



Republic of Iraq

Ministry of Higher Education and Scientific Research

University of Babylon

College of Materials Engineering

Department of polymer and petrochemical industries

**Preparing Insect Repellent polymeric ribbons to reduce
the harm of pesticides to the Environmental**

A Thesis

Submitted to the Council of the College of Materials
Engineering / University of Babylon in Partial Fulfillment of
the Requirements for the Master Degree in Materials

Engineering / Polymer

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(B. Sc. in Polymer and composite materials engineering, 2016)

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2021A.D

1442 A.H

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿ يَا أَيُّهَا الَّذِينَ آمَنُوا إِذَا قِيلَ لَكُمْ تَفَسَّحُوا فِي الْمَجَالِسِ فَافْسَحُوا
يَفْسَحُ اللَّهُ لَكُمْ وَإِذَا قِيلَ انشُرُوا فَانشُرُوا يَرْفَعُ اللَّهُ الَّذِينَ آمَنُوا
مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ ﴾

صدق الله العلي العظيم

سوره المجادلہ 11

Supervisors Certification

We certify that this thesis entitled (Preparation of insect repellent polymeric films) was prepared by (Noor Hussein Radhy) under our supervision at Babylon University / College of Materials Engineering /Department of polymer and petrochemical industries, in Partial Fulfillment of the Requirements for the Award Master Degree of Science in Materials Engineering / Polymers Engineering.

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Acknowledgments

Firstly, all the thank and praise be to **ALLAH** in enabling me to achieve this study.

*** **

Thanks are due to the faculties of the College of Materials Engineering \ Department of Polymer and Petrochemical Industries, especially the polymer laboratories and their staff for helping me with the interviews and examinations and completing the examinations.

I would like to express my sincere thanks and deepest gratitude to **Assist. Prof. Dr-Mohammad AL_maamori and Dr. Mohammad Abd Al Hamza and Dr. Asraa Ali** for his continued encouragement, knowledgeable advice, guidance, and support throughout this study.

I do not know how can I reach my big respect and thank my family for their care, patience and encouragement throughout the study period," I am indebted to them. Additionally, I would like to thank **Eng. Fadhaa Atheer** for her help in carrying out the research. With the utmost gratitude

Dedication

To

The One Who Worth's Praise and Thanks.....

The one who Revives the skies by His Throne and Decorates the Universe by his
Mention.....

Allah

To

the source of humanity...

And the savior of mankind is our noble Messenger Mohammad

To

To the one who drenched the empty cup to give me a drop of love

To those who harvest thorns from my path, to pave the way for me to learn

(my mother and my father)

To

my companion , the light of my eyes

This is a tender heart ... and a kind soul

(My dear husband)

To

The light that illuminates my life ... and my strong bond

my brothers (Ali, Mustafa, Youssef)

To

It is the home of my heart my heaven in my world

My sister (Damoaa, Hadeer)

To

My friend, thank you, because every time you are a positive thing and a strong motivation for me ...

(Haneen , Zahraa , Asmaa , Safa, Zainab)

To

All teachers and colleagues who were supported and pushed me forward.

I present this research with my regards.

Noor Hussein

2021

Abstract

Recently, insects have spread very widely. This led to an increase in diseases transmitted to humans.

To get rid of them used insecticides. But these pesticides cause great harm to humans and the environment, and we will mention later in this research.

The research was prepared polymeric films that repellent insects.

In this research, polymeric insect repellent strips were prepared. Use of biopolymer (PVA) with insecticides.

Where we used a polyvinyl alcohol polymer, which is an environmentally friendly biopolymer that has many distinctive properties, the two of which are non-toxic and biodegradable.

20 g of polyvinyl alcohol polymer was dissolved in 250 ml of water and the polymer solution was applied to the ester until well dissolved.

Then dissolve the pesticide in water.

We prepared the samples, where we took 7% of the polymer solution, and this amount remains constant, and we add different percentages of the pesticide, then we pour the samples into a silicone mold and leave it in normal weather for 36 to 48 hours to dry and get the polymeric tapes.

After that, we conducted several tests.

Structural tests, such as FTIR and DSC.

Physical tests, such as tensile strength

Morphological tests, such as AFM

And we got the following results: From the results of the DSC test of the polymer tape with the insecticide, we note that the insecticide increased the degree of decomposition, TG and, TM The ratio of 2 % of the insecticide izagata to the polymer was the best ratio and gives the best properties. As for the second type of insecticide (Icon), the addition ratio of 2 % was the best ratio in terms of properties. From the results of the FTIR test of the

polymer tape with the insecticide, we note that the insecticide worked to increase the strength of the bonds. The ratio of 2 % of the insecticide (izagata) to the polymer was the best ratio in terms of increasing bond strength. As for the second type of insecticide (Icon), the addition ratio of 2 % was the best in terms of increasing the strength of bonds.

From the results of the UV test of the polymer tape with the insecticide, the ratio of 2 % added from the insecticide (izagata) to the polymer was the best ratio in terms of absorbance and transmittance to visible light.

As for the second type of insecticide (Icon), the addition ratio of 2 % was the best in terms of absorption and transmittance to visible light.

From the results of the tensile test of the polymer tape with the insecticide, we note that the ratio of 2 % added from the insecticide (Icon) to the polymer is the ratio that gives the best mechanical properties.

From the results of the AFM test of the polymer tape with the insecticide, we note that the ratio of 4 % added from the insecticide (izgeta) to the polymer is the ratio that gives the best mechanical properties.

Through the Bioassay experiment the polymer and insecticide activity (Icon, izgeta) were tested.

The results were effective in expelling and killing insects. During (1 to 2) minutes to kill and expel insects inside the cube of the Bioassay experiment for all proportions mentioned.

From the results of the viscosity and density of the polymer with the insecticide (Icon, izagata), the ratio of 4 % for both types of insecticide is the best ratio in terms of viscosity, which gives us a high viscosity.

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List of Abbreviations

Abbreviate	Meaning
AFM	Atomic Force Microscopy
DSC	Differential scanning calorimeter
FTIR	Fourier transform infrared spectroscopy
PVA	Poly (vinyl alcohol)
UV	Ultraviolet

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Chapter One

Introduction

Chapter One: Introduction**1-1 Introduction:**

In the past and until now, insects spread widely, and the presence of insects represents a great danger to human life, as they are the main cause of transmission of many diseases, such as dengue fever, malaria, and yellow fever. [1]. Its presence also causes contamination of foods and the environment. Perhaps butcher shops are a good example of the presence of insects because they are considered one of the most polluted places, so we use insecticides, but the continuous and prolonged exposure to mosquitoes to a group of traditional pesticides reduced the effectiveness of mosquito killing [1]. Use aromatic extracts from plant species as excellent alternatives to synthetic insecticides in that they reduce negative impacts on human health and the environment [2]. To solve this problem, different types of insecticides are used. However, these pesticides have a bad effect on human health and the environment on the other hand, as they may cause allergies and pollute the environment. In addition to infectious diseases, insect bites stimulate local bites. Irritation and discomfort. [3] some insects have become resistant to the present formulations. The medical importance of mosquitoes is mainly due to their ability to transmit many diseases such as fever and encephalitis [4]. As mosquitoes kill nearly one million people every year, children are also affected by mosquito-borne diseases [4].

The insect repellent used and the effective use of some types of pesticides have been banned by environmental concerns [5]. In order to obtain a solution to this problem, the idea came to use polymers to produce polymeric films that repel insects and are environmentally friendly. In addition, the innovative production does not have any negative impact on human, environment and foodstuffs. At any time it is used in malls, stores and butchers' stores.

1-2 Insecticide

Insecticide is a pesticide that is used against insects in all stages of their growth [6]. The control process is by using types of chemical pesticides, as well as some natural plant derivatives. Among the chemical pesticides used is Bordeaux mixture, which consists of copper sulfate, live lime and water, and preparations that include mercury and lead. and sulfur, and such pesticides stick to their inert sediments that can accumulate in the soil, polluting it to be washed later, either by torrential rain or by irrigation with water, carried to the water table and rivers, leading to the death of algae and fish. However, these inorganic chemicals did not pose a significant risk of contaminating soil and water [6]. Figure (1-1) showing the composition of the insecticide. The insecticide should be fatal to target pests, but not to non-target species, including humans. Unfortunately, this is not the case, so controversy has arisen over the use and abuse of pesticides. The rampant use of these chemicals, under the adage, if a little is good, a lot is better has wreaked havoc on man and other life forms [7]. The Figure (1-1) showing the composition of the insecticide

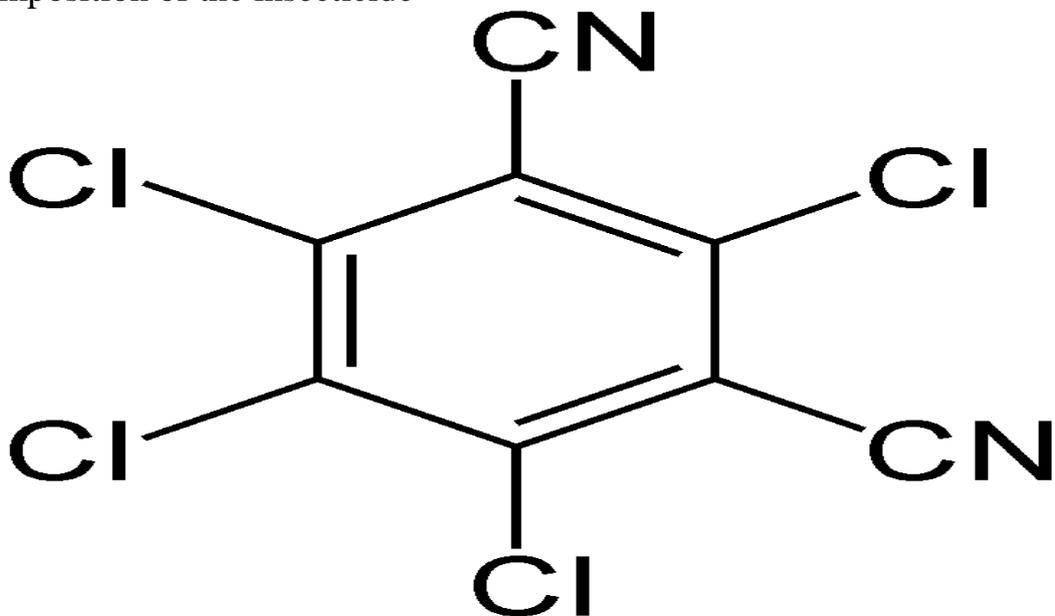


Figure (1-1) showing the composition of the insecticide

1-3 The reason for the spread of pesticides

Fast effect (quick-acting). Easy to obtain at a cheap price. The method of use is simple [8]

1-4 Pesticides and human health:

Pesticides can cause short-term adverse health effects, called acute effects, as well as chronic adverse effects that can occur months or years after exposure. Examples of acute health effects include stinging eyes, rashes, blisters, blindness, nausea, dizziness, diarrhea and death. Examples of known chronic effects are cancers, birth defects, reproductive harm, immune toxicity, neurological and developmental toxicity[9].

Exposure to pesticides can be through skin contact, ingestion, or inhalation. The type of pesticide, duration and route of exposure, and individual health status (eg, nutritional deficiency, healthy/damaged skin) are determinants of a potential health outcome[10]

In this study, a polyvinyl alcohol polymer was used to mix with pesticides. Previous studies also proved that this polymer is one of the best biopolymers to mix with the pesticide. due to the unique properties it possesses, the most important of which are Non-toxic and non-carcinogenic ,compatible with the environment and people ,colorless, water-soluble synthetic polymer ,has good film forming ability PVA undergoes esterification with both inorganic and organic compounds[11].

PVA is widely used as a surfactant, such as films and adhesives due to its biocompatibility, and its stability to temperature change [12].

It can be widely used as a biomaterial due to its high biocompatibility [13]

Water, which acts as a plasticizer, will reduce its tensile strength, but increase the rupture's elongation strength. [14]

1-2 Aims of work

Preparation of polymeric strips reinforced with insect repellents to provide protection from insects, preserve the environment and reduce pollution

And reduce the harm caused by pesticides to humans.

Chapter Two

Theoretical Part And Literature Review

2-1 Introduction

Pesticides: Chemicals that are intended for use by a person or a small group of people to reduce the spread of insects. Reducing the number of arthropod bites requires a topical repellent that is used directly for a short period. Therefore, diseases transmitted through insect bites constitute a global public health problem. Causing human impacts and their impact on social development and economic development [15] Great efforts have been made on a large scale to date to develop effective repellents against insects. However, the use is about hazards to the environment human health, and safety .Insect repellent is used to protect cultivated plants from insect There are many types of insecticides widely used in this field, and the use of synthetic insecticides has caused many unexpected problems [16].Some types of insecticides irritate the mucous vessels, sensitivity, and discomfort. Some of these synthetic repellents have toxic effects, and some lead to allergic reactions and damage to the nervous system [17]. Also, when using insecticides, one of the main problems is eliminating the effect of the pesticide on insects after washing them with soap or detergents (after about five washes it was the most common thing) the effectiveness of the insecticides on the nets was removed [18]. Among the growing diseases are insect-borne diseases, only a few can be avoided. And for this, It is very important to take personal security measures against insects [19] Considering Mosquitoes It directly reacts to environmental changes especially temperatures, It can reproduce quickly in high temperature, high humidity [20].Controlling the spread of insects is a great challenge for human [21].

2-2 Methods of Protection from Insect

1-Protection from insects by relying on killing them. It is the most common and most effective way for people to be safe in their homes.

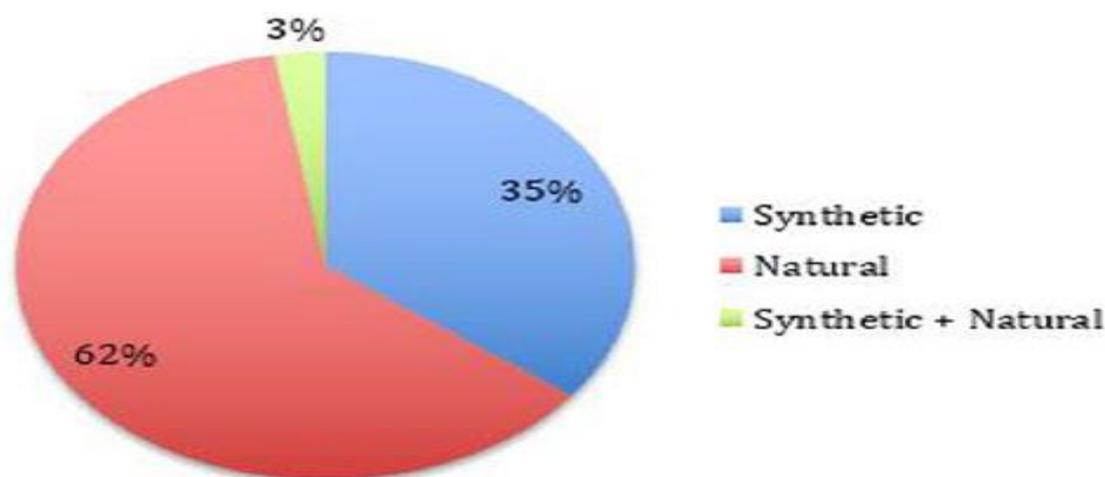
Long-life mosquito nets and other materials, as well as indoor spraying, especially the use of insecticides to treat mosquito nets.

2-Protection is based on preventing insects from absorbing blood repellents. Insecticides are synthetic substances (DEET) or natural substances (such as essential oils) that repel females and prevent them from consuming blood and prevent the transmission of any infection. However, while this form of indirect defense is effective and relatively common, it also provides less efficacy, due to the need to repeat the application of the repellent at periodic intervals of several hours. Reducing insect population density two basic strategies are included in this category: the first is based on removing natural bearers suitable for spawning and larval growth (for example, dewatering from natural or artificial tanks). Human Source Larvae (LSM), which use insecticides or parricides to kill mosquito larvae, is the second strategy for thousands of years, man has used plant compounds such as eucalyptus and citronella, as well as smoke from incense or burning plant material, to repel insects. In the twentieth century, strong synthetic insect repellants were advanced to repel insects that are perceptible to humans without a strong scent. [22] Mosquitoes now ubiquitous, mosquitoes transmit disease from animals and birds and reptiles to humans. Mosquitoes are known to carry many infectious diseases to humans [23] .

We notice the presence of a lot of insects, flies, and mosquitoes near or in the markets, shops, malls, fruit and vegetable stores, and this is one of the places where insects congregate and cause significant pollution and direct disease transmission to people.

To get rid of insects, insecticides are used, but they do not last long. Sometimes the same pesticides pollute these obstacles and pollute to get rid of them. The idea was to use insect repellent polymers to produce

environmentally friendly insect repellent polymers that do not cause any side effects and to reduce pesticide risks. Where used a polymer (Poly vinyl alcohol) which is a granular synthetic polymer with distinct properties, including non-toxic and biological properties. To get rid of the toxicity and harm of the pesticide, this polymer is combined with different forms of pesticides in different quantities. As in the figure (2-1) the distribution of synthetic and natural insecticide[24].used



Distribution of synthetic , natural insect Fig (2-1) : repellents

2-3The Harm Caused To Humans by Pesticides

Among the harm caused by Pesticides are respiratory paralysis, weak immune system, sensitivity, hypertension, central nervous system damage, cancer, liver function breakdown and hormonal imbalance. Indeed extreme and terrifying damage caused by pesticides to humans, the environment and all types of life cannot be quantified, because these damages vary at the time of their appearance and differ in the magnitude of their harm between different species[25].These losses are reflected, either directly, through the arrival of the pesticide to humans through touch, inhalation, mouth, or eyes in the areas close to the application of

the pesticide. Or indirectly through ingestion of materials contaminated with pesticides (food, water and air) [25].

2-4 Water pollution by pesticides (wells, rivers and seas)

The arrival of insecticides to the water through several methods, including combating the spraying of water insects or by dissolving the residues of pesticides in agricultural soil or through rain and irrigation water, as well as the waste of pesticide factories in drains and valleys. And rivers. Spraying pesticides is one of the main sources of water pollution, and most insecticides do not dissolve easily and stay in place.

2-5 Damages of pesticides on soil and the environment

Insecticides are considered among the most dangerous environmental and ground toxins, On the other hand, the frequent use of these pesticides contributes to the loss of fertility, pollution, and severe toxicity of pesticides. The killing and degradation of many beneficial living organisms and the destruction of biological diversity, including all types of living organisms, Which are carcinogens produced by plants and which result in their transfer to them when animals or humans feed on those plants [25].

2-6 Types of pesticides

Pesticides can be divided into either biodegradable insecticides that are broken down into harmless compounds by microbes and other organisms, or persistent insecticides that may take months or years to dissolve [26].

2-7 Classification of pesticides

The classification distinguishes between the more and the less hazardous forms of each pesticide in that it is based on the toxicity of the

technical compound and on its formulations. [In particular allowance is made for the lesser hazards from solids as compared with liquids[27].

2-7 -1 Classification of pesticides according to chemical composition

2-7- 1- 1 Pesticides of Organ Chlorine, or Chlorinated Hydrocarbons

These compounds contribute to severe damage to the environment by contaminants, resulting in the toxicity of the different species exposed to them and are thus identified as toxic pollutants, the effects of which are derived from their properties. A pentachlorophenol example [28].

2-7-1-2- Phosphorous organic pesticides

It was produced in the fifties of the twentieth century and is now used in greater amounts of organ chlorines, but it is more toxic because the organic phosphorous compounds are brittle, so that they do not survive long in the atmosphere and break down easily in the soil, which is quickly fatal [29].

2-7-2 Classification of insecticides based on the way of entry into the

Stomach poisons , Contact poisons, Fumigants

2-7-3- Classification of insecticides based on mode of action

They are classified as physical toxins, neurotoxins, respiratory toxins, prototoxins , general toxins [30]

2-7-4 Classification of insecticides based on toxicity : Table (2_1)

shows the classification of pesticides according to toxicity [30]

Toxicity	Color
highly toxic	Red
medium toxicity	Blue
Less toxic	Green

2-8 Insecticides used for mixing with the polymer

2-8-1- Type Icon insecticide

An international health insecticide in the form of a powder that can be dampened with water to be prepared in the form of an emulsion concentrate. Each 1 gram contains 1 gram of lampdasylthothrin, a pyrethroid compound. The active ingredient is intended as a general insecticide to be used in aerospace spraying or pest control programs for vector control.

2-8-2 type insecticide izagata

An insecticide including that both active ingredient thiamethoxam and a pheromone attractant that is sure to attract flies to any location I use it. This formula is used as a coating in which surfaces are painted and flies collect and die on these surfaces. As in the figure shows the process of spraying pesticides in the air

2-9 Polymers

It is a compound made up of repeating subunits of high molecular weight [31]. These materials can be classified based on their origin as either natural or synthetic [32] Polymers are materials composed of long, continuous, and repeating molecules. These materials have special properties depending on the chain shape, how they are bound, and the type of ties. Certain types of polymers, such as rubber and polyester, are elastic and brittle. Others including glass and epoxy, are solid and durable. The polymer is found in nearly every aspect of modern life. People deal with and use products that contain polymers, from water bottles to tires and household items. Polymers are also widely used in medicine. In nearly every aspect of modern life, polymers are used. People deal with and use

polymer-containing goods, from bottles of water to tires and household items. In medicine, polymers are also widely used. In all areas of our daily life, polymers are used. Polymers are used in shopping bags, cloth fibers, tablets, laptops, food wrappers, car parts, and toys. Some modern technologies use polymers, such as membranes for desalination, biopolymers used in tissue engineering.

2-10 Types of Polymers and Classification

As shown in Figure (2-2) Classification of Polymer

A- Natural Polymer : -according to sources

These polymers are divided into

1-Polymer organic

These polymers are natural plant or animal products based on it: Amylose, starch, Arabica, cat, natural cat, silk, proteins, nic acids, Wool hair, skin, and others. These are expensive polymers, because they are limited.

2- Inorganic polymers

Inorganic polymers are polymer materials that do not have carbon atoms in the backbone. However, most of these polymers are about hybrid polymers because there are some regions as well. These chemicals are related to other chemical elements; For example sulfur and nitrogen. Such as: asbestos, graphite – glass.

B- Synthetic Polymers

Synthetic polymers are derived from petroleum oil and developed by scientists and engineers. Nylon, polyethylene, polyester, Teflon, and

epoxy are all examples of synthetic polymers. In nature, natural polymers exist and can be extracted. Mostly they are water-based. Silk, wool, DNA, cellulose, and protein are examples of naturally occurring polymers This type

1-Organic polymers THEN Acrylic - Polycarbonate - Polypropylene and others.

2-Inorganic polymers –Such as polysilicon polymers

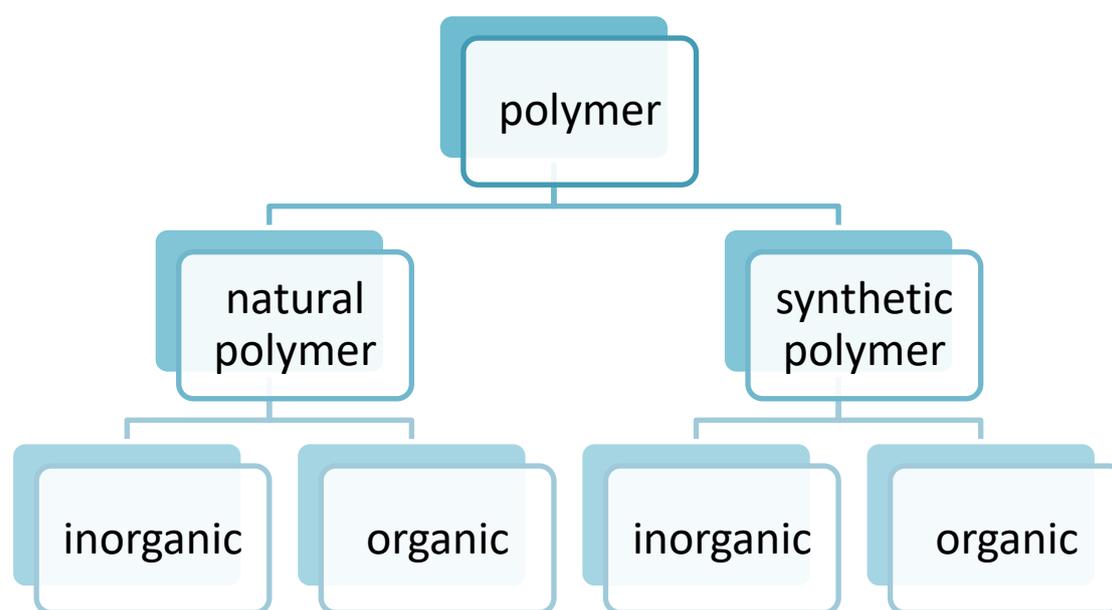


Fig (2-2) Classification of Polymer

2-11 Classification of polymers according to their type

Its technology the properties of chemical agents and their dependence and its practical uses to the following types

2-11-1 Thermoplastic polymer

It is a polymeric softens with heat and becomes a paste. Its shape can be changed manually, and when it is cooled it becomes more solid. Without any changes in their chemical or mechanical properties, thermoplastics can be cooled and heated multiple times. In used

electronic applications, some products made of thermoplastic materials are used. Such as polypropylene, polyvinyl alcohol, polyethylene and polystyrene [33]

2-11-2 Thermosetting Polymers

Includes the type of polymers that do not melt by heating, but heating helps to stabilize their final shape, as they harden by heat and pressure, and these polymers suffer from chemical changes and the chains are intertwined and these polymers, after being treated thermally, become insoluble, and poorly conductive for heat and electrical.

2-11-3 Elastomer

These polymers have distinctive properties that represent elongation and their ability to expand and contract. The ability of this type of polymer to exhibit its elastic properties depends on polymeric molecules with long, flexible chains wrapped together. Like rubber.

2-12 biopolymer

Are natural polymers produced by the cells of living organisms. Biopolymers consist of monomeric units that are covalently bonded to form larger molecules. The biopolymer material is divided into two types: natural biopolymer and synthetic biopolymer [34].

2-12-1 Biopolymer applications

The applications of biopolymers can be categorized under two main fields, which differ due to their biomedical and industrial use [34].

2-13 Biodegradable polymer

Are a special class of polymer that breaks down after its intended purpose by bacterial decomposition process to result in natural

byproducts such as gases (CO₂, N₂), water, biomass, and inorganic salts[35]. These polymers are found both naturally and synthetically made, and largely consist of ester, amide, and ether functional group .

2-13-1 Properties of Biodegradable polymer

Biodegradable polymers should be stable and durable enough for use in their particular application upon disposal they should easily break down non-toxic capable of maintaining good mechanical integrity until degraded capable of controlled rates of degradation[36] .

2-14 The development of the use of polymers with pesticide

The development of mosquito resistance is a destructive factor that hinders its effectiveness. Mosquito resistance mechanisms such as selection pressure and cross-resistance have been greatly affected by the continuous exposure to combinations of conventional pesticides For example, *Culex pipiens* have developed the anatomical resistance barrier by developing thicker cuticles due to prolonged exposure to fenthion, an organ phosphorous pesticide. To overcome resistance, several research groups have formulated inorganic nanopesticides that have efficacy in mosquito repellents, larvicides and pesticides. Most inorganic nano pesticides are made from plant systems to reduce environmental toxicity. The main drawback is environmental uncertainty and toxicity. Therefore, polymers were used with the insecticide in several forms (either in the form of nano-fibers, or in the form of a derrick, or in the form of food boxes, or in the form of paint, as mentioned in this study) to get rid of insect resistance to the same pesticide and get rid of insects at the same time[37].

2 -15 Type of polymer used with repellent

propylene ,low density poly ethylene ,poly methyl, methlacrlet , poly vinyl alcohol Studies have proven that the polyvinyl alcohol polymer is the best polymer to mix with the insecticide because biodegradable polymer

2-16 Materials used in this study

Polymer (poly vinyl alcohol) 2-16-1

2-16-2 Insect repellent (icon, izagata)

Polyvinyl alcohol 2-16-1

Herman and Haehnel prepared the PVA for the first time in 1924 [38] Polyvinyl alcohol (PVA) is a non-toxic, cold-water-soluble synthetic polymer that has a good film-forming ability [39]. It has a large number of hydroxyl groups which allows it to react with many types of functional groups [40]. This' allows' it' to be widely used as biomaterials because of its highly biocompatible. It has the formula $[\text{CH}_2\text{CH}(\text{OH})]_n$. It is used in the manufacture of paper, and the manufacture of weaving and covering. It is a white substance that does not smell. They are sold as granules or aqueous solutions [41]. PVA participates with both organic and inorganic compounds in the esterification process and reacts with boric acid and borax to form cyclic esters that are insoluble in water. As in the figure (2-3) below, it shows PVA used.



Fig (2-3) PVA Used

Polyvinyl acetate, (PVA), is a kind of thermoplastic polymer. Elastomeric synthetic polymer Elastomers. Polyvinyl acetate is prepared by polymerizing acetate monomer (free radical vinyl polymerization of the monomer vinyl acetate [41]. Poly (vinyl alcohol) was purchased from the local market, made in (India) with the degree of hydrolysis properties (226-230), MW = 16000. The repellent was from the local Market

2-16-1-1 properties of PVA

Polymer dissolved in cold water, Non-toxic, Use as a good adhesive Scentless, high tensile strength and flexibility, resistant to grease oils and solvent.

2-16-1-2 Structure of PVA

PVA is an atactic, material that exhibits crystallinity. In terms of microstructure, it is composed mainly of 1, 3-diol linkages [-CH₂-CH(OH)-CH₂-CH(OH)-] but a few percent of 1,2-diols [-CH₂-CH(OH)-CH(OH)-CH₂-] occur, depending on the polymerization conditions of the vinyl ester precursor [41]. There are excellent properties such as

emulsification, and adhesion to polyvinyl alcohol; resistance to oils, greases, and solvents as well. In addition to its high oxygen resistance, it has high tensile strength and high elasticity. These properties, however, depend on moisture, which means that more water is absorbed with greater humidity. This water, which serves as a plasticizer, decreases the tensile strength but increases the elongation and strength of the tear. Considerations of protection and the environment. Thanks to its nontoxicity and biodegradability, PVA is commonly used. Solutions containing 5% PVA are non-toxic in water for fish and also slowly degrade. The figure(2-4) shows the composition of polyvinyl alcohol

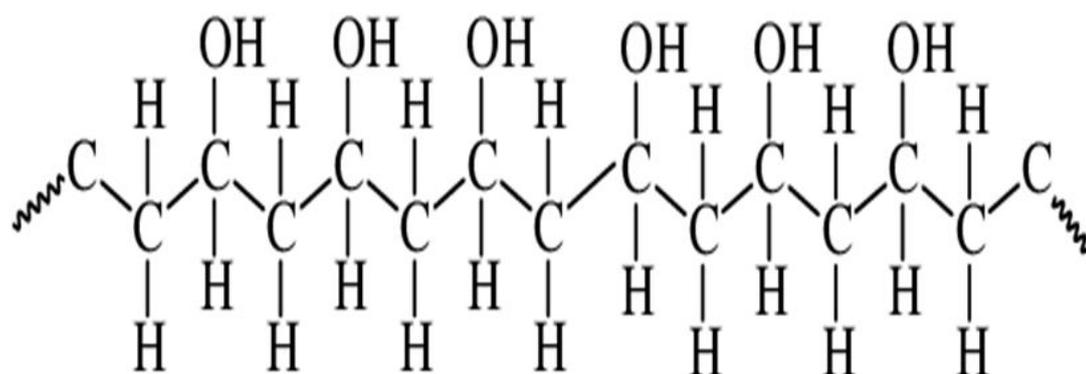


Figure (2-4) PVA Structure

2-16-1-4 Applications of PVA

PVA polymers have found applications in various industries, including cloth, paper, adhesives, food, biomedical, and pharmaceutical in particular, due to simple structure and specific properties such as adhesiveness, strength, film formation, biocompatibility, swelling, protection, and non-carcinogenicity. [41]. Properties such as high water content, swollen elastic nature, biocompatibility, and swelling make the PVOH hydrogels a potential candidate as a material for tissue replacement. PVOH hydrogels have been investigated as soft contact lens

material, artificial heart linings, artificial cartilage, catheters, skin, and membranes of the pancre

2-17 Literature review

Spécos *et al.*, (2010) [42] Prepare mini capsules made of gelatin, gum Arabic, and citronella oil. Envelope To treat cotton fibers, citronella oil was used. It was the kinetics of oil release and the effectiveness of the insect repellent treated fibers treatment with microcapsules are shown high insect protection compared to the control groups. number of mosquitoes that land on micro capsulated fabrics In 3 weeks they were insignificant, and provide expulsion Higher than 90%.

Faulde *et al.*, (2010) [43]] Using a novel polymer coating process, a long effect insect repellent mesh that housed an insect repellent was prepared and developed (DEET and IR3535) into grids. Their results showed that the fabrics were wet. Permissible dose aversion was revealed with DEET bath and IR3535. Where it could have been achieved 100% protection with 4.66 impregnated mosquito net G / m² of DEET over 29 weeks, 54 weeks of 100% protection With 8.8 g / m² of DEET, 61 weeks at a rate of 10.48 g / m² of DEET, and 23 weeks of total treated tissue protection With 10.02 g / m² or IR3535. These results indicate that The new method is a possible candidate for potential insect disposal.

Kim *et al.*, (2013)[44] Prepare accurate capsules from Gum Arabic, Cinnamon oil is present in whey protein isolate (WPI) / maltodextrin (MD) and polyvinyl alcohol (PVA). The encapsulated oil has been incorporated into low-density capsules Polyethylene (LDPE) films provided insect repellent films. The results indicated that films containing microcapsules had higher Insects resistances compared to the untreated films that lasted for 7 days with little. Films treated with PVA and WPI /

MD micro-capsules were shown More efficient compared to the micro-capsules that contain Cinnamaldehyde, which repels the cinnamon oil bug., Its launch was extended when inserted in Small capsules. The amount of cinnamaldehyde that I'm excreting The films containing the micro-capsules was 23 times smaller in comparison To films containing Empty Cinnamon Oil.

Chung et al., (2013) [45] Prepare microcapsules coated with thyme oil consisting of a polymer of melamine formaldehyde. Use three surfactants to assess their effect on the profile of oil release: Pluronic® F-127, Tween® 80, and sodium lauryl sulfate. Micro-capsule packaging It was possible to maintain the release of oil and repel it for at least 4 weeks, representing 90 percent of the successful expulsion. The results showed the storage temperature and the type of surfactant influencing the thyme oil release profile. Packaging containing melamine-formaldehyde was seen in this article. Micro-resin capsules promise to prevent food from infecting insects.

Nagueira et al., (2013) [46] Thermally produced Micellar gel-like systems for DEET topical delivery and these She studied drug release and penetration properties. Formulations, based on Condensed Solutions from Pluronic F127 Co-polymer and DEET, create a thermoplastic gel-like. Suggested results that DEET may have functioned as a kernel factor and induces the development of liquid crystal structures produced by Pluronic F127 Chains The formulations showed that up to 7 hours of drug release is sustainable and that after this time the permeated amount of DEET decreases by approximately 35 percent. After 6 hours, approximately 62% of the formulations consisting of Pluronic F127 and DEET were extracted from the skin. These outcomes were well-deserved for the anisotropic structures that are an obstacle.

De Figueiredo et al., (2014) [47] Alginate gene (ALG) /cashew gum (CG) nanoparticles were prepared by spray drying, to fill in Lippie sidoides (Ls) aromatic oil that works to fight aides larvae. Variability parameters such as packaging efficiency and oil emission of nanoparticles with different polymer concentrations and oil content were evaluated in this research. The findings proved that the nanoparticle was from ALG and CG in different proportions. The nanoparticles formed from ALG: CG 3: 1 showed a 45% release of oil within 50 hours, and the lowest rate was found in this study.

Ichiura et al., (2014) [48] They prepared a membrane, useful as an insecticide membrane, containing a polyamide membrane between polymerization, paraffin-DEET compounds to study the release of DEET and its dependence on temperature. The paraffin-DEET was coated with a polymer. PMMA-bound capsules are then added to the polyamide films. At higher temperatures in the melting paper, the volatilization of DEET was controlled by paraffin. Therefore, the realistic paper containing the paraffin-DEET mixture was able to release DEET in a sustainable manner.

Licciardello et al., (2014) [49] Produce a new bug Mosquito repellent food packages contain citronella and oregano And rosemary essential oils in polypropylene films (PP) and tested for efficacy against red flour beetle (Tribalism) Titanium) .PP laminated films appeared remarkably. Higher repellent compared to control sample that Essential oils are not restricted but only absorbed. Aversion A control sample lasted 3 hours and was obtained Then, it decreased aromatically, while coated films showed prolonged periods of Insect protection, the percentage ranges from 60% for citronellas PP films and 87% for rosemary-based PP films.

Hebetic et al., (2014) [50] prepared chemically modified cotton fibers grafted with glycidyl methacrylate and β cyclodextrin containing Permethrin to provide protection against adult mosquitoes. All chemically treated fibers showed toxic and repellent effects to mosquitoes after 60 minutes and also after 24 hours compared to untreated fibers their results demonstrated that chemical modification of cotton fibers was reflected in three properties: Strong repellent action, moderate knockdown ability and a striking killing property.

Balaji et al., (2015) [51] Preparation of advanced synthetic insect repellants, DEPA nan emulsions. Polymerization of poly (ethylene glycol) (PEG) followed by PIT emulsification resulted in stable stability of the polymer in PEG mode micelles for 45 days and further aqueous DEPA dispersion. *Culex tritaenariensis* larvae have been tested for this Nano-formulation (Nano DEPA). Japanese vector of encephalitis and outcomes equate the results obtained for free depa. These results demonstrated improved anti-larval efficacy of Nano DEPA due to its high penetration Larval tissues and enhance bioavailability even in less Concentration.

Marcin Przybylak et al., (2017)[52] the study was conducted to differently treat cotton fabrics Poly siloxanes to impart bio pesticides and waterproofing Poly siloxanes to impart biocide and water repellent properties Tested on modified fabrics. Water resistance was determined by measuring the angle of contact with water. Samples were evaluated by SEM, FTIR Spectra, and Elemental analysis. The results show that the multi-functional fabrics are obtained with biocide, hydrophobic, and washable properties. Modified samples show protection against mold growth at level 2 and angle of contact with water up to 140. Modification

This does not cause any default changes to hardening, discoloration, or mechanical deficiency Properties.

Tom Gheysens et al., (2019) [53] have studied direct micro-encapsulation of emulsion repellants and incorporate repellants already encapsulated into the Nanofibers via electrostatic spinning. The different repellants were electrically spun into the synthesis of polyvinyl alcohol(PVA)nanofibers, namely the p-menthane-3,8-diol microcapsules, permethrin, chili, and catnip oil. Their results indicated that all insect repellents were incorporated into the Nanofibers. When incorporating insect repellents into Nanofibers.

Significantly reduced the number of mosquitoes shed compared to the control group. Consequently, The process currently described has resulted in a new and highly efficient tissue material that can be used to prevent mosquito-borne diseases.

Changjiao Sun et al., (2020) [54] Use of polymers as nano carriers for pesticides. expect them to ensuring a higher level of protection for humans and the environment, while ensuring the good efficacy of the active ingredient. Use some synthetic polymers (including polyethylene glycol, polylactic acid, polycaprolactone and polyhydroxybutyrate), which is widely used in pharmaceutical or cosmetic fields, can be used as carriers of pesticides. Polymeric materials can be prepared with different types of 3D Structures, among which the nanocapsules, nanospheres, micelles, nanogels, and Nano fibers are most commonly used to conduct active ingredient. The environmental risks of polymer-based nano pesticides have been highlighted, along with the major risks Challenges to be solved before marketing in the future. These challenges include lowering the cost of its production and evaluate their performance, especially at the field level. conclusions. Polymer-based nanostructures appear promising

for targeted release of active ingredients while minimizing excess run off. In order to facilitate the development of new useful products, cooperation between countries around the world is needed.

Adrian C. Williams et al., (2021) [55] developed a novel polymer insect repellent conjugate for extended release and decreased skin permeation of the volatile insect repellent p-menthane-3,8-diol (PMD). Methods: PMD was conjugated with acryloyl chloride via an ester bond to form acryloyl–PMD, which was subsequently copolymerised with acrylic acid at varying molar ratios. Copolymer structures were characterised by ¹H NMR and FT-IR, analysed by thermo gravimetric analysis (TGA), differential scanning calorimetry (DSC), molecular weights and reactivity ratios determined, and repellent loading assessed. Results: Using porcine liver esterase's, 45% of the insect repellent was released over five days. Penetration and permeation studies of the copolymer and free repellent using excised, full-thickness porcine ear skin showed no detectable permeation of the copolymer through skin compared to the PMD. Moreover, tape stripping revealed that over 90% of the copolymer remained on the outer surface of the skin, whereas free PMD was within all skin layers. A planarian toxicity fluorescence assay indicated that that the copolymer is unlikely to be a significant irritant when applied topically.

Chapter Three

Experimental Part

3.1 Introduction

The following sections are included in this chapter:

1. Properties of the materials employed. Such materials are made:

A. Polyvinyl alcohol (PVA)

B- insect repellent

2. The following experimental procedures were carried out to prepare the following samples:

A. ribbon of Pure PVA.

B. Insect repellent PVA/ types In various proportions (2,4 %)

Repellent to 1.PVA/ Izagata .

Repellent of 2.PVA/Icon.

3. Tests, which comprises from the following types:

A. Structural tests, such as FTIR.

B. Physical tests, such as wettability, tensile strength.

C. Morphological tests, such as AFM.

d. Thermal properties such as DSC

3.2 The used materials

3.2.1 Poly vinyl alcohol (PVA) (It was bought from the local market

Poly vinyl alcohol properties maintain in table (3.1).and made in India

Table (3.1) Poly vinyl alcohol Properties

Property	Data
Color	white crystalline powder- flakes – granules
Solubility	4% solution in cold water is clear and colorless
Viscosity	27-30 cp aqueous solution at 20 °C
Molecular weight	160000 (g/mol)
Degree of hydrolysis (%)	86.50-89.0

3.2.2 Repellent insection (icon , izagata): It was bought at the local market

1- **Icon Insecticide** made in France and has been successfully evaluated by the WHO Pesticides Evaluation Scheme (WHOPES) for indoor residual spraying for malaria prevention and control .a modern high technology insecticide containing the active ingredient Lambda – cyhalothrin, recognized as one of the most powerful pyrethroids available for the control of crawling and flying insects. It provides extended residual control of up to nine months compared to conventional formulations.uses state of the art micro-encapsulation technology to give a product, which combines the ease of use of an emulsifiable concentrate, with the long lasting residual strength of a wet table powder. The insecticide is contained in a polymer microcapsule which remains intact on the target surface after spraying. The active ingredient is protected from the environment and offers extended residual activity, particularly on porous surfaces like cement and mud. It also shows improved performance on challenging vinyl painted surfaces when compared to other formulations .exhibits a fast knockdown and killing action against a broad spectrum of insects. It has minimal odor after application and is none staining on household surfaces and is therefore accepted by householders ensuring high levels of coverage during spray programmes . presented in a single unit sachet. This unit dose “Pump Charge” facilitates accurate dosing and reduces wastage. The contents mix quickly and easily with water, and should be applied through a quality compression sprayer with a flat fan 8001E or 8002 E nozzle. This ensures the correct application rates onto the target surfaces normally found in traditional and western type houses.

2- **Insecticide Izagata** : An insecticide that contains thiamethoxam as an active ingredient, plus a pheromone attractant that is sure to attract flies wherever they are used. This pesticide is used as a surface coating

3-4 Test

Figure (3-1) below illustrates first the sample preparation process and secondly, It is poured into the mold, placed under normal weather conditions, left to dry, and finally the required tests are performed

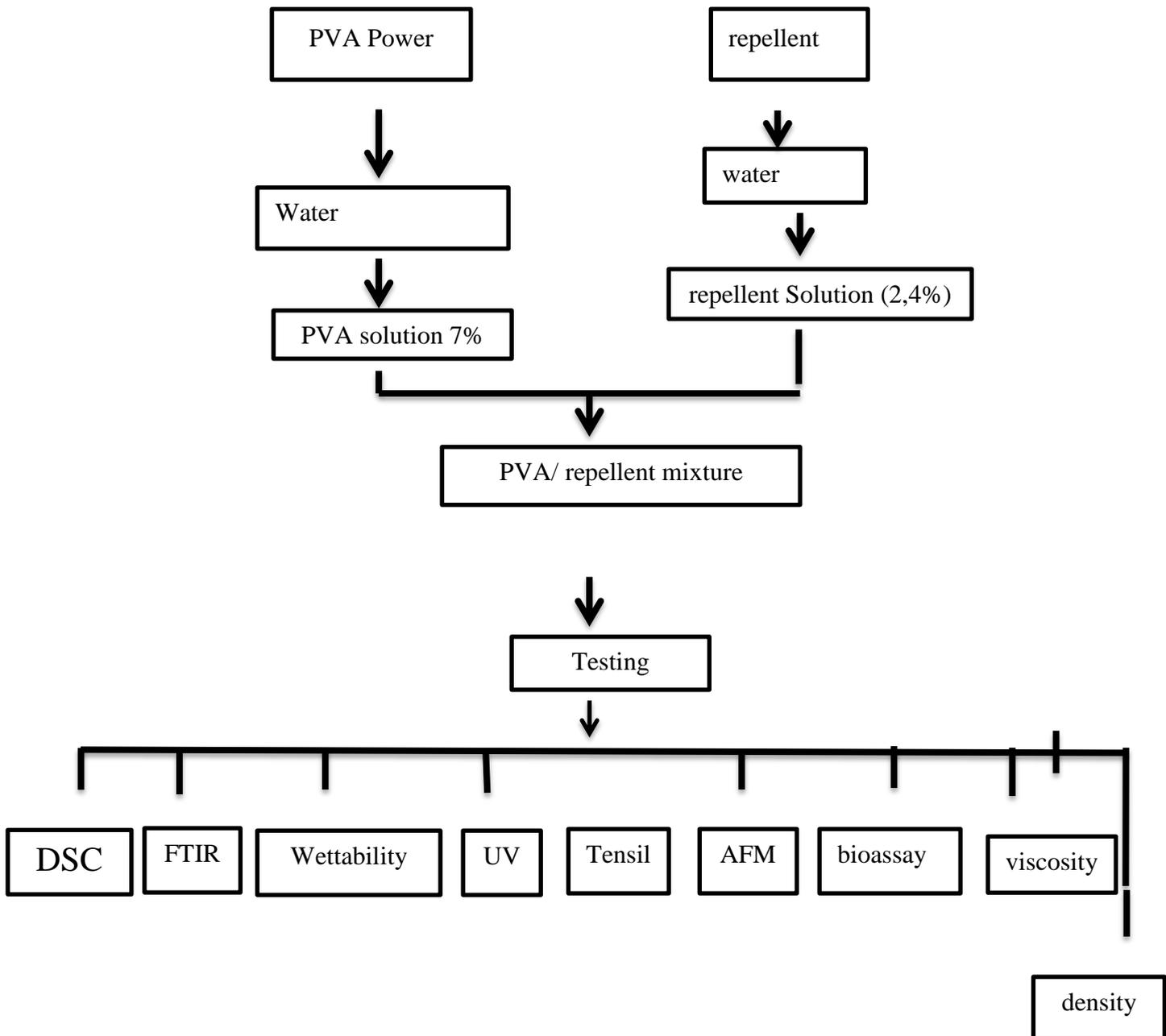


Figure (3.1): Explains the preparation process and required tests

3.3 Preparation of solutions(PVA + Repellent)

In 250 ml of cold water, dissolve 20 grams of polyvinyl alcohol granules and place them on a stretcher without heat and leave two hours for the polymer to dissolve well. The solution is wrapped and covered well and left for a whole day before mixing with the insecticide .Then we dissolve the insecticide (60 grams) in 1 liter of water.

After completing the process of preparing and dissolving the polymer and the insecticide (Icon, izagata), we take 7 % of the polymer solution (PVA) and this amount remains constant and we add to it different percentages of the insecticide (Icon, izagata) with proportions (2,4%). After adding the insecticide to the polymer, it is mixed by a mechanical mixer at a speed (50) for one hour so that the polymer and pesticide are well combined as in the figure (3.2) . Then pour the mixture (polymer + insecticide) into a silicone mold as in the figure (3.3) and leave it under normal conditions (temperature, humidity) for (36-48 hours) to dry and get a sample to perform the required test combined as in the figure (3.4) and (3.5). The table (3-2) shows the proportions of mixing the polymer with the insecticide.

Table (3.2) Pesticide concentration and PVA

Sample	Consideration %	Consideration %
PVA pure	0	0
PVA + Izagata	2	4
PVA+icon	2	4



Figure (3.2) Explains the mixing process

2.1 Preparing samples of the first type of pesticide (Izagata) with the polymer

A-Preparation of first and second spesmeint (PVA + Izagata 2 ,4 %)

We take 70ml of a polymer solution (PVA) and add to it a proportion (2 ,4 %) of the insecticide (izagata).

After adding the pesticide to the polymer, it is mixed with a mechanical mixer quickly (50 km) for an hour until the polymer and the pesticide are well combined.

Then pour the mixture (polymer + izagata) into a silicone mold and leave it under normal conditions (temperature, humidity) for (36-48 hours) to dry, and get a sample to perform the required tests.

2.2 Preparing samples of the second type of pesticide (icon) with the polymer

A-Preparation of first and second spesmeint (PVA + icon 2,4 %)

We take 70ml of a polymer solution (PVA) and add to it a proportion (2,4cc) of the insecticide (icon).

After adding the pesticide to the polymer, it is mixed with a mechanical mixer quickly (50 km) for an hour until the polymer and the pesticide are well combined.

Then pour the mixture (polymer + izagata) into a silicone mold and leave it under normal conditions (temperature, humidity) for (36-48 hours) to dry, and get a sample to perform the required tests.

The figure(3.3) shows the template used to prepare the polymer samples with the insecticide,The figure (3-4) shows one of the samples that was obtained by polymer with the insecticide Icon ,The figure (3-5) shows one of the samples that was obtained by polymer with the insecticide Izagata.



Figure (3.3) Mold used to prepare samples



Figure (3-4) specimen polyvinyl alcohol with repellent icon



Figure (3-5) Spearmint polyvinyl alcohol with repellent izagata

Table (3.3) showing the device and its specification ASTM

The Device Name	ASTM
FTIR	E1252
DCS	D3418-03
UV	E 3088 E
Tension	D-638-02a
VISCOMETER	D7395
AFM	(AA3000)
Wettability	SL 200C
Density	D -792

3.4.1 Infrared Fourier transform spectrometer (FTIR) Test

Fourier transforms the infrared technology used to characterize the samples prepared using instrument type (IR Affinity-1) developed in the Department of Polymer and Petrochemicals (Kyoto Japan) (shown in figure 3.6). Calibrate the unit using KBR to weigh a sample, and then prepare a powder from the sample to be analyzed and blend it with a KBR mixing ratio of 99 percent KBR

Diagram between the permeability or absorption and the number of waves that indicate the chemical composition of the material is given by the FTIR spectrum. This test was carried out in conjunction with ASTM E1252, for PVA and PVA/Repellent to determine if there is a chemical or physical bond between the polymer and the filler. This technique was also used to classify the substance of propolis.

3.4.2 Atomic force microscopy (AFM) Test

By using the technique of atomic force microscopy (AFM), topography and other surface properties can be determined. The AFM theory is based on mechanical contact between the sample surface and the tip; the nano-scale particle measurement is therefore highly influenced by the interaction of the surface sample-tip. Morphological investigations were conducted in the laboratories of the Department of Polymer and Petrochemical Industries for pure material and Nano composite material by tapping model AFM (AA3000) In the laboratories of the polymer and petrochemical industries department.

3.4.3 Differential Scanning Calorimetric (DSC) Test

The heat transitions, entropy, real heat, and enthalpy are calculated by this unit. This test was performed using the SHIMADZU-4 DSC-60 system as per ASTM D3418-03. In the form of a sheet weighing 0.004 g, samples of (PVA) and (PVA /Repellent,) were compressed in the pan and put in the testing unit. The samples were measured with an mm heating range from RT to 250 C under nitrogen gas and a heating rate.

3.4.4 Tensile Test

This test was conducted using a Universal Tensile Test Machine (WDW/5E) as shown in figure (3.4) according to ASTM D-638-02a. To study the mechanical properties of pure (PVA) and what happened when antibacterial agents were applied. The test begins by applying the specified load with a cross-head speed of 1 mm/min.

3.4.5 Wettability Test

The contact angle test to determine the effect of additives on the wettability of pure materials was carried out. SL 200C – optical Dynamic I Static Interfacial Tensiometer & Contact Angle Meter manufactured by KINo Industry Co., Ltd., USA with contact angle ranges the instrument used (0.0

to 1800). This system calculates the contact angle and calculates its average value, providing real-time data graph tracking of contact angle changes with video recording.

3.4.6 Ultraviolet – Visible Spectrophotometer

To determine the absorption of light from a sample, the UV-Visible-CECIL 2700 computerized spectrophotometer. The sample is placed in the specific position of UV / VIS. A double beam. Two beams of light are used by the spectrophotometer: a reference beam and the sampling beam in a cell made of quartz, measured at room temperature with an optical Length of path: 1cm. This test was conducted on the water inside the envelopes This test was conducted in compliance with ASTM E 3088 E.

3.4.7 Bioassay

The test consists of the cube cage dimensions of the cube (30 * 20 * 10 cm³) the substance is placed inside the cube to attract flies such as (sugar) and is coated from the inside with liquid containing polymer and insecticide and placed in a position containing insects or insects (flies) The test consists of a cube cage dimensions of the cube (30 * 20 * 10 cm³) the substance is placed inside the cube to attract flies such as (sugar) and is coated from the inside with liquid containing polymer and insecticide. [33]

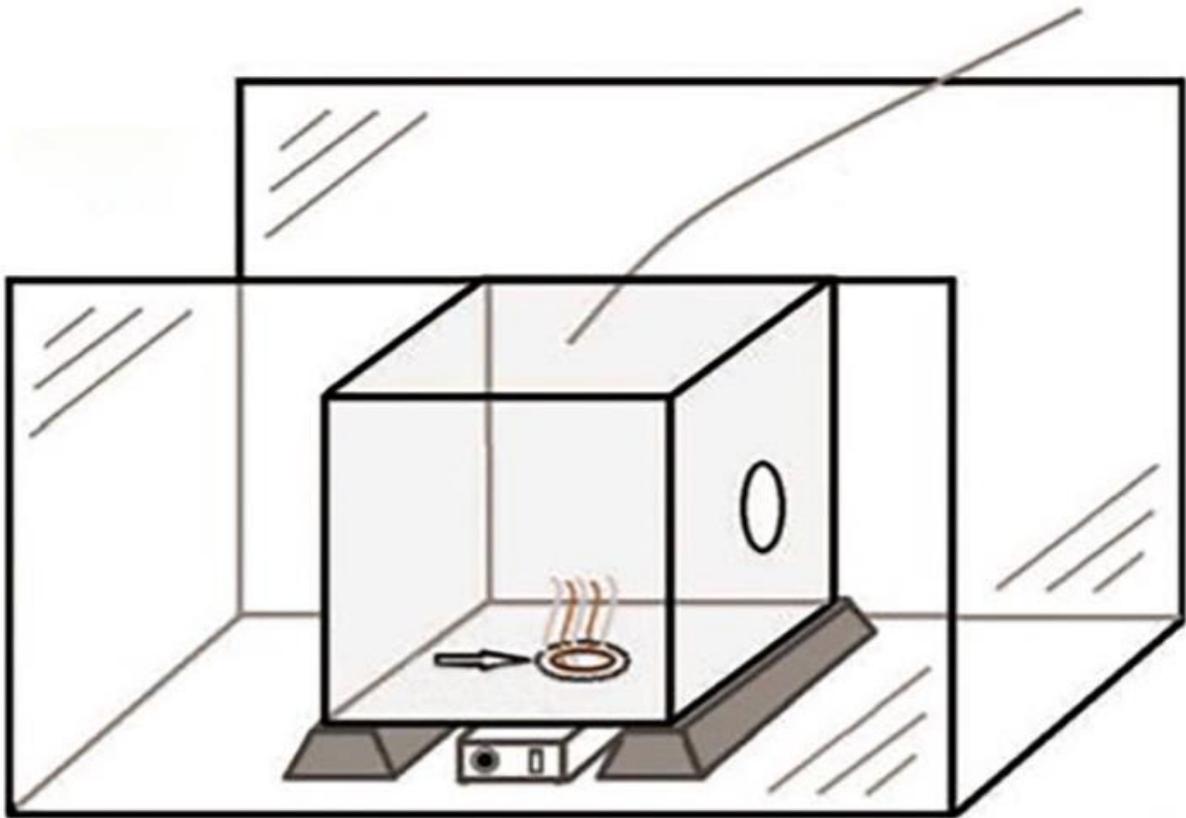


Figure (3.12): Bioassay

3.4.8 Density Test

This test was done according to ASTM D -792 using a high precision density tester (Figure 3.17). Digital precision = $\pm 0.0001 \text{ g / cm}^3$, type GP S, made in Matsu Haku, china, was the characteristics of this device. Density is measured by the room temperature of water (inside layer), as well as on the standard water. The specimen weighs in the air then the plunger and wire used in distilled water at $23 \text{ }^\circ\text{C}$ to keep the specimen completely immersed as necessary.

3.4.9 Viscosity Test

Using a cone-plate viscometer. this test was done according to ASTM D7395 used to measure the viscosity of water (inside layer) of the envelopes. The diameter of the cone is 48 mm, its angle is 3.00 and the sample size is ml. The water has a plate on horizontal and the cone is Putin. At a steady 0.5 mm gap, all tests are performed and provided to achieves thermal equilibrium at an original stability period of 2 minutes.

3-4-10 Release Capacity and Repellent Time

In a controlled release system or controlled release formulations, a pesticide or other biologically active agent is incorporated into a carrier material, generally a polymeric material. these systems able to deliver the active ingredient slowly and continuously for a longer duration to a specific target at the desired rate [52].

Chapter Four

Results and Discussion

4.1 Introduction:

This chapter discusses all the experimental results obtained from the structural, morphology, physical, wettability, absorbency. The experimental tests and the results the prepared sample were used to investigate at first, the structural properties including (FTIR, UV, and DSC) and physical properties including (tensile test). Finally morphology tests performed by using optical microscopy and atomic force microscopy (AFM).

4.2 FTIR result For (PVA/repellent insect) film

Through this analysis, we observed bonds (PVA and repellent) PVA / repellent (icon, izagata) As in the figures below according to the values of bonds recorded in Table (4-1) by FTIR of pure polymers and the mixture prepared by casting with different concentrations of mixtures Summarization. As in the table (4-1), it shows the values of bonds and the amount of your shaft

Type of Bond of PVA	Standar d PVA	PVA Exp	PVA +Repellent (Icon)		Izataga	
			2 %	4%	2%	4%
O-H stretching	3331.43	3363.86	3379.29	3479.58	3579.02	3572.17
C=O stretching	1654.62	1751.36	1681.93	1681.93	1728.22	1720.50.
C-H stretching	2939.95	2885.51	2970.38	2890.1	2970.38	2954.95
-C-H (bending)	1333	1396.46	1288.45	1396.46	1489.o5	1442.75
C-C stretching	849.49	817.82	879.54	871.82	879.54	717.52

FTIR test for PVA shows many bands such as the bands at 3363.86cm⁻¹ for (O-H stretching), the band at 1751.36cm⁻¹ for (C=O stretching), the bands at 2885.51cm⁻¹ for (C-H stretching), the band at (1333.46) cm⁻¹ for (-C-H bending), the band at (849.49) cm⁻¹ for (C-C stretching). The mixture from (PVA/repellent izagata) for 2cc, the bands at 3363.86 cm⁻¹ shifted to 3579.02 cm⁻¹, the band at 1751.36 shifted to 1728.22, the band

at 2885.51 cm^{-1} shifted to 2970.38, the band at 1333.03 cm^{-1} shifted to 1489.05 cm^{-1} the band at 849.49 cm^{-1} shifted to 879.54 cm^{-1} . The mixture from (PVA/repellent izagata) for 4 %, the bands at 3363.86 cm^{-1} shifted to 3572.17 cm^{-1} , the band at 1751.36 shifted to 1720.50, the band at 2885.51 cm^{-1} shifted to 2970.38, the band at 1333.03 cm^{-1} shifted to 1442.75 cm^{-1} the band at 849.49 cm^{-1} shifted to 717.52 cm^{-1} .The mixture from (PVA/repellent icon) for 2 %, the bands at 3363.86 cm^{-1} shifted to 3379.29 cm^{-1} , the band at 1751.36 shifted to 1681.93, the band at 2885.51 cm^{-1} shifted to 2970.38, the band at 1333.03 cm^{-1} shifted to 1288.45 cm^{-1} the band at 849.49 cm^{-1} shifted to 879.54 cm^{-1} .The mixture from (PVA/repellent icon) for 4 %, the bands at 3363.86 cm^{-1} shifted to 3479.58 cm^{-1} , the band at 1751.36 shifted to 1681.93, the band at 2885.51 cm^{-1} shifted to 2890.1 ,the band at 1333.03 cm^{-1} shifted to 1396.46 cm^{-1} the band at 849.49 cm^{-1} shifted to 871.82 cm^{-1}

FTIR of the mixtures from (PVA /repellent icon, izagata) for different concentrations (2, 4 %), it was observed shifting spectra to lower wavenumbers, higher wavenumbers respectively, as shown in figure (4-4) . 2% Icon A strong interaction occurred between the polymer and the insecticide (meaning that the polymer becaes interfered with the pesticide)The results from FTIR. Note the disappearance of the CH bond at 4CC, and this explains the occurrence of an interaction between the polymer and the pesticide. The results indicated some associations that alter this due to physical contact. Because of the strong physical bond between the polymer and the insecticide (Icon, Izagata)

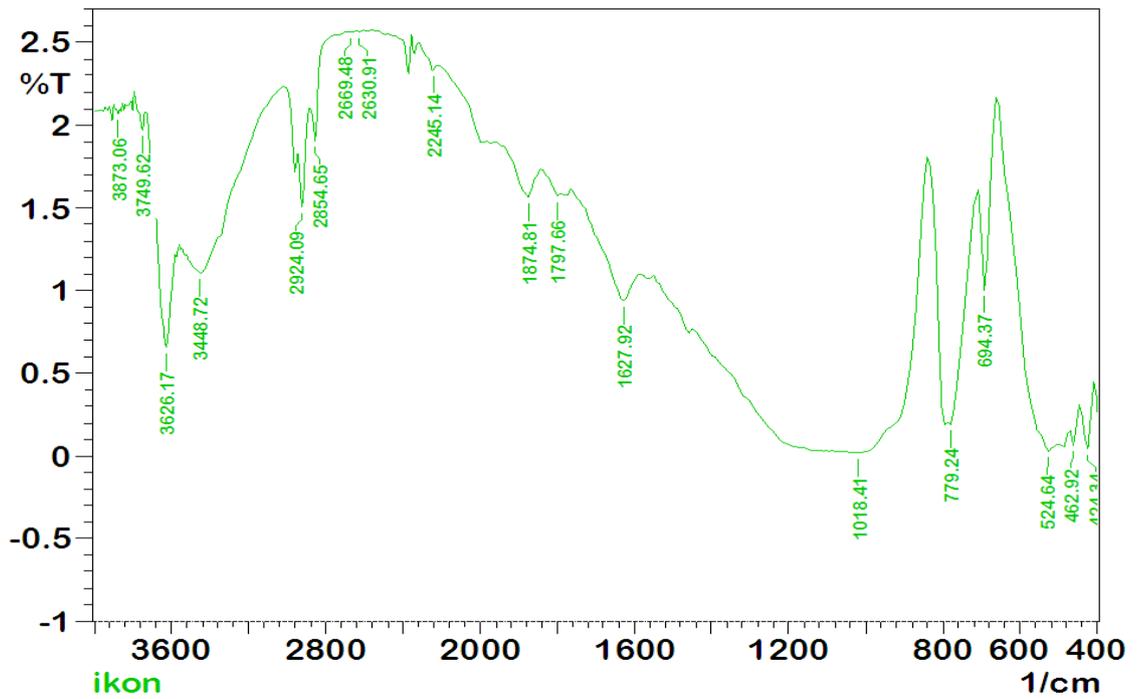


Figure (4.1): FTIR analysis of repellent icon

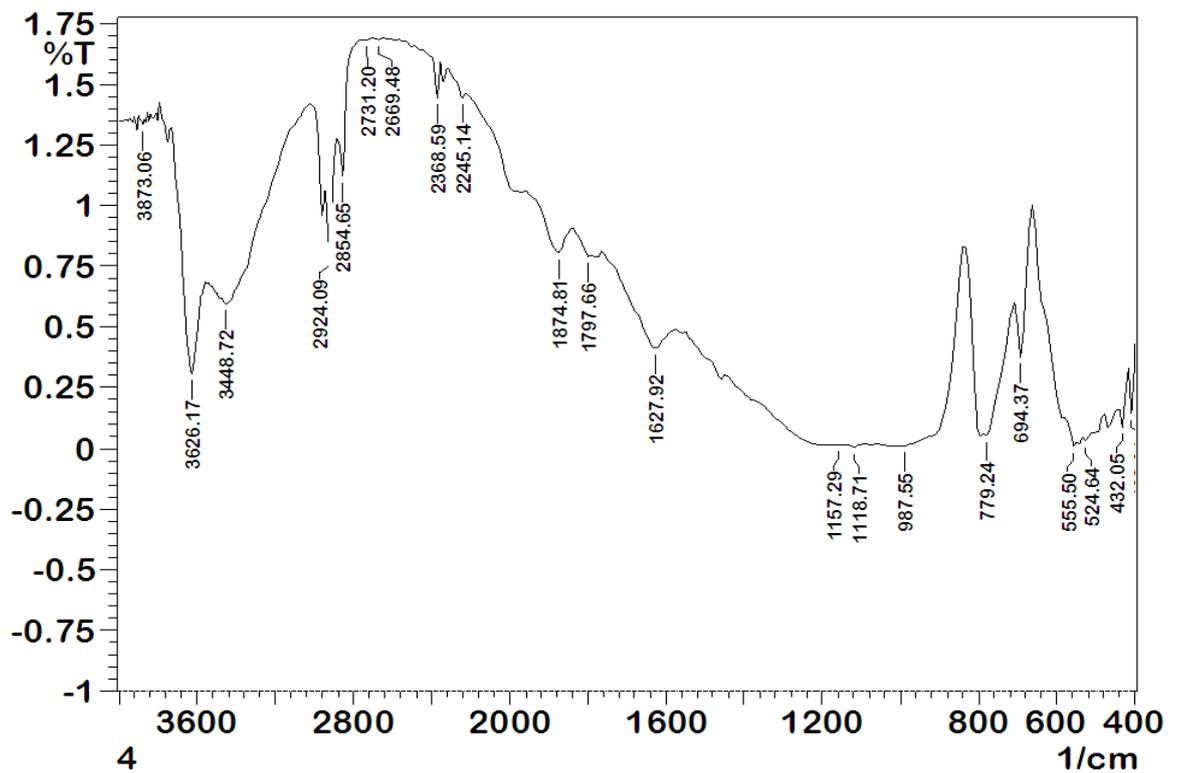


Figure (4.2): FTIR analysis of repellent izagata

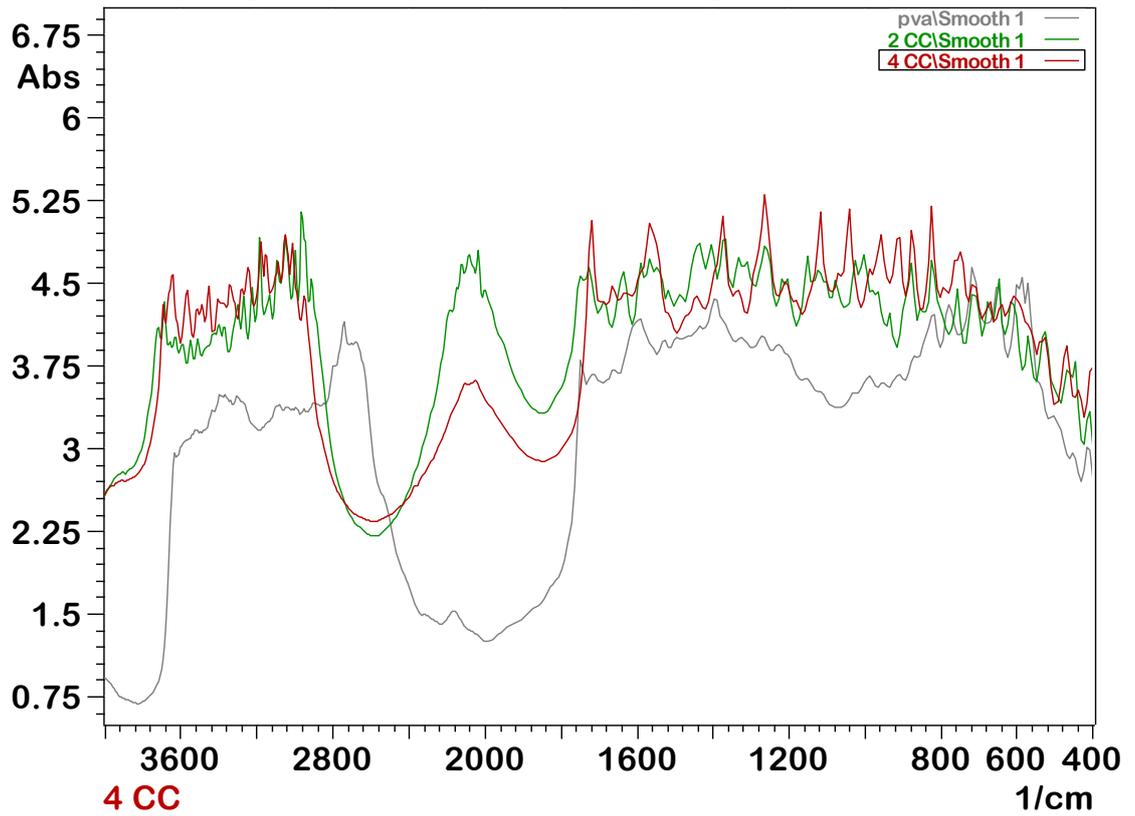


Figure (4.3): FTIR analysis of PVA+(2,4) repellent izagata

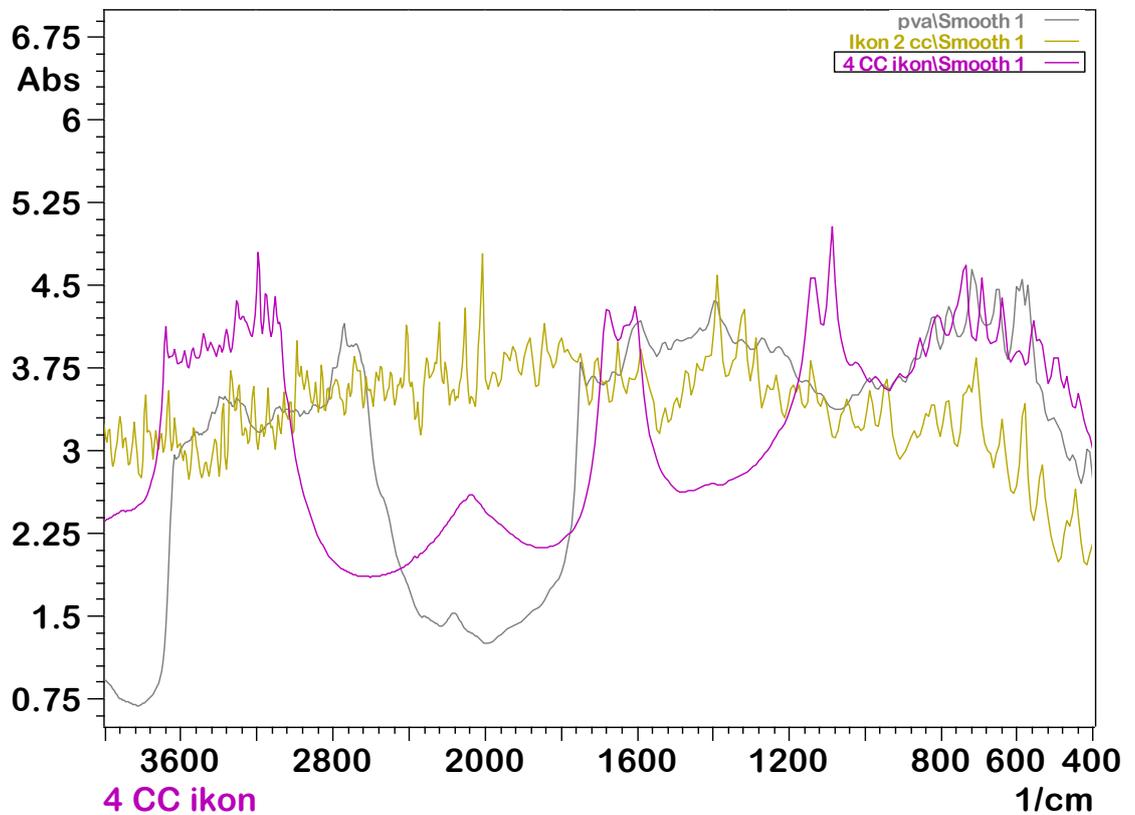


Figure (4.4): FTIR analysis of PVA+(2,4) repellent ikon

4.3 DSC Result

Differential scanning calorimetric is used to show the effect of insect repellent on thermal properties of PVA. table (4-2) explain the thermal behavior of PVA composite with and without insect repellent .Table (4-2) thermal properties of PVA and PVA with repellent(icon , izagata)

	<i>Sample</i>				
	<i>PVA pure</i>	<i>PVA+2c c izagata</i>	<i>PVA+4c c izagata</i>	<i>PVA+2c c icon</i>	<i>PVA+4c i icon</i>
TG	87.29	108.59	97.14	92.15	91.48
TM	188	192.04	200.10	191.57	192.41
Degradation	230	240	248	250	248

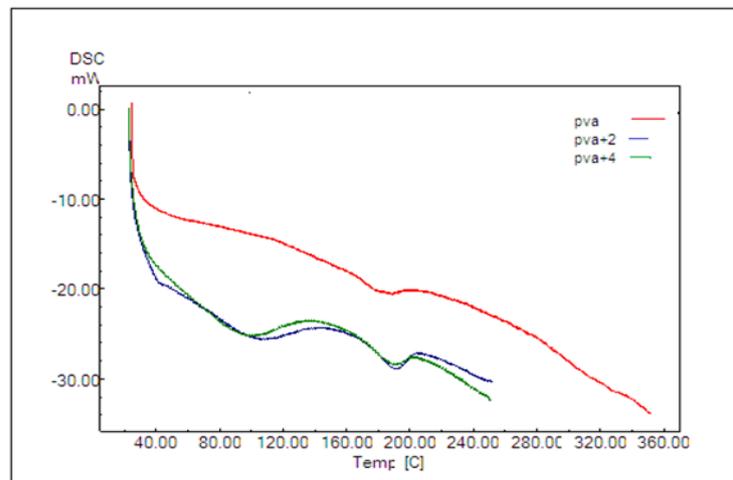


Figure (4.5): DSC analysis of(PVA +Repellent icon)

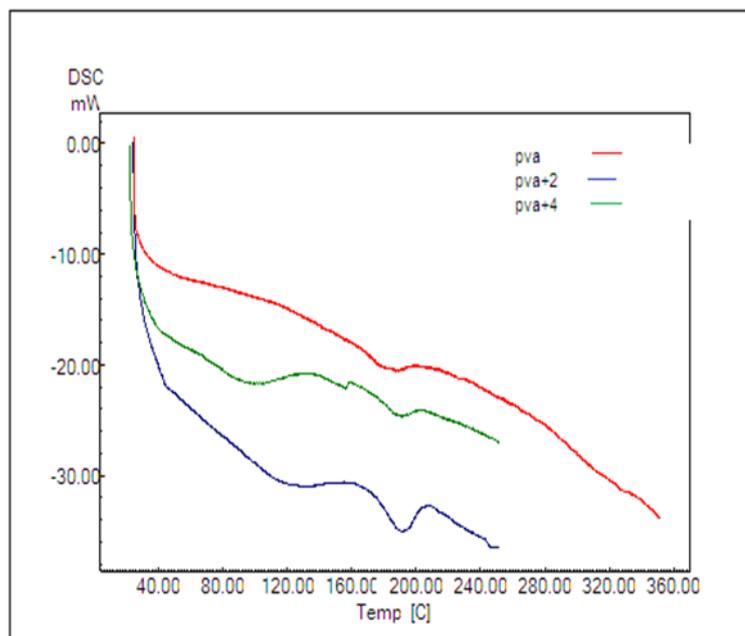


Figure (4.6): DSC analysis of (PVA+ Repellent izagata)

We note from the above table that adding the insecticide in general leads to an increase in TG, TM, and the temperature of decomposition. We conclude that the insecticide acted crosslink with the polymer and was bound by strong bonds (hydrogen bond). (The presence of hydrogen bonds leads to an increase in TG)

TM and the temperature of decomposition and TG increase when adding the insecticide (Icon and Izagita) because increased sliding of the chains over each other. according to the above ratios as shown in table (4.2)

The melting point of the polymer also increased due to the increase in crystallinity.

4.4 UV-Visible result

The visible UV spectrum of pure PVA shows the absorption of n a (275-295 nm). When adding the insecticide, we notice a change in the composition as a result of the reaction, and this leads to an increase in the absorbance with wavelength towards the visible light region (380-780 nm). When adding the first type of insecticide (izagata), the electrical gap card changes, causing it to absorb a wide spectrum of rays. The transmittance is 60%, and this indicates that the prepared ribbons reduces the transmittance

to light as shown in the figure (4-7)

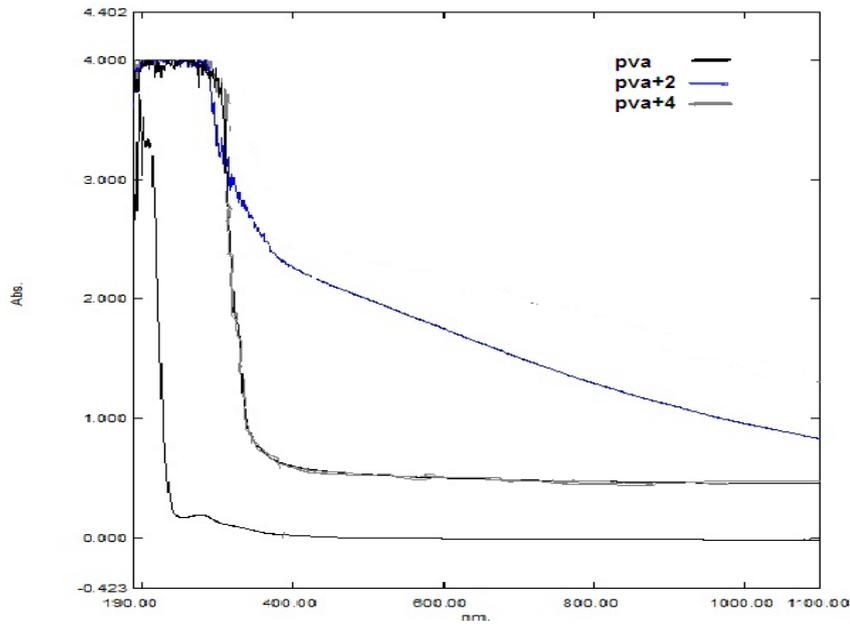


Figure (4.7): UV analysis of PVA+ izaraga

When the second type of insecticide (Icon) is added, there is less change in the electrical gap and energy absorption up to 400 nm, and the permeability is very high, up to 90%, as in the figure below (4.8):

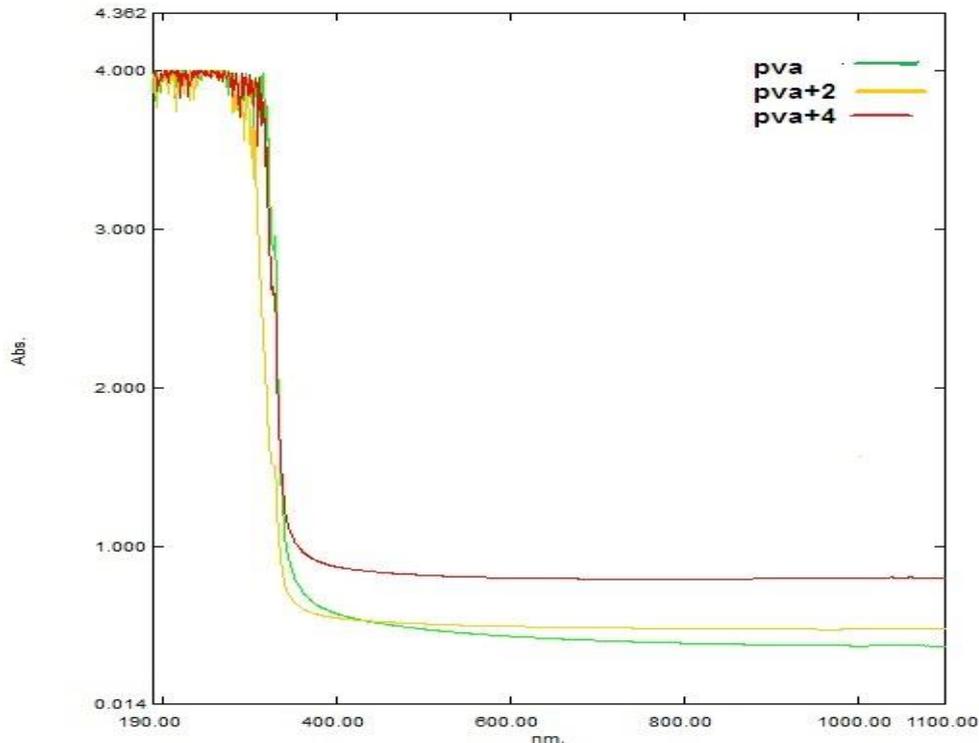


Figure (4.8): UV analysis of PVA+ icon

4.5 Wettability

contact angles of pure PVA /repellent insect composite. We tested the PVA mixture on two rough and smooth surfaces (concrete, cushy) to find out which surfaces are best for coating and obtained the following results.

tabel (4.3) shows contact angle pure PVA which is (32.309) after (60 s)

This indicated that the stability of (pure) and the angle decreases at the time increases until reach to (23.439) after (120 s). I. e wettability increased as a function time.

For the (PVA + 2cc icon) showed the angle of (40.99) after (the 60s) and the angle decreases at the time increases until reach to (23.439)after (120s).

For the (PVA + 4 % icon) showed the angle of (45.73) after (the 60s) and the angle decreases at the time increases until reach to (54.18)after (120 s)

For the (PVA + 2cc izagata) showed the angle of (59.74) after (the 60s) and the angle decreases at the time increases until reach to (54.18)after (120 s).

For the (PVA + 4 % izagata) showed the angle of (47.40)

(40.19).after (the 60s) and the angle decreases at the time increases

As in the figures below (4-9) contact angel of PVA+ icon on surface concert . (4-10) contact angel of PVA+ izagata on surface conceret . Table (4-3) Contact angle of PVA and PVA with repellent (icon ,izagata) on surface roughness (Concrete).

Table (4.3) Contact angle of PVA and PVA with repellent (Icon,izagata) on surface roughness (Concrete).

Material	time	Contact angle	Types
PVA pure	1 min	32.30952	Circle Fitting
	2 min	23.43923	
PVA+2cc icon	1 min	40.99647	Circle Fitting
	2 min	34.301152	
PVA+4 % icon	1 min	45.7399041	Circle Fitting
	2 min	27.986902	
PVA+2cc izataga	1 min	59.74223	Circle Fitting
	2 min	54.18393	
	3 min	0	
PVA+4cc izagata	1 min	47.40475	Circle Fitting
	2 min	40.19176	

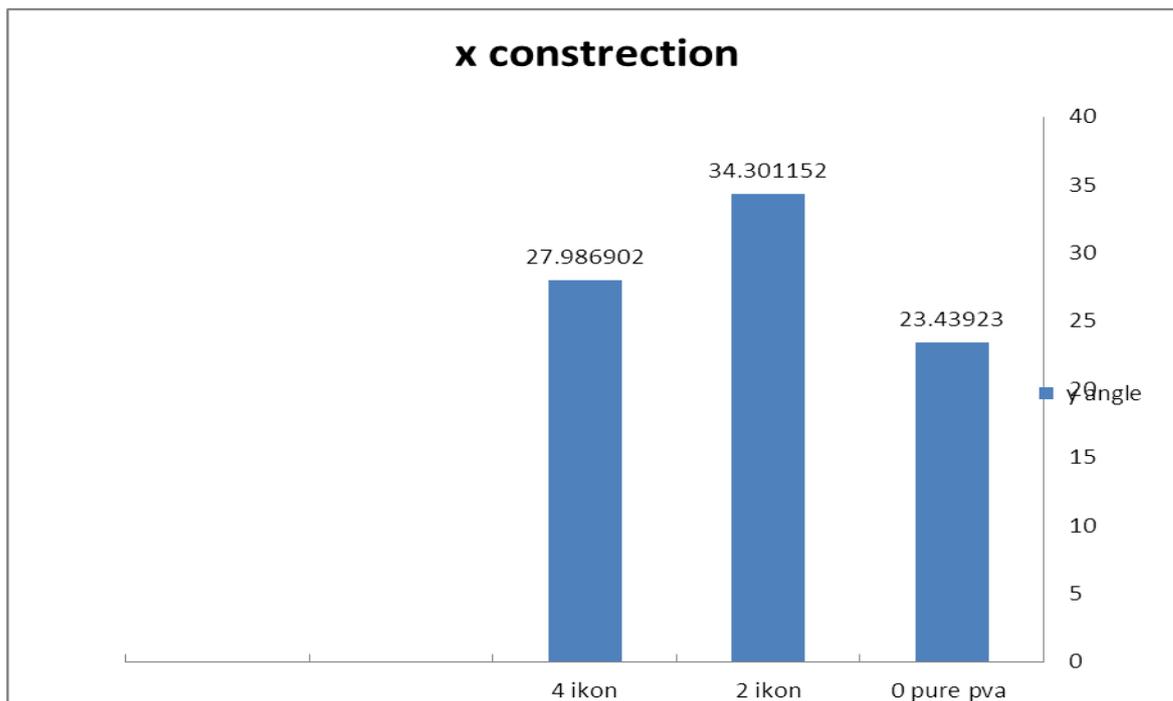


Figure: (4.9) contact angel of PVA+ Icon on surface concert

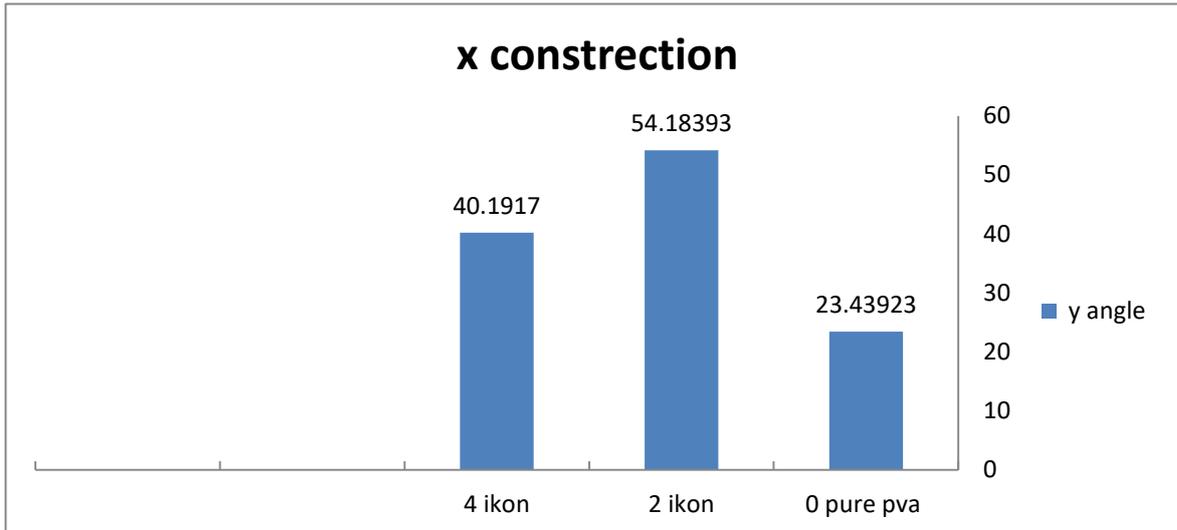


Figure (4-10) contact angel of PVA+ Izagata on surface concreet

For the (PVA + 2cc ikon) showed the angle of (29.86)after (60s) and the angle decreases at the time increases until reach to (23.77053) after (120s).

For the (PVA + 4 % ikon) showed the angle of (41.28) after (60s) and the angle decreases at the time increases until reach to (23.43)after (120 s)

For the (PVA + 2cc izagata) showed the angle of (35.06) after (60s) and the angle decreases at the time increases until reach to (30.11) after (120s).

For the (PVA + 4 % izagata) showed the angle of (30.36) after (60s) and the angle decreases at the time increases until reach to(29.23) after (120 s)

Table (4-4) Contact angle of PVA and PVA with repellent on surface smooth (kashy) Table (4.4) Contact angle of PVA and PVA with repellent on surface smooth

Material	Time	Contact angle	Types
PVA pure	1 min 2 min	32.30952 23.43923	Circle Fitting
PVA +2cc izitaga	1 min 2 min	35.06454 30.11885	Circle Fitting
PVA +4cc izitaga	1 min 2 min	30.36576 29.23776	Circle Fitting
PVA +2cc icon	1 min 2 min	29.86283 23.77053	Circle Fitting
PVA +4cc icon	1 min 2 min	41.28429 23.43944	Circle Fitting

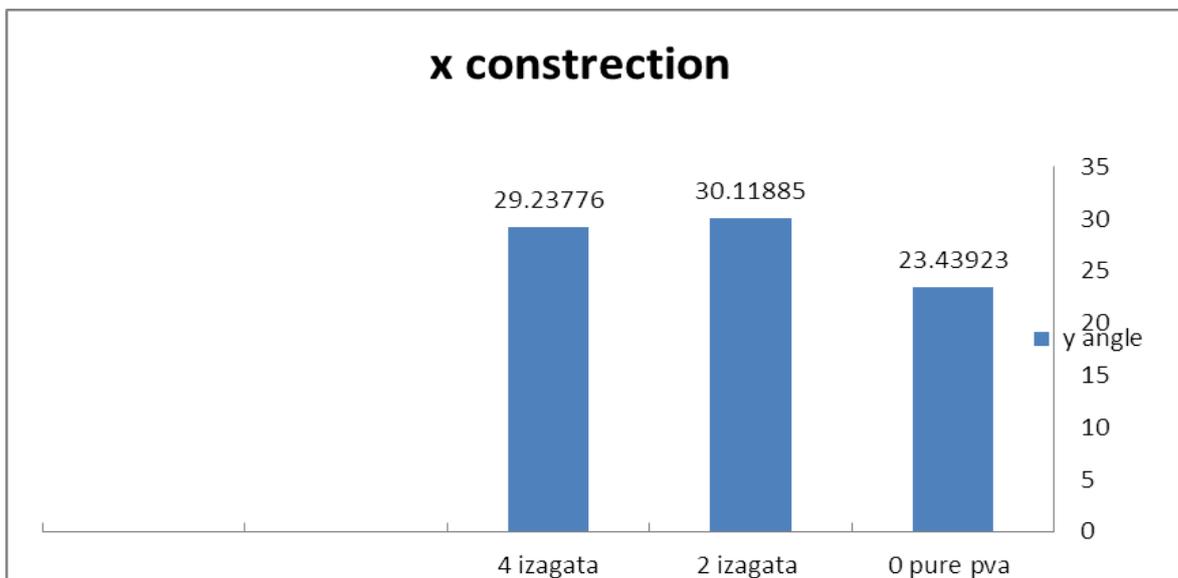


Figure (4.11): contact angel of PVA+2 Izataga on surface kashy

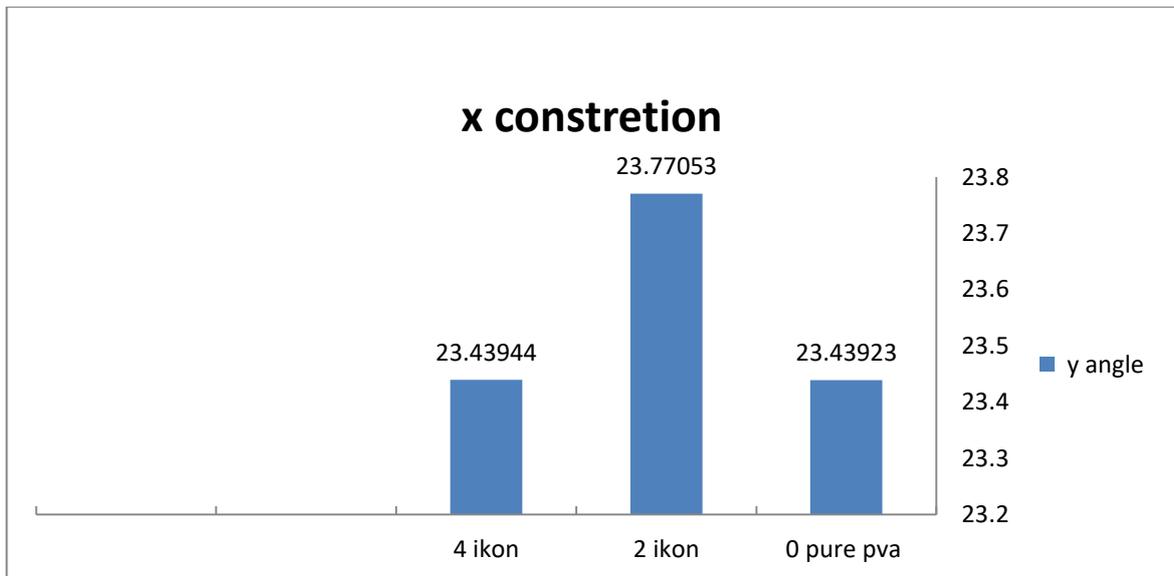
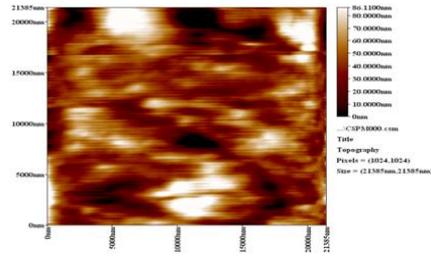


Figure (4.12): contact angel of PVA+ Icon on surface kashy

4.6 Atomic Force Microscope result (AFM)

the images of the atomic force microscope of the PVA\ PVA repellent film roughness as in Table(4-5) Roughness PVA /PVA+ Repellent(icon,izagata)

Sample	roughness
PVA	15.9
PVA+2cc icon	1.13
PVA+4cc icon	2.11
PVA+2cc izagata	1.74
PVA+4cc izagata	2.84



SPM Imager Surface Roughness Analysis

Image size:21385.00nm X 21385.00nm

Amplitude parameters:
 Sa(Roughness Average) 15.9 [nm]
 Sq(Root Mean Square) 20.1 [nm]
 Ssk(Surface Skewness) 0.114
 Sku(Surface Kurtosis) 2.72
 Sy(Peak-Peak) 86.1 [nm]
 Sz(Ten Point Height) 59.4 [nm]

Hybrid Parameters:
 Ssc(Mean Summit Curvature) -0.00436[1/nm]
 Sdq(Root Mean Square Slope) 0.0777[1/nm]
 Sdr(Surface Area Ratio) 0.294

Functional Parameters:
 Sbi(Surface Bearing Index) 1.8
 Sci(Core Fluid Retention Index) 1.59
 Svi(Valley Fluid Retention Index) 0.126
 Spk(Reduced Summit Height) 19.4 [nm]
 Sk(Core Roughness Depth) 45.9 [nm]
 Svk(Reduced Valley Depth) 22.4 [nm]
 Sdc 0-5(0-5% height intervals of Bearing Curve) 11.2 [nm]
 Sdc 5-10(5-10% height intervals of Bearing Curve) 8.16 [nm]
 Sdc 10-50(10-50% height intervals of Bearing Curve) 25.8 [nm]
 Sdc 50-95(50-95% height intervals of Bearing Curve) 39.1 [nm]

Spatial Parameters:
 Sds(Density of Summits) 0.0285[1/um2]

Fractal Dimension 2.66

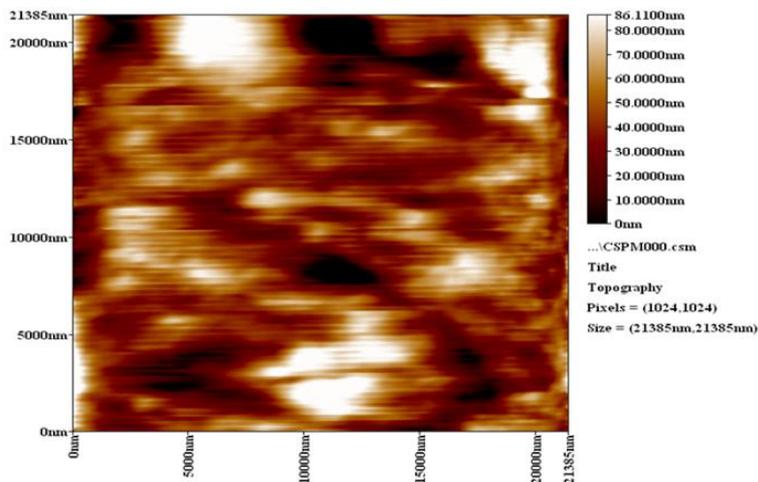
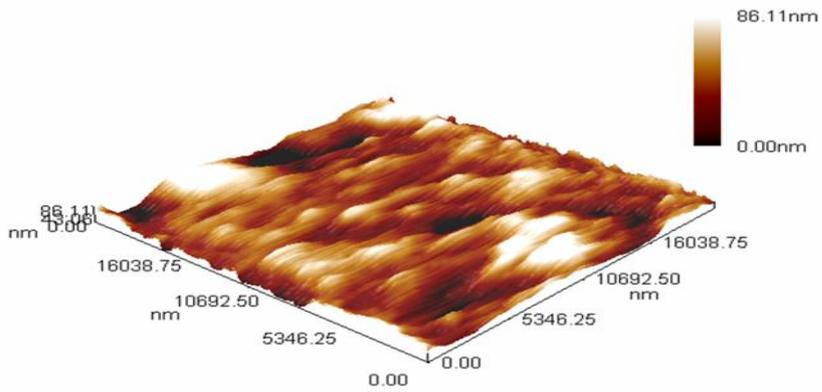


Figure (4.13) AFM images for PVA "

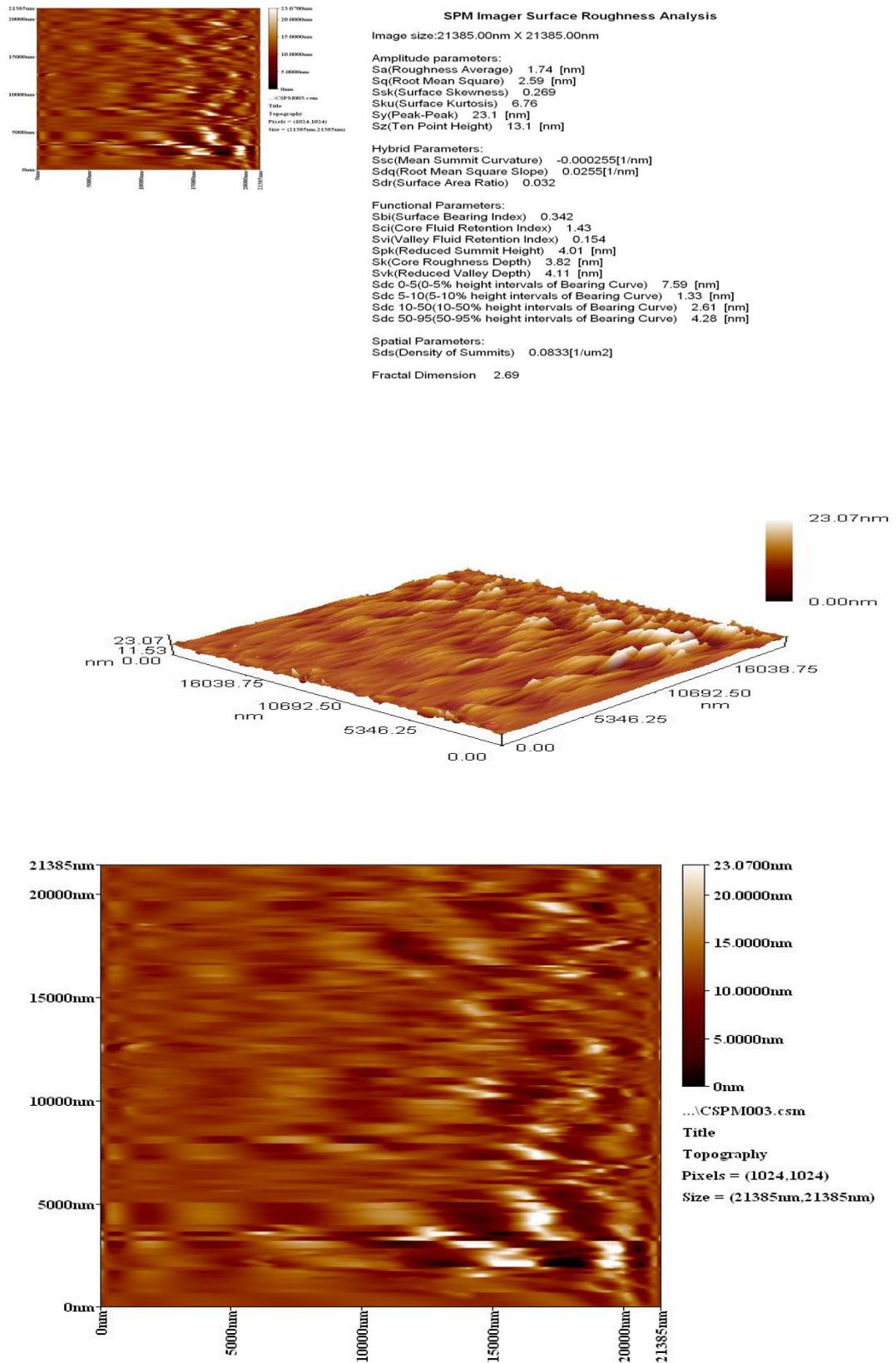


Figure (4.14): AFM images for 2 % PVA/repellent izataga sample

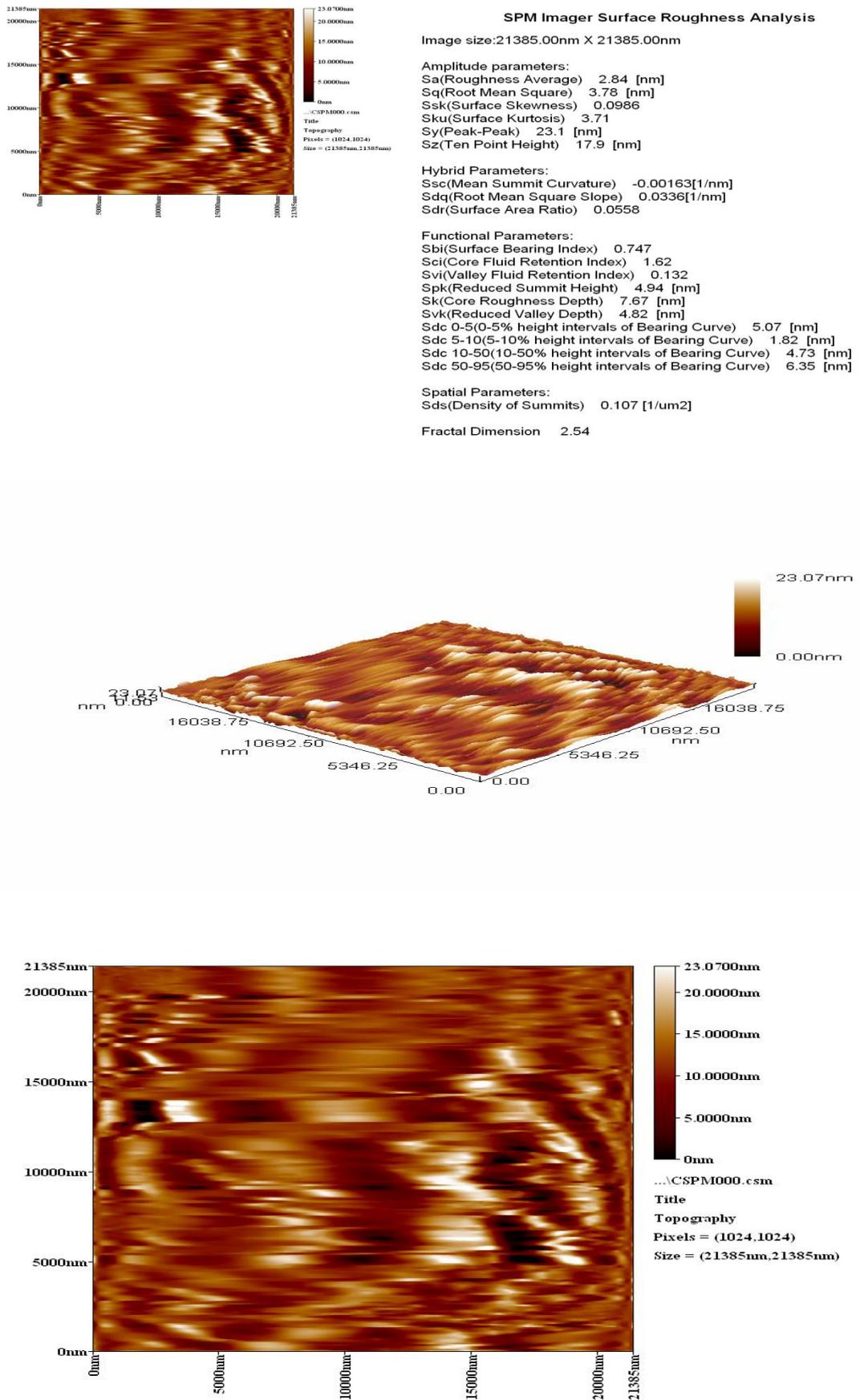


Figure (4.15): AFM images for 4 % PVA/repellent izataga sample

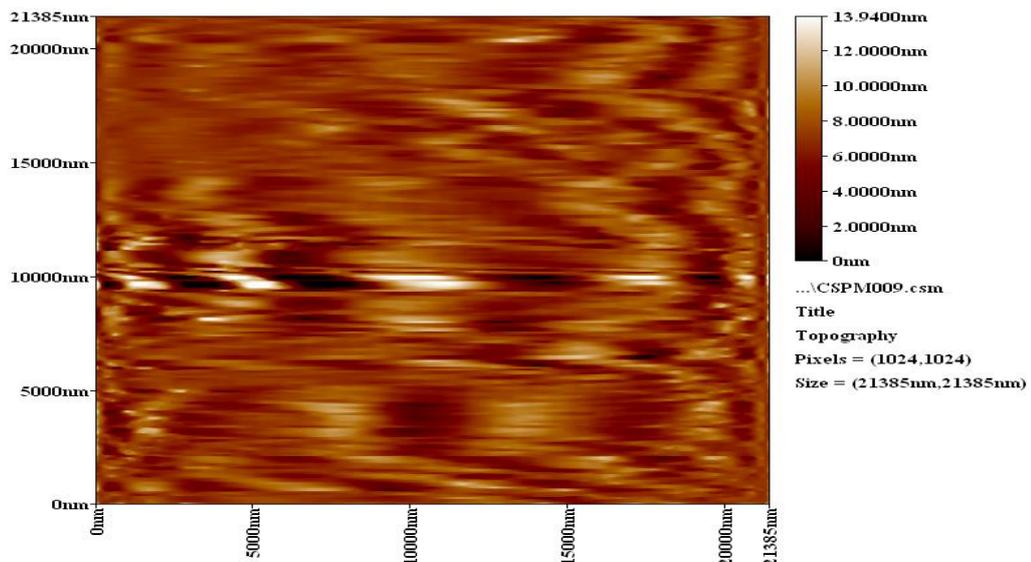
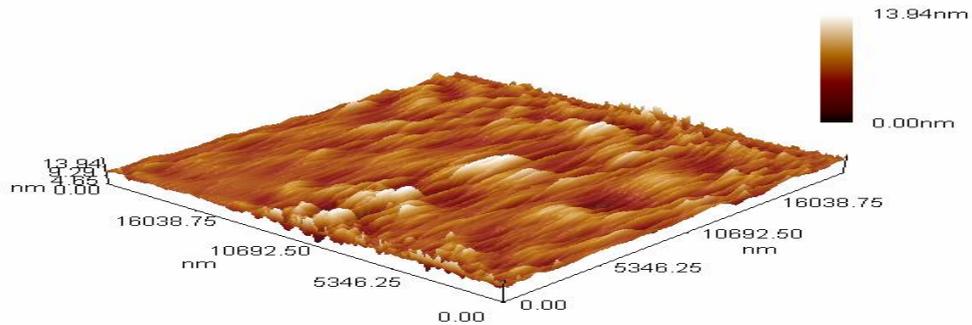
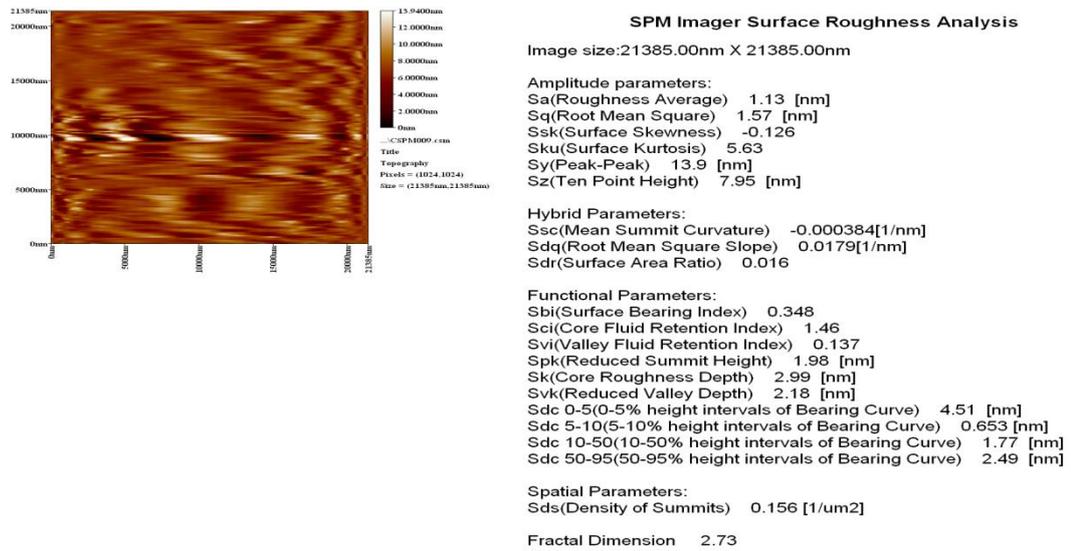


Figure (4.16): AFM images for 2 % PVA/repellent icon sample

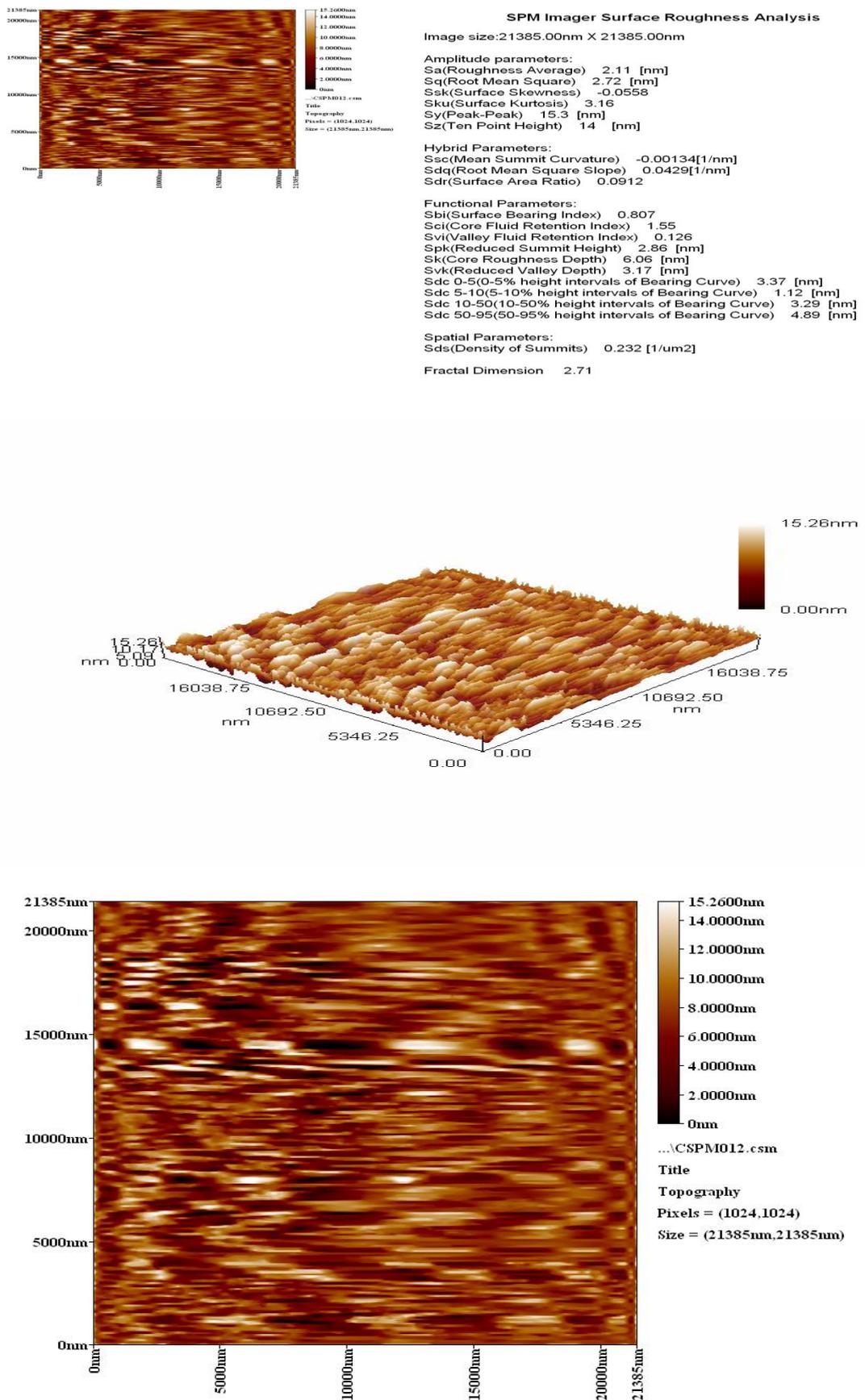


Figure (4.17): AFM images for 4 % PVA/repellent icon sample

The sample for pure polyvinyl alcohol was roughness (15.8)

When adding 2 % of the insecticide Akon, the harshness decreased to(1.13).When adding 4 %, the roughness increased to (2.11) but remained less rough than PVA .This means that the roughness decreased by 2 % and interfered well with the polymer chains, which increased the bonds with the polymer, and consequently the terrain and clusters of the polymer itself were reduced.

When adding 4 %, the roughness increased and this means that the insecticide became a disease that clumps, and when it clumps, the surface terrain and clusters increase.

When adding 2 % of the insecticide izagata, the harshness decreased to (1.74)

When adding 4 %, the roughness increased to (2.84) but remained less rough than PVA .This means that the roughness decreased by 2 % and interfered well with the polymer chains, which increased the bonds with the polymer, and consequently the terrain and clusters of the polymer itself were reduced

When adding 4 %, the roughness increased and this means that the insecticide became a disease that clumps, and when it clumps, the surface This means that the low percentages of the . terrain and clusters increase pesticide interact with the polymer perfectly, so the lumps are reduced consequently the terrain and clusters of the polymer itself were reduced

4.7 Bioassay Result

The experience of Bioassay was a knockout of insects (flies) after coating the glass cube with polymer with the insecticide and releasing the flies inside the cube and calculating the time during which the insects are killed or expelled from (1-3) minutes completely spent on the insects inside the cube, which led to their death quickly.

We can conclude from this that the insecticide with polymer served the required purpose, which was to repel and kill the insects



Figure (4.18): Bioassay images for PVA/repellent Izagata sample

4.8 viscosity Result

The table(4.6) shows viscosity PVA /PVA+ Repellent(icon , izagata)

Sample	Viscosity c.p
PVA pure	9.9
2% izagata	10.19
4% izagata	13.54
2%icon	10.12
4% icon	11.19

The addition of the insecticide in general caused an increase in viscosity, due to the strong bonding forces between the polymer and the insecticide, as shown in an examination for FTIR.

When adding the insecticide izagata, we notice an increase in viscosity due to the strong bonding forces between the polymer and this insecticide, and the bonding forces are strong and stronger than the second type Akon, as shown in an examination for FTIR.

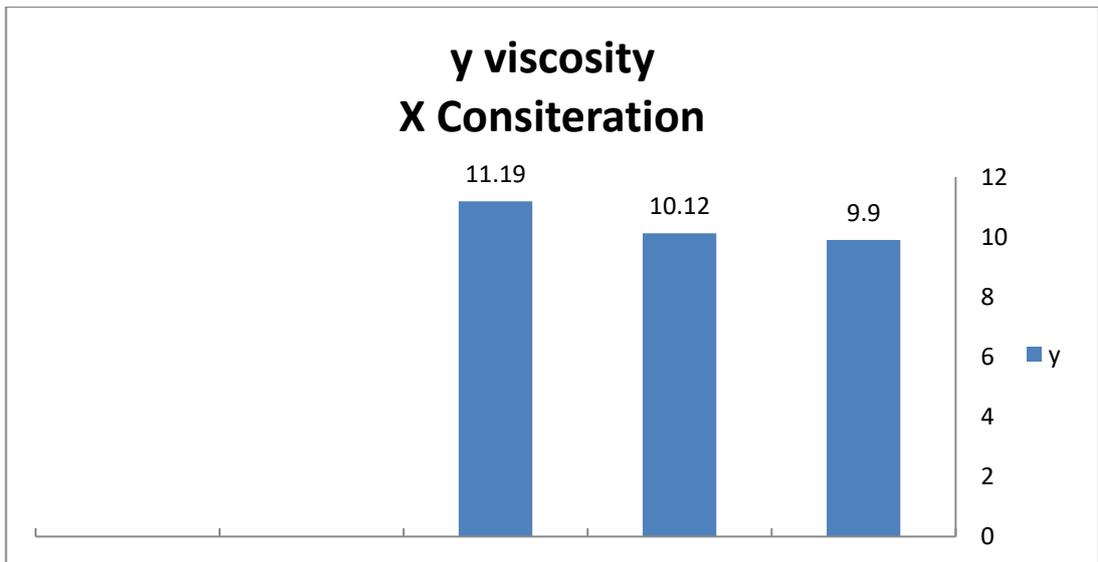


Figure (4.19): Viscosity of PVA/repellent icon

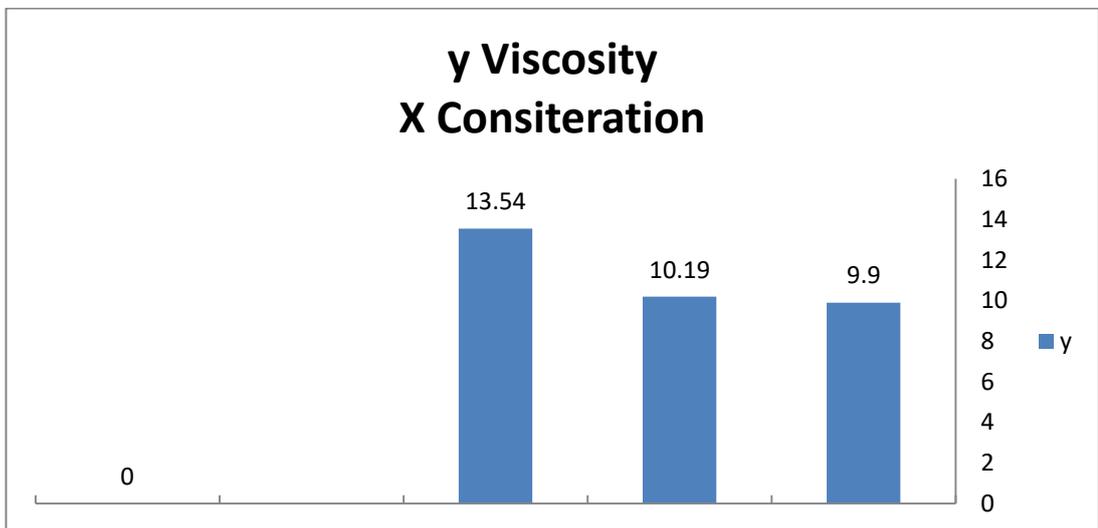


Figure (4.20): Viscosity of PVA /repellent izagata

4.9 Density Rustle

The Table(4.7) shows Density PVA /PVA+ Repellent(icon , izagata)

Sample	Density
PVA pure	9.8
2% icon	10.1
4% icon	12.5
2% izagata	11.8
4% izagata	12.9

The addition of the insecticide in general caused an increase in viscosity, due to the strong bonding forces between the polymer and the insecticide, as shown in an examination for FTIR.

When adding the insecticide izagata, we notice an increase in viscosity due to the strong bonding forces between the polymer and this insecticide, and the bonding forces are strong and stronger than the second type Akon, as shown in an examination for FTIR.

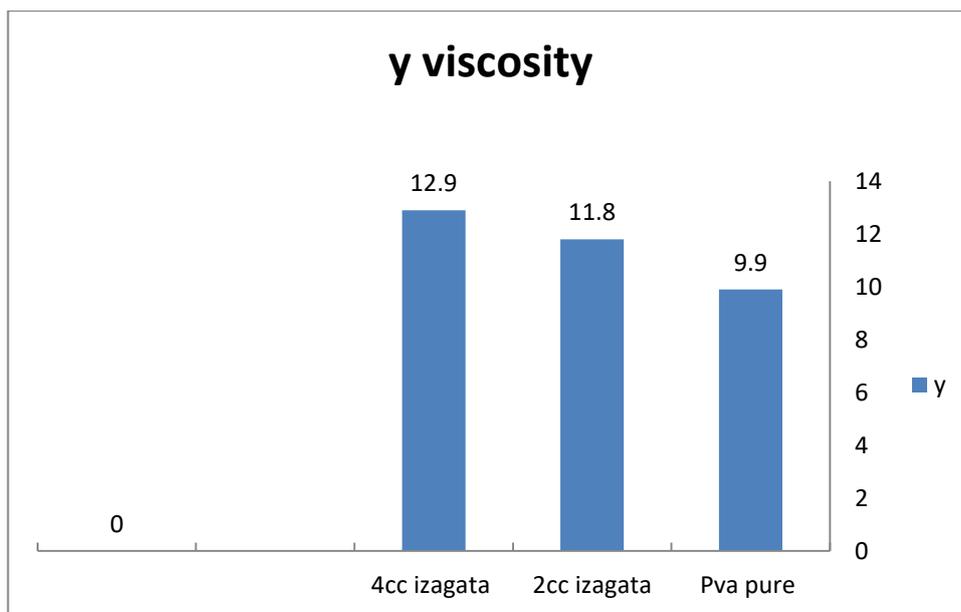


Figure (4.21): Density PVA/repellent ,izagata

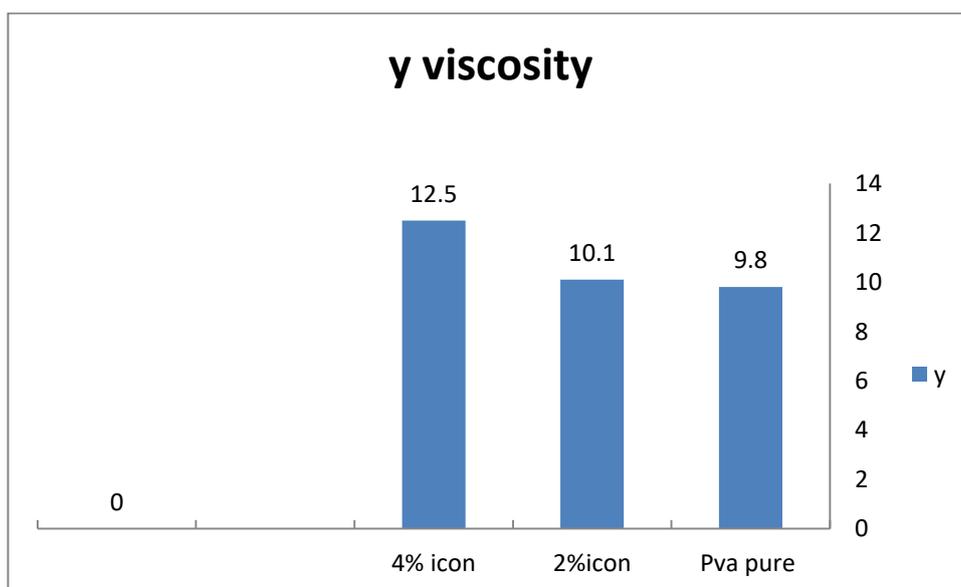


Figure (4.22): Density PVA/repellent icon

4.10 Tensile Result

The table(4.8) shows Tensile PVA /PVA+ Repellent(icon , izagata)

Figures (4-23),(4-25),(4-27),(2-29),(4-31) show Stress-Strain of PVA and Repellent (Icon, Izagata)

Figures (4-24),(4-26),(4-28),(2-230),(4-32) show Load-Deform of PVA of (PVA and Repellent (Icon, Izagata)

Sample	Tensile stress	E modules	Elongation %
PVA Pure	0.0014	1.25	1.5
PVA+2cc icon	0.0007	0.672	2.5
PVA+4cc icon	0.0006	0.553	1.0
PVA+2ccizagata	0.003	0.644	1.5
PVA+4ccizagata	0.002	0.017	2.0

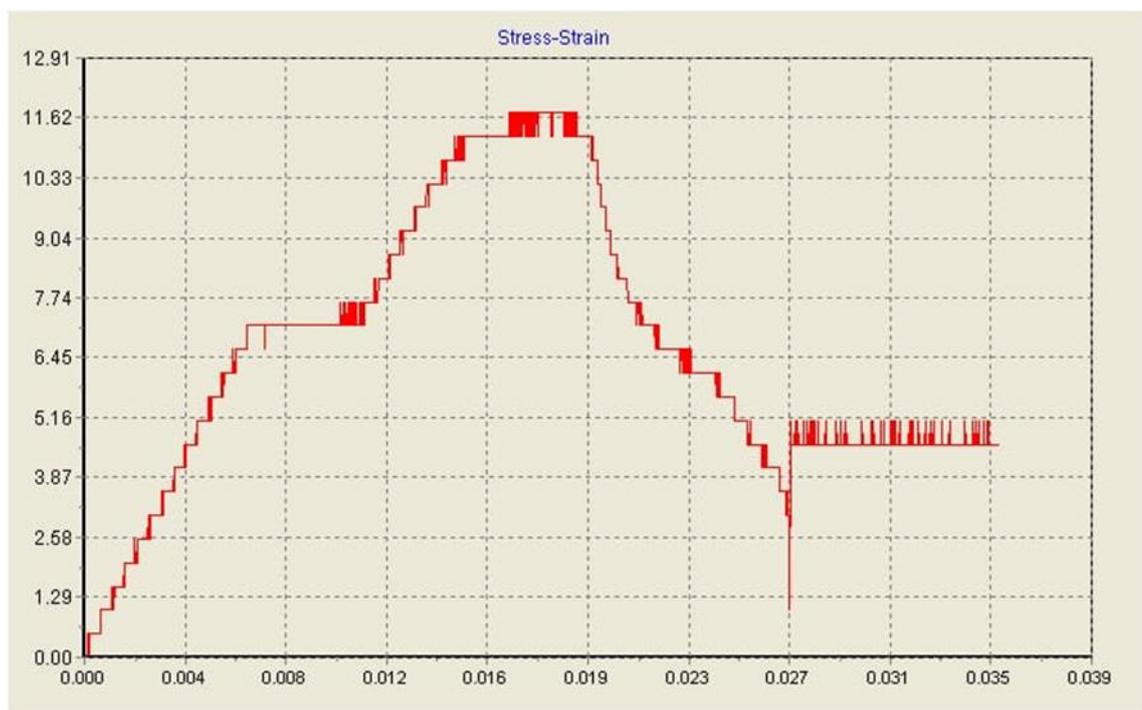


Figure (4.23): Stress-Strain of PVA



Figure (4.24): Load-Defor of PVA



Figure (4.25): Stress-Strain of PVA /PVA Repellent(2% icon)



Figure (4.26): Load-Deform of PVA /PVA Repellent(2%icon)



Figure (4.27): Stress-Strain of PVA /PVA Repellent(4%icon)

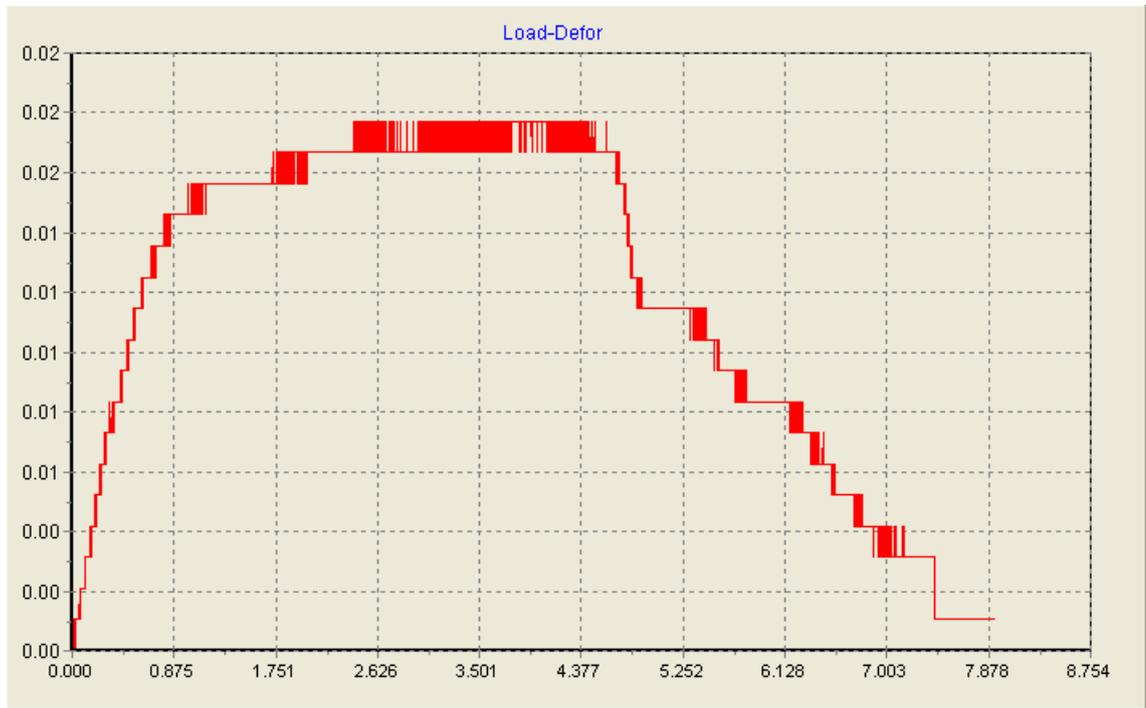


Figure (4.28): Load-Deform of PVA /PVA Repellent(4% icon)



Figure (4.29): Stress-Strain of PVA /PVA Repellent(2% izagata)

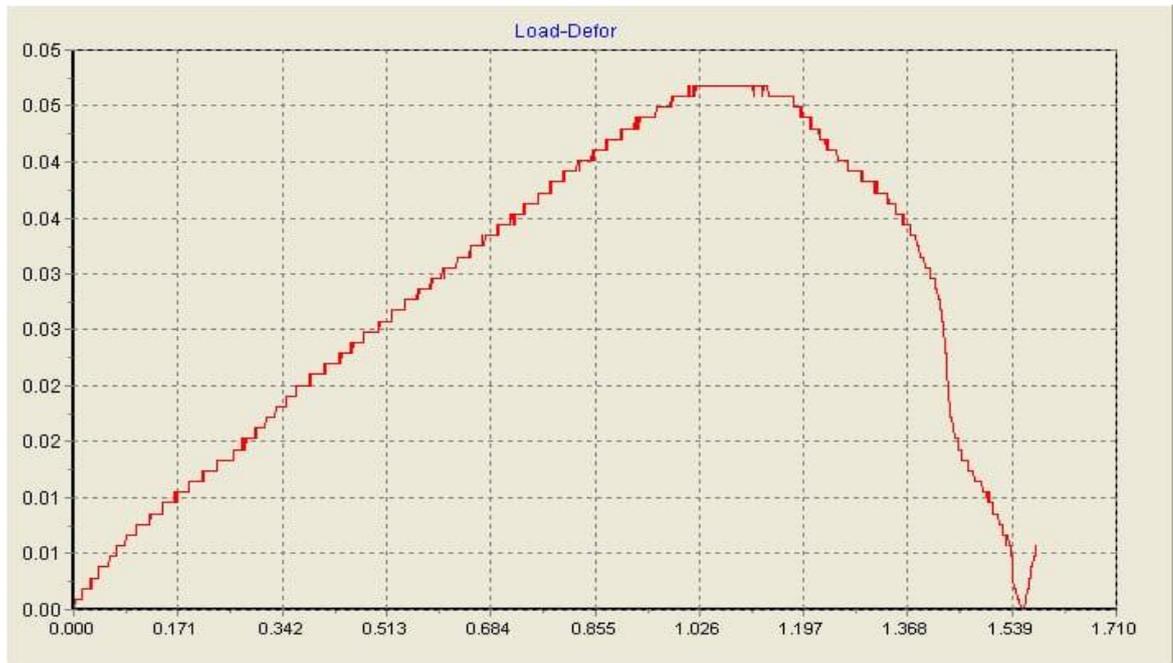


Figure (4.30): Load-Defor of PVA /PVA Repellent(2% izagata)



Figure (4.31): Stress-Strain of PVA /PVA Repellent(4% izagata)

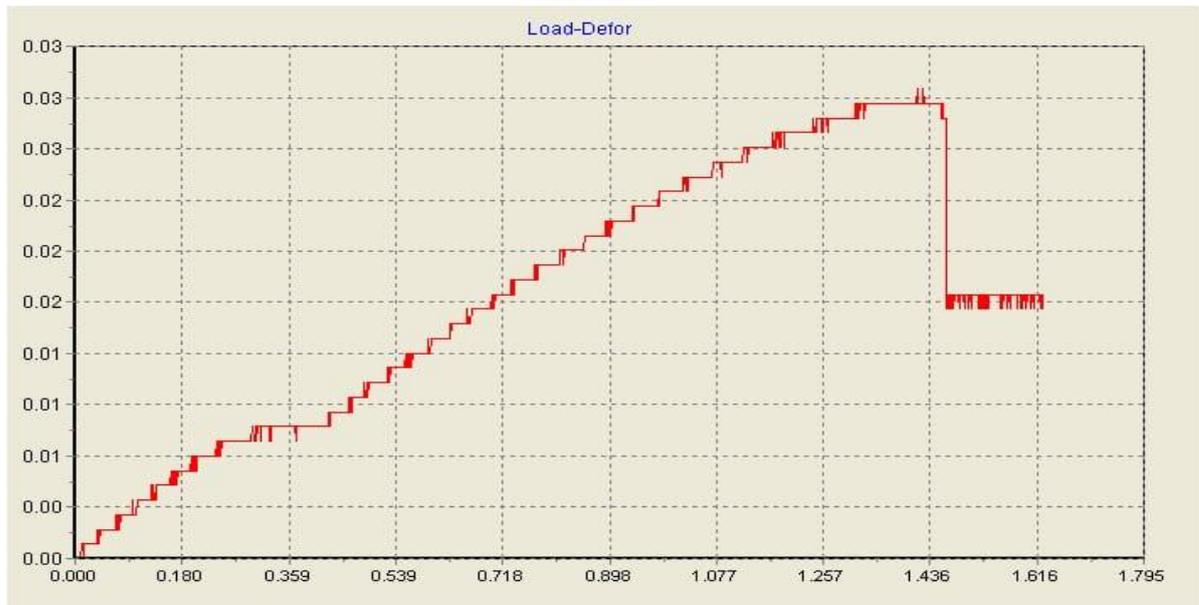


Figure (4.32): Load-Deformation of PVA /PVA Repellent(4% izagata)

Note that PVA pure has the highest tensile strength, the highest modulus of elasticity and the least elongation as in the table (4-9). When the insecticide (icon, izagata) is added at a rate of (2 %) to both types, the tensile strength, modulus of elasticity decreases and elongation increase. This means that the molecules of the insecticide (icon, izagata) are loosened between the polymer chains and lead to an increase in their strands, and this acts as a plasticizer. The pesticide reduces the surface tension, meaning that the surface roughness is as low as possible. When adding 4 % from both types of insecticide (icon, Izagata), we noticed that the tension and elasticity modulus decreased and elongation increased to the insecticide Izagata, but I said to the insecticide Icon. This means that the low percentages of the insecticide interact with the polymer perfectly.

4.11 Release Capacity and Repellent time

The release capacity is calculated from the equation

$$R.C = (W_m - W_t) * 100\%$$

W_m = Sample weight before examination

W_t = Sample weight after examination

The table (4.9) shows Weigh samples before and after examination for the two types of insecticide (Icon, Izagata)

Sample	WN	WT
PVA	0.12	0.12
2% icon	0.14	0.11
4% icon	0.15	0.10
2% izagata	0.15	0.12
4 % izagata	0.16	0.11

The table (4-10) shows the release values of the two types of insecticide (Icon, Izagata)

Sample	Release Capacity %
PVA Pure	0
2% Icon	3
%4 Icon	5
2% Izagata	4
4% Izagata	5

Repellent Time

The is calculated from the equation

$$R.T=1-(\text{average of Release Capacity of three sample}/\text{total sample})$$

The table (4-11) shows the repellent time values of the two types of insecticide (Icon, Izagata)

Sample	Repellent Time (m)
PVA +icon (0+ (2,4%)	0.97
(PVA +icon (0+ (2,4%)	0.97

Chapter Five

Conclusions and Recommendations

Chapter Five : Conclusions and Recommendations**5-1 Conclusions :**

The following findings from this work can be summarized.

- 1- The insecticide added to the polymer improves the thermal properties and decomposition of TG and TM polymers.
- 2- The action of the polymer to eliminate damage caused to humans by pesticides, such as mucous vessel sensitivity and discomfort.
- 3- However its effect on the killing of insects was not affected, but rather increased its effectiveness.
- 4- He reached a knockout to get rid of insects by using polymers and pesticides and eliminated them by 90%.
- 5- Increased hydration and diffusion (fine and rough) on the surface (cache and concert).

5-2 Recommendations :

The following suggestions for further research may be useful from the present study:

1-Using Natural according polymer such as starch chitosan with insted synthetic polymers to reduce the effect of polymer derived palpation.

2-Using Biodegradable polymers which help to in degradation easily of polymer after use and improve environmental.

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الخلاصة

يركز هذا العمل على استخدام البوليمر مع المبيدات الحشرية وتحضير اغشيه او شرائط بوليميرية طارده للحشرات لتقليل من انتشار الحشرات وتقليل اثار المبيدات على البيئة والانسان. في الآونة الأخيرة ، انتشرت الحشرات بصورة كبيره. وأدى ذلك إلى زيادة في الأمراض التي تنقلها الإنسان. من ناحية أخرى ، يجب علينا استخدام المبيدات الحشرية للتخلص من هذه الحشرات . لكن هذه المبيدات تسبب ضررا كبيرا للإنسان والبيئة . في هذا البحث تم تحضير اغشيه بوليميرية مدعمة بمواد طاردة للحشرات . استخدمنا البوليمر الحيوي (pva) مع المبيدات الحشرية (izagata ، Ikon) حيث استخدمنا بولي فينيل بوليمر الكحول، وهو بوليمر صديقة للبيئة (اللدائن الحرارية) التي لديها العديد من الخصائص المميز واهما بوليمر متحلل وغير سام .

قمنا بإذابة 20 جرامًا من بوليمر البولي فينيل الكحول في 250 مل من الماء. كذلك نذوب المبيد في الماء. نقوم بإعداد العينات حيث نأخذ 70 مل من محلول البوليمر وتبقى هذه الكمية ثابتة ونضيف نسب مختلفة من المبيد الحشري (izagata ، Ikon). ونصب في قالب من السيليكون ونتركه يجف في الجو الطبيعي لمدة (36 إلى 48 ساعة) لكي يجف ونحصل على اشربة من بوليمر PVA والمبيد الحشري بعد ذلك ، نجري عدة فحوصات الاختبارات الهيكلية ، مثل FTIR و DSC. الاختبارات البدنية ، مثل قوة الشد الاختبارات المورفولوجيا ، مثل AFM وحصلنا على النتائج التالية: من نتائج اختبار DSC لشريط البوليمر مع المبيد الحشري نلاحظ ان المبيد الحشري عمل على زيادة درجة التحلل و TG و TM وكانت نسبة 2 % المضافة من المبيد الحشري ايزيجيتا إلى البوليمر هي افضل نسبه وتعطي افضل خواص اما النوع الثاني من المبيد الحشري (ايكون) كانت نسبه الاضافة 2 % هي افضل نسبه من حيث الخواص من نتائج اختبار FTIR لشريط البوليمر مع المبيد الحشري نلاحظ ان المبيد الحشري عمل على زيادة قوه الاواصر وكانت نسبة 2 %؟ المضافة من المبيد الحشري (ايزيجيتا) إلى البوليمر هي افضل نسبه من حيث زيادة قوه الاواصر .اما النوع الثاني من المبيد الحشري (ايكون) كذلك كانت نسبه الاضافة 2 % هي افضل نسبه من حيث زيادة قوه الاواصر

من نتائج اختبار UV لشريط البوليمر مع المبيد الحشري كانت نسبة 2 % المضافة من المبيد الحشري (ايزيجيتا) إلى البوليمر هي افضل نسبه من حيث الامتصاصية ونفاذيتها للضوء المرئي اما النوع الثاني من المبيد الحشري (ايكون) كذلك كانت نسبه الاضافة 2 % هي افضل نسبه من حيث الامتصاصية ونفاذيتها للضوء المرئي.

من نتائج Wettability للبوليمر مع المبيد الحشري (ايكون, ايزيجيتا) على السطح الخشن كان ترطيب جيد جدا. اما نتائج Wettability للبوليمر مع المبيد الحشري (ايكون, ايزيجيتا) على السطح الناعم كان الترطيب جيد جدا

من نتائج اختبار tensile لشريط البوليمر مع المبيد الحشري نلاحظ ان نسبة 2 % المضافة من المبيد الحشري (ايكون) إلى البوليمر هي النسبة التي تعطي افضل خواص الميكانيكية من نتائج اختبار AFM لشريط البوليمر مع المبيد الحشري نلاحظ ان نسبة 4 % المضافة من المبيد الحشري (ايزيجيتا) إلى البوليمر هي النسبة التي تعطي افضل خواص الميكانيكية

من خلال تجربة Bioassay تم اختبار نشاط البوليمر والمبيدات الحشرية (Izagita ،Ikon).

وكانت النتائج فعالة في طرد وقتل الحشرات. خلال (1 إلى 2) دقيقة لقتل وطرده الحشرات داخل مكعب تجربة Bioassay لجميع النسب المذكورة .

من نتائج Viscosity and density للبوليمر مع المبيد الحشري (ايكون, ايزيجيتا) لكلا النوعين من المبيد الحشري زادة الزوجة والكثافة مع زياده نسبه المبيد الحشري المضاف .



جمهورية العراق

وزارة التعليم العالي والبحث العلمي

جامعة بابل / كلية هندسة المواد

قسم هندسة المواد البوليمرات والصناعات البتروكيمياوية

تحضير اشربة بوليمرية طاردة للحشرات للحد من اضرار المبيدات على
البيئة

رسالة

مقدمة الى كلية هندسة المواد / جامعة بابل وهي جزء من متطلبات نيل
درجة الماجستير في هندسة المواد / البوليمر

من قبل الطالبة

نور حسين راضي عبود

(بكالوريوس في هندسة المواد / البوليمرات 2016)

باشراف

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