonds and forming chain free radicals in close proximity to each other. Combination of the radicals will occur resulting in crosslink.

PVC is one of the most widely used polymers in industry. In practice, most PVC systems contain chemical additives, very often various types of lubricants, stabilizers, plasticizers, antioxidants, pigments and fillers for the processing of plastics, prevention of the decomposition of the resin and for economic purposes. Olive oil cake (OOC), a mixture of skins, pulp, and seeds obtained as an industrial by-product from olive oil processing factories. It is available in appreciable quantities in countries of the Mediterranean zone [7]. World olive oil cake product can be estimated at about 2 900 000 tons [8]. Libya produces substantial quantities of OOC reaching an amount of tens of thousands each year. The composition of OOC varies appreciably due to the different methods used in the processing of olive. In Libya expeller method is used which results in the production of OOC of high fatty acids content (10-15%). Studies indicated that (65-85%) of the fatty acids were composed of oleic acid. OOC contains high amounts of fiber and minor proportions of antioxidants and minerals [9, 10]. OOC can be considered as good source of fibrous material.

Material and Methods

Materials

Industrial grade PVC powder of Abu-kammash chemical complex Type S6858, K-value is 68 and bulk density is 470 gm/l is used. Olive oil cake is obtained from olive oil production plant in Tajoura, dried at 110^{O}C for five hours, grinded and screened (0.354 mm). Di-2-ethylhexylphthalate is used as Plasticiser. Chemical additives used for PVC- plastic pipe manufacture were obtained from Janzour plastic pipes factory.

Experimental procedure

Preparation of PVC-OOC plastic composite materiel

The components (PVC and 3 % wt. OOC) were weighted into a beaker and mixed by hand mixer with speed up to 200 RPM for two minutes at room temperature till typical dry blend (free flowing powder without lamps) was obtained. The mixture was transferred into a planetary mixer and 10 % Plasticiser was added. The mixer was running at 60 RPM and at temperature of 85 ^{O}C for 15 minutes. The mixture was then charged onto heated rolls at average temperature of 165 ^{O}C, the rolling was continued till a sheet of 1 mm thickness was formed. After the corresponding time of rolling, the plastic sheet was removed and cooled. Square pieces of (20x20 cm) were cut from the plastic sheets and placed between two press plates and subjected to pressing operation in two steps. First, heating at low pressure (30-40 bar) for 23 minutes and finally heating at 165 ^{O}C at high pressure (200 bar) for two minutes. Bright red color plastic sheets with dimensions of (200x200x3.5mm) were obtained. The same procedure described

above was followed to prepare sheets of PVC plastic using 3% weight of Janzour chemical additives for the purpose of comparison.

Irradiation of the plastic composite material

The prepared sheets of PVC-OOC plastic composite materiel were irradiated by Co-60 gamma rays with a dose rate of 73 Gry / min at room temperature for six hours.

Study of thermal stability

An automatic heating oven (Met stat, type S) with temperature controlling device was used to determine the static thermal stability of samples as rolled strips. The time until a sharp color change is occurred on the sample strip is the thermal stability expressed as consumed minutes. For the calculation of thermal stability the following formula was used;

$$T = L / V = ((L_1 + L_2 + L_3 - 5.1) / 3) X (t / 25)$$

Where; T is the thermal stability in minutes, L is the distance strip color change measured in cm, V is the speed of tray traveling in cm/min, 5.1 cm is the amount which has to be subtracted from L, (because it does not participate in the traveling), t is the time of traveling in minutes, and 25 cm is the total distance covered by tray in its motion. For t = 60 min, the above formula becomes:

$$T = 0.8 X (L1 + L_2 + L_3 - 5.1).$$

Study of dielectric constant

To determine the dielectric constant of samples in Farad/meter, low voltage measuring bridge (Model NF Dekameter DK 05) and plate electrode measuring (Type NFM 5/TS) were used. Two measurements at 25 ^{O}C are performed at test frequency of 50 Hz.

Mechanical properties

Tensile specimens having the dimensions of (65x13.5x3.5 mm) were prepared. Tensile test performed at room temperature on an Instron Universal Testing Machine at cross head speed of 2 mm/min. As a result of tensile test, load-elongation to fracture curves were obtained from which stress and strain percent were calculated.

Results and Discussion

A new industrial plastic composite material has been prepared by incorporation of olive oil cake with polyvinyl chloride followed by gamma irradiation. A 3% by weight of OOC was selected because this is the percentage of chemical additives used in the industrial processing of PVC plastic pipe factory. The quantity of the component substances with various shapes and sizes and the composite processing conditions are considered to be especially important for the manufacture of the composite, because they control the formation of matrices and the interfacial structure among these matrices. To obtain the desired composite products, the composite components were mixed homogeneously and the rolling conditions were controlled carefully. Dispersion structure matrix is most likely formed in the composite processing and the system can be considered as a state of dispersed OOC particles in a network dimensional polymer medium.

Thermal stability and dielectric constant for the prepared composite material as compared to the PVC plastic is shown in table1.

Table 1: Thermal stability and dielectric constants for the prepared composite material and the PVC plastic

Material	Dielectric Constant F/M X 10^{-11}	Thermal Stability (min)
Irradiated (PVC + 3%OO)	26.2	20.7
Plastic (PVC+3%chemical additives)	30.6	32.9

From this table, it is obvious that the dielectric constant of the irradiated (PVC + 3% OOC) has a lower value in comparison to Plastic (PVC + 3% chemical additives). On the other hand, the new material shows lower value of thermal stability.

Plastic (PVC + 3% chemical additives). On the other hand, the new material shows lower value of thermal stability.

Variation of stress with percent strain for the prepared composite material and the PVC plastic are presented in figures 1 and 2 respectively.

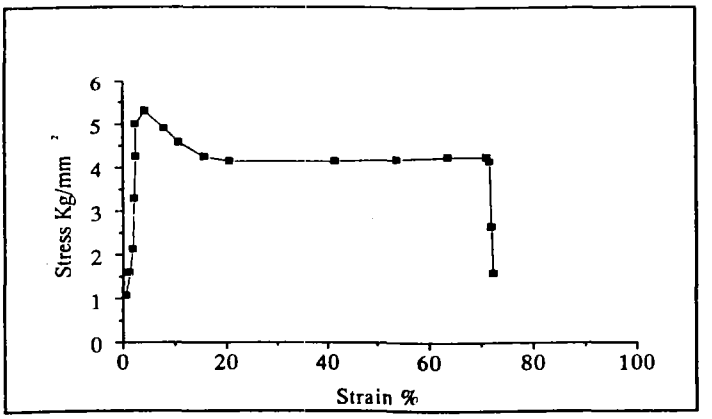

Fig. 1 Stress Strain curve for PVC-3% OOC

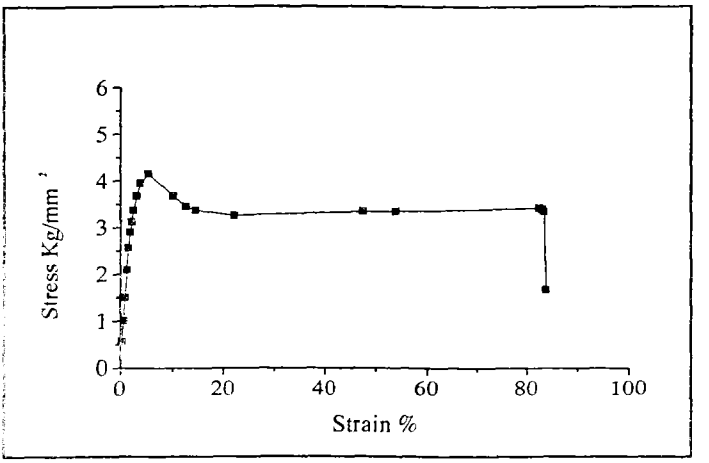

Fig. 2 Stress Strain Curve for PVC-3% chemical additive

It can be observed from these figures and figure 3 (superimpose of the two stress-strain curves), that the new prepared composite material shows higher yield and ultimate strength. In addition, the ductility was decreased as a result of cross-linking which resist the movement of polymer molecules.

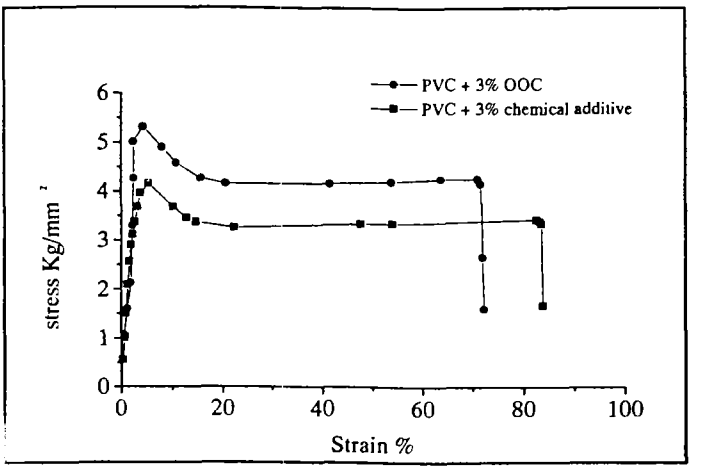

Fig. 3 Superimpose of the two stress-strain curves

Conclusion

Commercially produced PVC in Abu-kammash chemical complex and olive oil cake waste of olive oil production plants have been utilized for the manufacture of a new industrial plastic composite material. The process comprises the incorporation of the OOC with PVC followed by gamma irradiation. Electrical and mechanical properties of the new material were improved as compared to PVC plastic pipes factory. In addition, use of toxic chemical additives is eliminated and the material can have a wide range of uses including anticorrosive construction materials and household goods.

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