DEVELOPMENT OF BIO-DEGRADABLE PACKING MATERIAL

A PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this project report **"DEVELOPMENT OF BIO-DEGRADABLE PACKING MATERIAL"** is the bonafide work of **R.KRUPASHREE, R.MOHANA PRIYA, A.NEHA, T.VENKETESH** who carried out project work under my supervision

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ABSTRACT

The demands to ban plastic bags are echoing all around the place with many states having already banned them or are in the process of passing such judgment. Thes plastic bags have created many problems ranging from choking drains and marine life t affecting environment on account of their being non-biodegradable.

This project is concerned about the development of biodegradable plastic bags. Aim of this project is to manufacture eco-friendly packaging materials that coincides with the standards of bio degradable norms and to track the path for the prope disposal of packing materials. To avoid the hazardous effect of non biodegradable packing materials.

Solution diluted to 50 times with tap water is sprayed on PE/PP pellets and left undisturbed for about 3 hours. Then the pellets are extruded into films through melt blown extrusion machine and finally converted into required form by cutting machines.

Tests like biodegradation, melting and toxicity tests are taken to prove its degradation.

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1. INTRODUCTION

The demands to ban plastic bags are echoing all around the place with many states having already banned them or are in the process of passing such judgment. These plastic bags have created many problems ranging from choking drains and marine life to affecting environment on account of their being non-biodegradable.

Well, the plastic bags came into being to prevent the massive felling of trees for manufacturing of paper bags. So the plastic bags were seen as the saviors and hailed. So their manufacturing was also recklessly promoted as they are being banned these days. Plastic bags did help in serving that purpose, preventing deforestation. But yes, they did become nuisance because they choked drains, became a threat to marine life and due to their non-biodegradable properties. So the bags once made were there for always that were hailed as saviors once, soon were rechristened as destructors.

So does that mean that manufacturing them was a big mistake that we committed and now it should be corrected by banning their production? The places where plastic bags are banned, shopkeepers have started using paper bags. So we are actually going back in time. Our drains will flow freely again but trees will be cut again.

The solution doesn't lie in a blanket ban on plastic bags. That way we'll just reach that point from where we began. Promoting paper bags in place of plastic bags is in no way wise. The media is full of myths about plastic bags and their uses. One of them is that it is costlier to recycle plastic bags than to produce new. A website, thetruthaboutplasticbags.com quotes a leading recycler as that recycling is in no way costlier but is about four times less costly. Govt. should actually promote recycling of plastic bags instead of having them dumped off in the landfills and then complain about their taking up space for ever.

Biodegradable plastic and plastic bags of proper thickness should be made available and promoted. These are any day better to environment than paper bags. The govt. should direct retailers in this direction as to promote these bags and also cloth bags. Kroger, a leading retail chain gives 5 cents off for every recyclable bag you bring yourself, a way of passing on the saving one does by not having to give away plastic bags. Providing incentives for the production of degradable plastic bags, setting up recycling plants and taking steps to promote their reuse is the way ahead.

A complete ban on plastic bags will only worsen the situation and take us full circle. We need to promote its judicious use and reuse and then its recycle. Alternatives like clothe bags and jute bags which have longer life and are nature friendly too should be promoted and their production should be given incentives as well. Plastic is not bad but it's about using it judiciously.

1.1 AIM

To manufacture eco-friendly packaging materials that coincides with the standards of bio degradable norms.

1.2 OBJECTIVE

- To track the path for the proper disposal of packing materials.
- To avoid the hazardous effect of non-degradable packing materials.

2. LITERATURE REVIEW

Biodegradable plastics are plastics that will decompose in natural aerobic (composting) and anaerobic (landfill) environments. Biodegradation of plastics can be achieved by enabling microorganisms in the environment to metabolize the molecular structure of plastic films to produce an inert humus-like material that is less harmful to the environment. They may be composed of either bioplastics, which are plastics whose components are derived from renewable raw materials, or petroleum-based plastics which utilize an additive. The use of bio-active compounds compounded with swelling agents ensures that, when combined with heat and moisture, they expand the plastic's molecular structure and allow the bio-active compounds to metabolize and neutralize the plastic.

Biodegradable plastics typically are produced in two forms: injection molded (solid, 3D shapes), typically in the form of disposable food service items, and films, typically organic fruit packaging and collection bags for leaves and grass trimmings, and agricultural mulch. Biodegradable bags are bags made from materials that are able to decompose under specified conditions of light, moisture, and oxygen.Every year approximately 500 billion to 1 trillion plastic bags are used worldwide.Often composting conditions or exposure to sun, moisture, and oxygen are needed: degradation is slow in landfills. Many stores and companies are beginning to use different types of biodegradable bags to comply with perceived environmental benefits.

2.1 Degradation or Biodegradation

Plastic bags can be made Oxo-biodegradable by being manufactured from normal polymer with an additive which causes accelerated breakdown of the molecular chains, and subsequent bioassimilation; or "Hydro-biodegradable" by being manufactured from vegetable-based materials.

The Trade Association for the Oxo-biodegradable plastics industry is the Oxo-biodegradable Plastics Association (www.biodeg.org), which will certify products tested according to ASTM D6954 or (as from 1st Jan 2010) UAE 5009:2009

The Trade Associations for the Hydro-biodegradable plastics industry are the Biodegradable Products Institute] (BPI) "European Bioplastics" and SPIBioplastics Council" Plastics are certified as biodegradable under composting conditions in the United States if they comply with ASTM D6400, and in Europe EN13432.The pros and cons of these two types of plastics will be found on the websites of the Trade Associations as above.The Standards appropriate to hydro-biodegradable plastics are not appropriate for oxo-biodegradable plastics and vice-versa.

2.2 Companies

Different companies use different kinds of biodegradable bags. Many stores use biodegradable bags. Multinational baking giant Grupo Bimbo SAB de CV of Mexico City claims to have been the first to make "Oxo Biodegradable metalized polypropylene snack bag". In addition to that, a company named "Doo Bandits" has created biodegradable bags used for picking up dog waste.Another company in Germany called Aldi Slid, offers biodegradable Ecovio bags. Ecoflex bags are flexible, tear-resistant, waterproof, and suitable for printing. It gives the bags renewable raw material, making them biodegradable.

All of these examples show where companies have claimed biodegradable products without qualification of how long, conditions required, end state results, or weither the residue contains harmful by products as outlined in the pass/fail ASTM D6400 standard. In most cases without clarification that these products require composting conditions to achieve endstate they products will be placed in traditional landfills with not degradation of anytype or environmental benefit.

2.3 Materials

Most bags are made from corn-based materials. Many bags are also made from paper, organic materials, or polycaprolactone.

2.4 Recycling

In- plant scrap can often be recycled but post-consumer sorting and recycling is difficult. Many biodegradable polymers have the potential to contaminate the recycling of other more recyclable homopolymers. They should be kept separate from the recyling stram. SPI Resin identification code 7 is applicable.

2.5 Marketing Qualification

Since many of these plastics require access to sunlight, oxygen, or lengthy periods of time to achieve degradation or biodegradation the Federal Trade Commission's, GUIDES FOR THE USE OF ENVIRONMENTAL MARKETING CLAIMS, commonly called the "green guide"[9] require proper marking of these products to show their performance limits.

The FTC provides an example:

Example 1: A trash bag is marketed as "degradable," with no qualification or other disclosure. The marketer relies on soil burial tests to show that the product will decompose in the presence of water and oxygen. The trash bags are customarily disposed of in incineration facilities or at sanitary landfills that are managed in a way that inhibits degradation by minimizing moisture and oxygen. Degradation will be irrelevant for those trash bags that are incinerated and, for those disposed of in landfills, the marketer does not possess adequate substantiation that the bags will degrade in a reasonably short period of time in a landfill. The claim is therefore deceptive

Since there are no pass fail tests for "biodegradable" plastic bags manufactures must print on the product the environmental requirements for biodegradation to take place, time frame and end results in order to be within US Trade Requirements.

2.6 Scientific definitions of biodegradable plastic

In the United States, ASTM International is the authoritative body for defining biodegradable standards. The specific subcommittee responsibility for overseeing these standards falls on the Committee D20.96 on Environmentally Degradable Plastics and Biobased Products. The current ASTM standards are defined as standard specifications and standard test methods. Standard specifications create a pass or fail scenario whereas standard test methods identify the specific testing parameters for facilitating specific biodegradable tests on plastics.

Currently, there are three such ASTM standard specifications which mostly address biodegradable plastics in composting type environments, the ASTM D6400-04 Standard Specification for Compostable Plastics , ASTM D6868 - 03 Standard Specification for Biodegradable Plastics Used as Coatings on Paper and Other Compostable Substrates , and the ASTM D7081 - 05 Standard Specification for Non-Floating Biodegradable Plastics in the Marine Environment .

Currently the most accurate standard test method for anaerobic environments is the ASTM D5511 - 02 Standard Test Method for Determining Anaerobic Biodegradation of Plastic Materials Under High-Solids Anaerobic-Digestion Conditions. Another standard test method for testing in anaerobic environments is the ASTM D5526 - 94(2002) Standard Test Method for Determining Anaerobic Biodegradation of Plastic Materials Under Accelerated Landfill Conditions , this test has proven extremely difficult to perform.

The current California legislation AB 1972 ensures accurate environmental advertising of plastics by allowing only the use of terms that can be verified by an American Society for Testing Materials (ASTM) standard specification. This legislation does not include ASTM standard test methods. The two ASTM standard specifications which are used in the legislation are ASTM D6400 and D7081. Products passing these ASTM specifications can use the term compostable on the product label.

2.7 Environmental benefits

Environmental benefits of biodegradable plastics depend upon proper disposal. Biodegradable plastics are not a panacea, however. Some critics claim that a potential environmental disadvantage of certified biodegradable plastics is that the carbon that is locked up in them is released into the atmosphere as a greenhouse gas. However, biodegradable plastics from natural materials, such as vegetable crop derivatives or animal products, sequester CO2 during the phase when they're growing, only to release CO2 when they're decomposing, so there is no net gain in carbon dioxide emissions.

However, certified biodegradable plastics require a specific environment of moisture and oxygen to biodegrade, conditions found in professionally managed composting facilities. There is much debate about the total carbon, fossil fuel and water usage in processing biodegradable plastics from natural materials and whether they are a negative impact to human food supply. Traditional plastics made from non-renewable fossil fuels lock up much of the carbon in the plastic as opposed to being utilized in the processing of the plastic. The carbon is permanently trapped inside the plastic lattice, and is rarely recycled.

There is concern that another greenhouse gas, methane, might be released when any biodegradable material, including truly biodegradable plastics, degrades in an anaerobic (landfill) environment. Methane production from these specially managed landfill environments are typically captured and burned to negate the release of methane in the environment. Some landfills today capture the methane biogas for use in clean inexpensive energy. Of course, incinerating non-biodegradable plastics will release carbon dioxide as well. Disposing of biodegradable plastics made from natural materials in anaerobic (landfill) environments will result in the plastic lasting for hundred of years.

The US EPA has mandated strict standards for landfill design and construction to prevent biodegradation in a landfill in the first place. The intentional production of methane from landfills is, therefore, the rare exception and not the rule for most municipal solid waste.

It is also possible that bacteria will eventually develop the ability to degrade plastics. This has already happened with nylon: two types of nylon eating bacteria, Flavobacteria and Pseudomonas, were found in 1975 to possess enzymes (nylonase) capable of breaking down nylon. While not a solution to the disposal problem, it is likely that bacteria will evolve the ability to use other synthetic plastics as well. In 2008, a 16-year-old boy reportedly isolated two plastic-consuming bacteria.

The latter possibility was in fact the subject of a cautionary novel by Kit Pedler and Gerry Davis (screenwriter), the creators of the Cybermen, re-using the plot of the first episode of their Doomwatch series. The novel, Mutant 59: The Plastic Eater, written in 1971, is the story of what could happen if a bacterium were to evolve—or be artificially cultured—to eat plastics, and be let loose in a major city.

2.8 Mechanisms

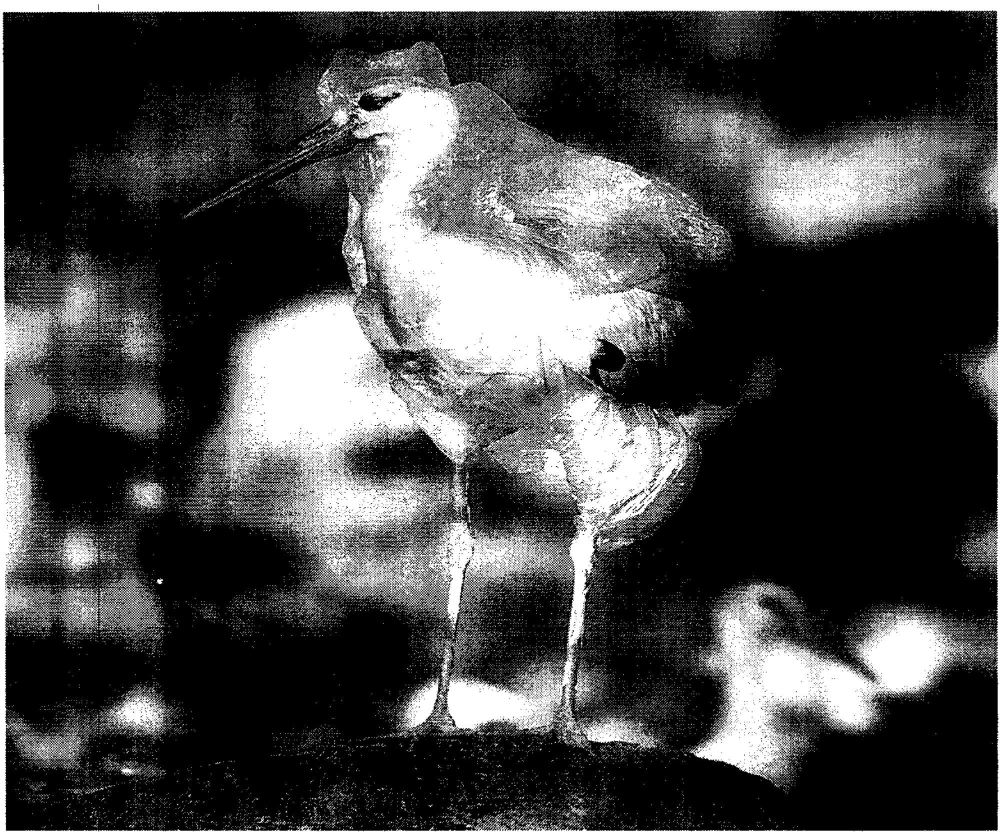
Materials such as a polyhydroxyalkanoate (PHA) biopolymer are completely compostable in an industrial compost facility. Polylactic acid (PLA) is another 100% compostable biopolymer which can fully degrade above 60C in an industrial composting facility. Fully biodegradable plastics are more expensive, partly because they are not widely enough produced to achieve large economies of scale.

EcoPure from Bio-Tec attracts the microbes to the molecular structure by allowing the hydrocarbons to be sensed once again by microbial colonies. When oil is in the ground the microbes attach themselves onto the hydrocarbons consuming the oil and creating natural gas, 50% of which is methane gas. When the oil is cracked 4% is used for the plastic industry, if the plastic industry did not use this 4% the 4% would be considered waste and be thrown away or removed and dumped into a waste disposal facility, another 4% is used in the generation of your consumer product. During this phase of cracking the organic compound which attracts the microbes to the molecular structure of the plastic is burnt out. The organic compound which is burnt out and other proprietary compounds which increase quorum sensing of the microbes and Ph balance for the microbes are placed into the molecular structure of the plastic, to create a plastic product that can biodegrade 100 times faster than normal plastic.

2.9 Environmental concerns

Over 200 million tons of plastic are manufactured annually around the world, according to the Society of Plastics Engineers. Of those 200 million tons, 26 million are manufactured in the United States. The EPA reported in 2003 that only 5.8% of those 26 million tons of plastic waste are recycled, although this is increasing rapidly.

Much of the reason for disappointing plastics recycling goals is that conventional plastics are often commingled with organic wastes (food scraps, wet paper, and liquids), making it difficult and impractical to recycle the underlying polymer without expensive cleaning and sanitizing procedures.



On the other hand, composting of these mixed organics (food scraps, yard trimmings, and wet, non-recyclable paper) is a potential strategy for recovering large quantities of waste and dramatically increase community recycling goals. Food scraps and wet, non-recyclable paper comprises 50 million tons of municipal solid waste.[10]. Biodegradable plastics can replace the non-degradable plastics in these waste streams, making municipal composting a significant tool to divert large amounts of otherwise nonrecoverable waste from landfills.

If even a small amount of conventional plastics were to be commingling with organic materials, the entire batch of organic waste is "contaminated" with small bits of plastic that spoil prime-quality compost humus. Composters, therefore, will not accept mixed organic waste streams unless they are completely devoid of nondegradable plastics. So, because of a relatively small quantity of nondegradable plastics, a significant waste disposal strategy is stalled.

However, proponents of biodegradable plastics argue that these materials offer a solution to this problem. Certified biodegradable plastics combine the utility of plastics (lightweight, resistance, relative low cost) with the ability to completely and fully biodegrade in a compost facility. Rather than worrying about recycling a relatively small quantity of commingled plastics, these proponents argue that certified biodegradable plastics can be readily commingled with other organic wastes, thereby enabling composting of a much larger position of nonrecoverable solid waste. Commercial composting for all mixed organics then becomes commercially viable and economically sustainable. More municipalities can divert significant quantities of waste from overburdened landfills since the entire waste stream is now biodegradable and therefore easier to process.

The use of biodegradable plastics, therefore, is seen as an enabler for the complete recovery of large quantities of municipal sold waste (via aerobic composting) that were are heretofore unrecoverable by other means except land filling or incineration.

Polyethylene or polythene film is usually stable and resistant to degradation. Methods are available to make it more degradable under certain conditions of sunlight, moisture, oxygen, and composting.

If traditional polyethylene film is littered it can be unsightly, and a hazard to wildlife. Some people believe that making plastic shopping bags biodegradable is one way to try to allow the open litter to degrade.

Plastic recycling improves usage of resources. Biodegradable films need to be kept away from the usual recycling stream to prevent contaminating the polymers to be recycled.If disposed of in a sanitary landfill, most traditional plastics do not readily decompose. The sterile conditions of a sealed landfill also deter degradation of "biodegradable" polymers.

Polyethylene is a polymer consisting of long chains of the monomer ethylene (IUPAC name ethene). The recommended scientific name polyethene is systematically derived from the scientific name of the monomer. In certain circumstances it is useful to use a structure–based nomenclature. In such cases IUPAC recommends poly(methylene). The difference is due to the opening up of the monomer's double bond upon polymerisation.

In the polymer industry the name is sometimes shortened to PE in a manner similar to that by which other polymers like polypropylene and polystyrene are shortened to PP and PS respectively. In the United Kingdom the polymer is commonly called polythene, although this is not recognised scientifically.The ethene molecule (known almost universally by its common name ethylene) $C2H4$ is $CH2=CH2$, Two $CH2$ groups connected by a double bond, thus polyethylene is created through polymerization of ethene. It can be produced through radical polymerization, anionic addition polymerization, ion coordination polymerization or cationic addition polymerization. This is because ethene does not have any substituent groups that influence the stability of the propagation head of the polymer. Each of these methods results in a different type of polyethylene.

2.10 Types of biodegradable polythene film

Polythene or Polyethylene film will naturally fragment and biodegrade, but it can take many decades to do this, and can in the meantime cause an environmental problem. There are two methods to resolve this problem. One is to modify the carbon chain of polyethylene with an additive to improve its degradability and then its biodegradability; the other is to make a film with similar properties to polyethylene from a biodegradable substance such as starch. The latter are however much more expensive.

===Starch based or biobased (hydrodegradable) film=== (Trade Associations for this industry are "Biodegradable Products Institute" (BPI); European Bioplastics, and "SPIBioplastics Council"

This type is made from corn (maize), potatoes or wheat. This form of biodegradable film meets the ASTM standard (American Standard for Testing Materials) and European norm EN13432 for compostability as it degrades at least 90% within 180 days or less under specified conditions. However, actual products made with this type of film may not meet those standards.

Examples of polymers with which starch is commonly used

Polycaprolactone (PCL)

Polyvinyl alcohol (PVA)

Polylactic acid (PLA)

The heat, moisture and aeration in an industrial composting plant are required for this type of film to biodegrade, so it will not therefore readily degrade if littered in the environment.

2.10.1 Pros & cons of starch based film/bag

Pros

- It is "compostable" under industrial conditions.
- Reduced fossil fuel content (depending on loading of filler).

Cons

- Much too expensive for everyday use

- Source of starch can be problematic (competition against food use, rainforests being cleared to grow crops for bioplastics)
- Fossil fuels are burned and CO2 produced in the agricultural production process.
- Poorer mechanical strength than additive based example – filling a starch bag with wet leaves and placing it curbside can result in the bottom falling out when a haulier picks it up.
- Often not strong enough for use in high-speed machines
- Degradation in a sealed landfill takes at least 6 months.
- Emits CO2 in aerobic conditions and methane under anaerobic conditions
- Limited Shelf life. Conditions must be respected for stockage.
- If mixed with other plastics for recycling, the recycling process is compromised.

Typical applications

Carrier bag, refusal sacks, vegetable bags, food films, agricultural films, mailing films. However, these applications are still very limited compared to those of petroleum based plastic films.Additive based (OXO-BIODEGRADABLE))=== (Trade Association for this industry is the Oxo-biodegradable Plastics Association - www.biodeg.org) These films are made by blending an additive to provide an oxidative and then a biological mechanism to degrade them. This typically takes 6 months to 2 years in the environment if adequate exposure to oxygen Degradation is a two stage process; first the plastic is converted by reaction with oxygen (light, heat and/or stress accelerates the process but is not essential) to low molecular-weight fragments that water can wet, and then these smaller oxidized molecules are biodegraded, i.e. converted into carbon dioxide, water and biomass by microorganisms. Commercial competitors and their trade associations allege that the process of biodegradation stops at a certain point, leaving fragments, but they have never established why or at what point. This is similar to the breakdown of woody plant material where lignin is broken down and forms a humus component improving the soil quality. If put in an in-vessel composting system this type of plastic will rapidly break down, but it is not currently marketed as compostable.

2.10.2 Pros & cons of additive based film/bag

Pros

- Much cheaper than starch-based plastics
- Can be made with normal machinery, and can be used in high speed machines, so no need to change suppliers and no loss of jobs
- Materials are well known
- Does not compete against food production
- These films look, act and perform just like their non-degradable counterparts, during their programmed service-life but then break down if discarded.
- They can be recycled with normal plastics (http://www.biodeg.org/position-papers/recycling/?domain=biodeg.org)
- Like normal plastics they are made from a by-product of oil or natural gas, but these would be extracted whether the by-product were used to make plastic or not.
- They are certified non-toxic, and safe for food-contact

Cons

- Degradation depends on access to air
- Not designed to degrade in landfill, but can be safely landfilled. Will degrade if oxygen is present, but will NOT emit methane in landfill

- European or American (EN13432 D6400)Standards on [compostable]] products are not appropriate, as not designed for composting. They should be tested according to ASTM D6954 or (as from 1 Jan 1010) UAE norm 5009:2009
- They are not suitable for PET or PVC
- Precise rate of degradation/biodegradation cannot be predicted, but will be faster than nature's wastes such as straw or twigs, and much faster than normal plastic .

Typical applications

Trash Bags, Garbage Bags, Compost Bags, Carrier bag, Agricultural Film, Mulch Film, produce bags, - in fact all forms of short-life plastic film packaging

2.11 Synthetic Biodegradable Polymer

Many opportunities exist for the application of synthetic biodegradable polymers in the biomedical area particularly in the fields of tissue engineering and controlled drug delivery. Degradation is important in biomedicine for many reasons. Degradation of the polymeric implant means surgical intervention may not required for removal at the end of its functional life, eliminating the need for a second surgery.In tissue engineering, biodegradable polymers can be designed such to approximate tissues, providing a polymer scaffold that can withstand mechanical stresses, provide a suitable surface for cell attachment and growth, and degrade at a rate that allows the load to be transferred to the new tissue.In the field of controlled drug delivery, biodegradable polymers offer tremendous potential either as a drug delivery system alone or in conjunction to functioning as a medical device.

In the development of applications of biodegradable polymers, the chemistry of some polymers including synthesis and degradation is reviewed below. A description of how properties can be controlled by proper synthetic controls such as copolymer composition, special requirements for processing and handling, and some of the commercial devices based on these materials are discussed.

2.11.1 Polymer chemistry and material selection

When investigating the selection of the polymer for biomedical applications, important criteria to consider are

- The mechanical properties must match the application and remain sufficiently strong until the surrounding tissue has healed.
- The degradation time must match the time required.
- It does not invoke a toxic response.
- It is metabolized in the body after fulfilling its purpose.
- It is easily processable in the final product form with an acceptable shelf life and easily sterilized.

Mechanical performance of a biodegradable polymer depends on various factors which include monomer selection, initiator selection, process conditions and the presence of additives. These factors influence the polymers crystallinity, melt and glass transition temperatures and molecular weight. Each of these factors needs to be assessed on how they affect the biodegradation of the polymer. Biodegradation can be accomplished by synthesizing polymers with hydrolytically unstable linkages in the backbone. This is commonly achieved by the use of chemical functional groups such as esters, anhydrides, orthoesters and amides. Most biodegradable polymers are synthesized by ring opening polymerization.

2.11.2 Processing

Biodegradable polymers can be melt processed by conventional means such as compression or injection molding. Special consideration must be given to the need to exclude moisture from the material. Care must be taken to dry the polymers before processing to exclude humidity. As most biodegradable polymers have been synthesized by ring opening polymerization, a thermodynamic equilibrium exists between the forward polymerization reaction and the reverse reaction that results in monomer formation. Care needs to be taken to avoid an excessively high processing temperature that may result in monomer formation during the molding and extrusion process.

2.11.3 Degradation

Once implanted, a biodegradable device should maintain its mechanical properties until it is no longer needed and then be absorbed by the body leaving no trace. The backbone of the polymer is hydrolytically unstable. That is, the polymer is unstable in a water based environment. This is the prevailing mechanism for the polymers degradation. This occurs in two stages.

1. Water penetrates the bulk of the device, attacking the chemical bonds in the amorphous phase and converting long polymer chains into shorter water-soluble fragments. This causes a reduction in molecular weight without the loss of physical properties as the polymer is still held together by the crystalline regions. Water penetrates the device leading to metabolization of the fragments and bulk erosion.

2. Surface erosion of the polymer occurs when the rate at which the water penetrating the device is slower than the rate of conversion of the polymer into water soluble materials.

Biomedical engineers can tailor a polymer to slowly degrade and transfer stress at the appropriate rate to surrounding tissues as they heal by balancing the chemical stability of the polymer backbone, the geometry of the device, and the presence of catalysts, additives or plasticizers.

2.11.4 Applications

As previously mentioned, biodegradable polymers are used commercially in both the tissue engineering and drug delivery field of biomedicine. Specific applications include

- Sutures
- Dental devices
- Orthopedic fixation devices
- Tissue engineering scaffolds
- Biodegradable vascular stents

2.12 Bioplastic

Bioplastics or organic plastics are a form of plastics derived from renewable biomass sources, such as vegetable oil, corn starch, pea starch, or micro biota, rather than fossil-fuel plastics which are derived from petroleum. Some, but not all, bioplastics are designed to biodegrade.

2.12.1 Applications

Biodegradable bioplastics are used for disposable items, such as packaging and catering items (crockery, cutlery, pots, bowls, straws). Biodegradable bioplastics are also often used for organic waste bags, where they can be composted together with the food or green waste. Some trays and containers for fruit, vegetables, eggs and meat, bottles for soft drinks and dairy products and blister foils for fruit and vegetables are manufactured from bioplastics.

Non-disposable applications include mobile phone casings, carpet fibres, and car interiors, fuel line and plastic pipe applications, and new electroactive bioplastics are being developed that can be used to carry electrical current. In these areas, the goal is not biodegradability, but to create items from sustainable resources.

2.12.2 Performance and usage

Many bioplastics lack the performance and ease of processing of traditional materials. Polylactic acid plastic is being used by a handful of small companies for water bottles. But shelf life is limited because the plastic is permeable to water - the bottles lose their contents and slowly deform. However, bioplastics are seeing some use in Europe, where they account for 60% of the biodegradable materials market. The most common end use market is for packaging materials. Japan has also been a pioneer in bioplastics, incorporating them into electronics and automobiles.

2.12.3 Plastic types

Starch based plastics

Constituting about 50 percent of the bioplastics market, thermoplastic starch, such as Plastarch Material, currently represents the most important and widely used bioplastic. Pure starch possesses the characteristic of being able to absorb humidity and is thus being used for the production of drug capsules in the pharmaceutical sector. Flexibiliser and plasticiser such as sorbitol and glycerine are added so that starch can also be processed thermo-plastically. By varying the amounts of these additives, the characteristic of the material can be tailored to specific needs (also called "thermo-plastical starch"). Simple starch plastic can be made at home shown by this method.

Polylactic acid (PLA) plastics

Polylactic acid (PLA) is a transparent plastic produced from cane sugar or glucose. It not only resembles conventional petrochemical mass plastics (like PE or PP) in its characteristics, but it can also be processed easily on standard equipment that already exists for the production of conventional plastics. PLA and PLA-Blends generally come in the form of granulates with various properties and are used in the plastic processing industry for the production of foil, moulds, tins, cups, bottles and other packaging.

Poly-3-hydroxybutyrate (PHB)

The biopolymer poly-3-hydroxybutyrate (PHB) is a polyester produced by certain bacteria processing glucose or starch. Its characteristics are similar to those of the petroplastic polypropylene. The South American sugar industry, for example, has decided to expand PHB production to an industrial scale. PHB is distinguished primarily by its physical characteristics. It produces transparent film at a melting point higher than 130 degrees Celsius, and is biodegradable without residue.

Polyamide 11 (PA 11)

PA 11 is a biopolymer derived from natural oil. It is also known under the tradename Rilsan B, commercialized by Arkema. PA 11 belongs to the technical polymers family and is not biodegradable. Its properties are similar to those of PA 12, although emissions of greenhouse gases and consumption of non-renewable resources are reduced during its production. Its thermal resistance is also superior to that of PA 12. It is used in high-performance applications like automotive fuel lines, pneumatic airbrake tubing, electrical cable anti-termite sheathing, flexible oil & gas pipes, control fluid umbilicals, sports shoes, electronic device components, and catheters.

Bio-derived polyethylene

The basic building block (monomer) of polyethylene is ethylene. This is just one small chemical step from ethanol, which can be produced by fermentation of agricultural feedstocks such as sugar cane or corn. Bio-derived polyethylene is chemically and physically identical to traditional polyethylene - it does not biodegrade but can be recycled. It can also considerably reduce greenhouse gas emissions. Brazilian chemicals group Braskem claims that using its route from sugar cane ethanol to produce one tonne of polyethylene captures (removes from the environment) 2.5 tonnes of carbon dioxide while the traditional petrochemical route results in emissions of close to 3.5 tonnes. Braskem plans to introduce commercial quantities of its first bio-derived high density polyethylene, used in a packaging such as bottles and tubs, in 2010 and has developed a technology to produce bio-derived butene, required to make the linear low density polethylene types used in film production.

Genetically modified bioplastics

Genetic modification (GM) is also a challenge for the bioplastics industry. None of the currently available bioplastics - which can be considered first generation products - require the use of GM crops. There is also concern that the route from corn to bioplastics is not the most efficient. Looking further ahead, some of the second generation bioplastics manufacturing technologies under development employ the "plant factory" model, using genetically modified crops or genetically modified bacteria to optimize efficiency.

2.12.4 Environmental impact

The production and use of bioplastics is generally regarded as a more sustainable activity when compared with plastic production from petroleum (petroplastic), because it relies less on fossil fuel as a carbon source and also introduces fewer, net-new greenhouse emissions if it biodegrades. They significantly reduce hazardous waste caused by oil-derived plastics, which remain solid for hundreds of years, and open a new era in packing technology and industry.

However, manufacturing of bioplastic materials is often still reliant upon petroleum as an energy and materials source. This comes in the form of energy required to power farm machinery and irrigate growing crops, to produce fertilizers and pesticides, to transport crops and crop products to processing plants, to process raw materials, and ultimately to produce the bioplastic, although renewable energy can be used to obtain petroleum independence.

Italian bioplastic manufacturer Novamont states in its own environmental audit that producing one kilogram of its starch-based product uses 500g of petroleum and consumes almost 80% of the energy required to produce a traditional polyethylene polymer. Environmental data from NatureWorks, the only commercial manufacturer of PLA (polylactic acid) bioplastic, says that making its plastic material delivers a fossil fuel saving of between 25 and 68 per cent compared with polyethylene, in part due to its purchasing of renewable energy certificates for its manufacturing plant.

A detailed study examining the process of manufacturing a number of common packaging items in several traditional plastics and polylactic acid carried out by US-group and published by the Athena Institute shows the bioplastic to be less environmentally damaging for some products, but more environmentally damaging for others.

While production of most bioplastics results in reduced carbon dioxide emissions compared to traditional alternatives, there are some real concerns that the creation of a global bioeconomy could contribute to an accelerated rate of deforestation if not managed effectively. There are associated concerns over the impact on water supply and soil erosion. Other studies showed that bioplastics represent a 42% reduction in carbon footprint. On the other hand, bioplastic can be made from agricultural byproducts and also from used plastic bottles and other containers using micro organisms.

2.12.5 Bioplastics and biodegradation

The terminology used in the bioplastics sector is sometimes misleading. Most in the industry use the term bioplastic to mean a plastic produced from a biological source. One of the oldest plastics, cellulose film, is made from wood cellulose. All (bio- and petroleum-based) plastics are technically biodegradable, meaning they can be degraded by microbes under suitable conditions. However many degrade at such slow rates as to be considered non-biodegradable .PLA plastics can take 100 to 1,000 years to completely biodegrade. Some petrochemical-based plastics are considered biodegradable, and may be used as additives to improve the performance of many commercial bioplastics.Non-biodegradable bioplastics are referred to as durable. The degree of biodegradation varies with temperature, polymer stability, and available oxygen content. Consequently, most bioplastics will only degrade in the tightly controlled conditions of industrial composting units. In compost piles or simply in the soil/water, most bioplastics will not degrade (e.g. PHA, starch-based bioplastics), will however an internationally agreed standard, EN13432, defines how quickly and to what extent a plastic must be degraded under commercial composting conditions for it to be called biodegradable. This is published by the International Organization for Standardization ISO and is recognized in many countries, including all of Europe, Japan and the US. However, it is designed only for the aggressive conditions of commercial composting units. There is no standard applicable to home composting conditions.

The term "biodegradable plastic" is often also used by producers of specially modified petrochemical-based plastics which appear to biodegrade. Traditional plastics such as polyethylene are degraded by ultra-violet (UV) light and oxygen. To prevent this process manufacturers add stabilising chemicals. However with the addition of a degradation initiator to the plastic, it is possible to achieve a controlled UV/oxidation disintegration process. This type of plastic may be referred to as degradable plastic or oxy-degradable plastic or photodegradable plastic because the process is not initiated by microbial action. While some degradable plastics manufacturers argue that degraded plastic residue will be attacked by microbes, these degradable materials do not meet the requirements of the EN13432 commercial composting standard.

2.12.6 Recycling

There are also fears that bioplastics will damage existing recycling projects. Packaging such as HDPE milk bottles and PET water and soft drinks bottles is easily identified and hence setting up a recycling infrastructure has been quite successful in many parts of the world. Polylactic acid and PET do not mix - as bottles made from polylactic acid cannot be distinguished from PET bottles by the consumer there is a risk that recycled PET could be rendered unusable. This could be overcome by ensuring distinctive bottle types or by investing in suitable sorting technology. However, the first route is unreliable as not everyone might actually separate the plastics manually and mistakes in separation might easily be made, and the second costly. However, the cost of automated machine separation could be offset by the use of renewable electricity resources such as solar and wind power.

2.12.7 Certification

Biodegradability - EN 13432, ASTM D6400

The EN 13432 industrial standard is arguably the most international in scope and compliance with this standard is required to claim that a product is compostable in the European marketplace. In summary, it requires biodegradation of 90% of the materials in a commercial composting unit within 180 days. The ASTM 6400 standard is the regulatory framework for the United States and sets a less stringent threshold of 60% biodegradation within 180 days, again within commercial composting conditions.

The "compostable" marking found on many items of packaging indicates that the package complies with either of the two standards mentioned above. However, the marking is not owned by either regulatory body but by third party trade associations representing companies making or selling biodegradable plastics. In Europe, this is European Bioplastics; in the U.S. it is the Biodegradable Products Institute.

Many starch based plastics, PLA based plastics and certain aliphatic-aromatic co-polyester compounds such as succinates and adipates, have obtained these certificates. Additivated plastics sold as fotodegradable or Oxo Biodegradable do not comply with these standards in their current form.

Biobased - ASTM D6866

The ASTM D6866 method has been developed to certify the biologically derived content of bioplastics. Cosmic rays colliding with the atmosphere mean that some of the carbon is the radioactive isotope carbon-14. CO2 from the atmosphere is used by plants in photosynthesis, so new plant material will contain both carbon-14 and carbon-12. Under the right conditions, and over geological timescales, the remains of living organisms can be transformed into fossil fuels. After ~100,000 years all the carbon-14 present in the original organic material will have undergone radioactive decay leaving only carbon-12. A product made from biomass will have a relatively high level of carbon-14, while a product made from petrochemicals will have no carbon-14.The percentage of renewable carbon in a material (solid or liquid) can be measured with an accelerator mass spectrometer.

There is an important difference between biodegradability and biobased content. A bioplastic such as high density polyethylene (HDPE) [21] can be 100% biobased (i.e. contain 100% renewable carbon), yet be non-biodegradable. These bioplastics such HDPE play nonetheless an important role in greenhouse gas abatement, particularly when they are combusted for energy production. The biobased component of these bioplastics is considered carbon-neutral since their origin is from biomass.

3. METHODOLOGY

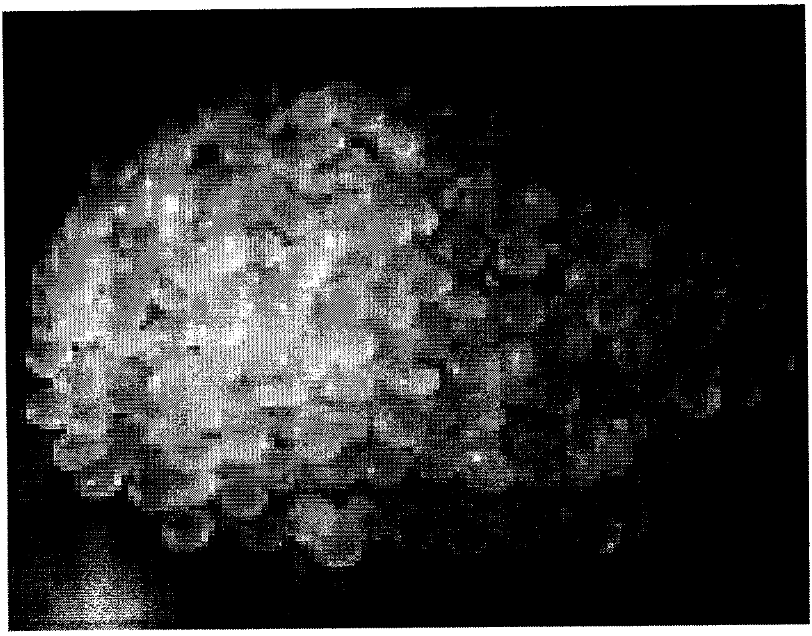
Step 1:

Solution is diluted 50 times with the tap water.

Step 2:

Then the above solution is sprayed on the PE/PP pellets.

Fig 2 solution sprayed pellets



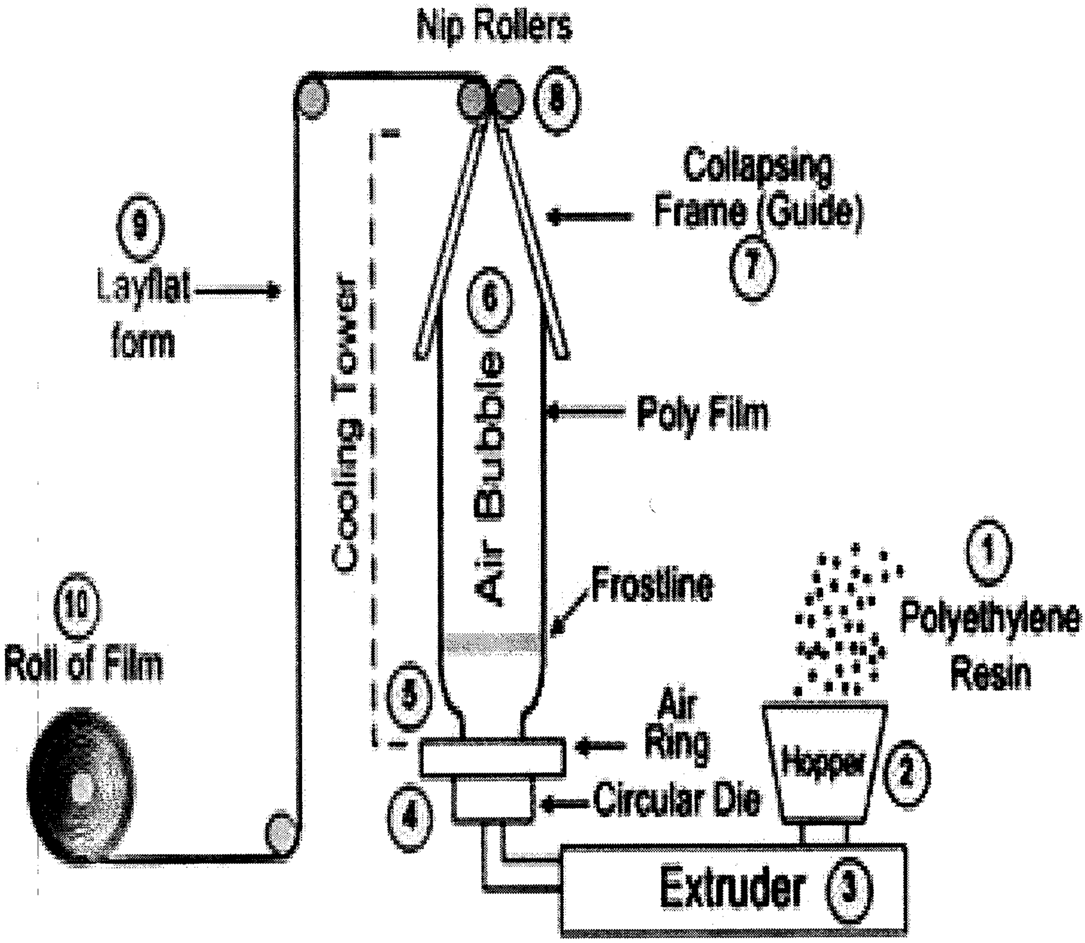
Step 3:

Next the pellets are kept undisturbed for about 3hrs.

Step 4:

After then the pellets are extruded into films through the melt blown extrusion machine.

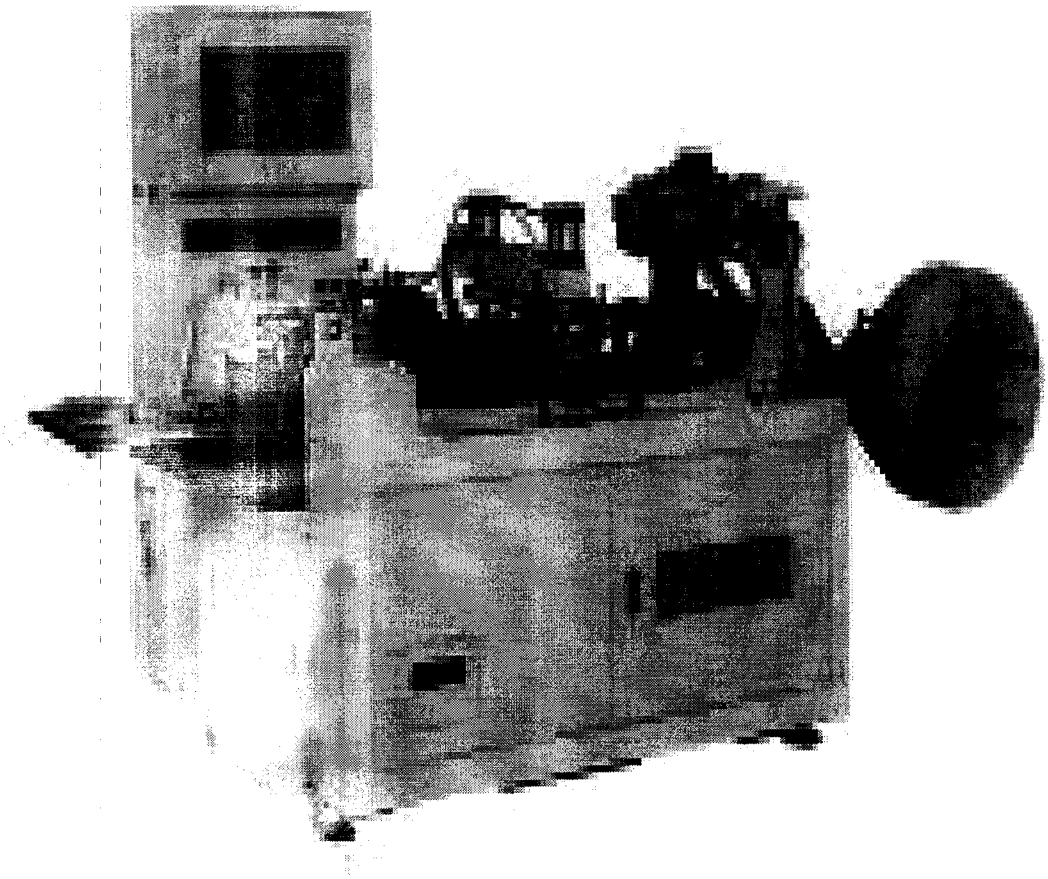
Fig 3 melt blown extrusion machine



Step 5:

Finally the films are converted into required forms through cutting machines.

Fig 4 Film cutting machine



4. RESULTS AND DISCUSSIONS

TESTING:

1. Bio degradation test.
2. Melting test.
3. Toxicity test.

4.1 Bio degradation test:

Procedure:

The sample is buried in two different soils and observed for 15 days.

Method 1:

5 set of treated samples and 1 untreated sample is buried in the area of peelamedu, Coimbatore. (Clay soil)

Results and Discussions:

In clay soil, degradation found to be in such a way that hole formation was found and the comparisons of above samples are mentioned below.

Method 2:

5 set of treated samples and 1 untreated sample is buried in the area of ayanavaram, Chennai.

Results and Discussions

As a result of degradation, the thickness of the sample is reduced (i.e.) micron level seems to be reduced.

4.1.1 MICROSCOPIC VIEW

The following figure shows the microscopic view of various stages.

Fig 5 Untreated Sample

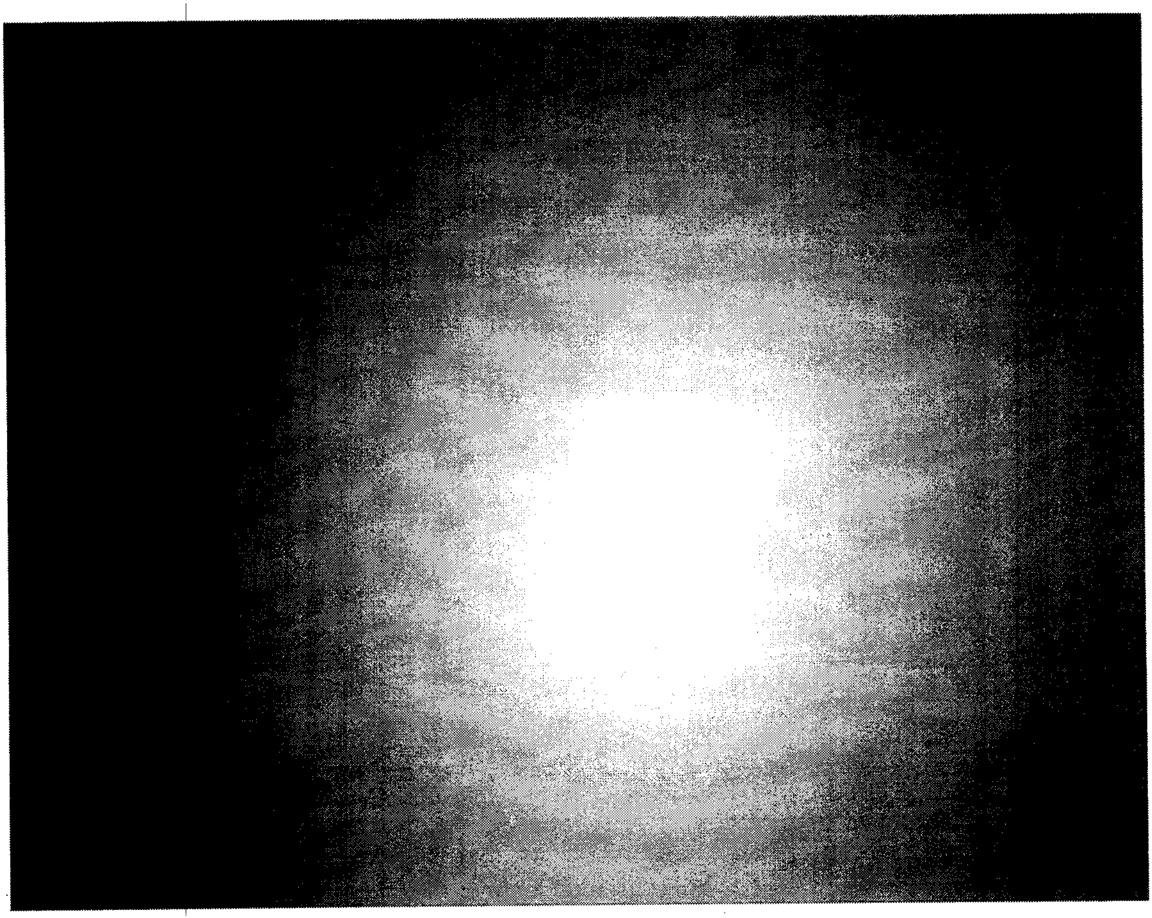


Fig 6   Treated Sample

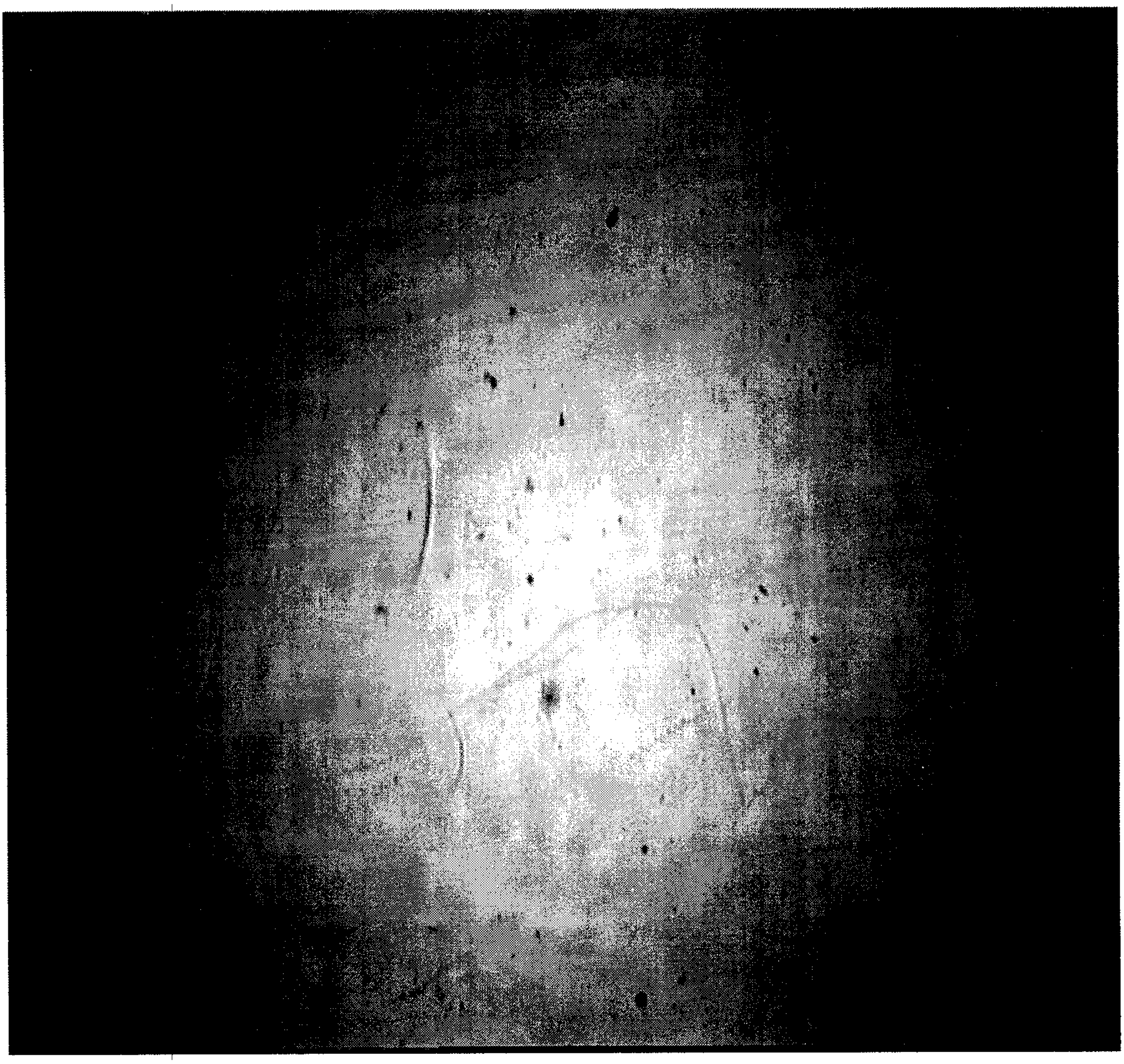
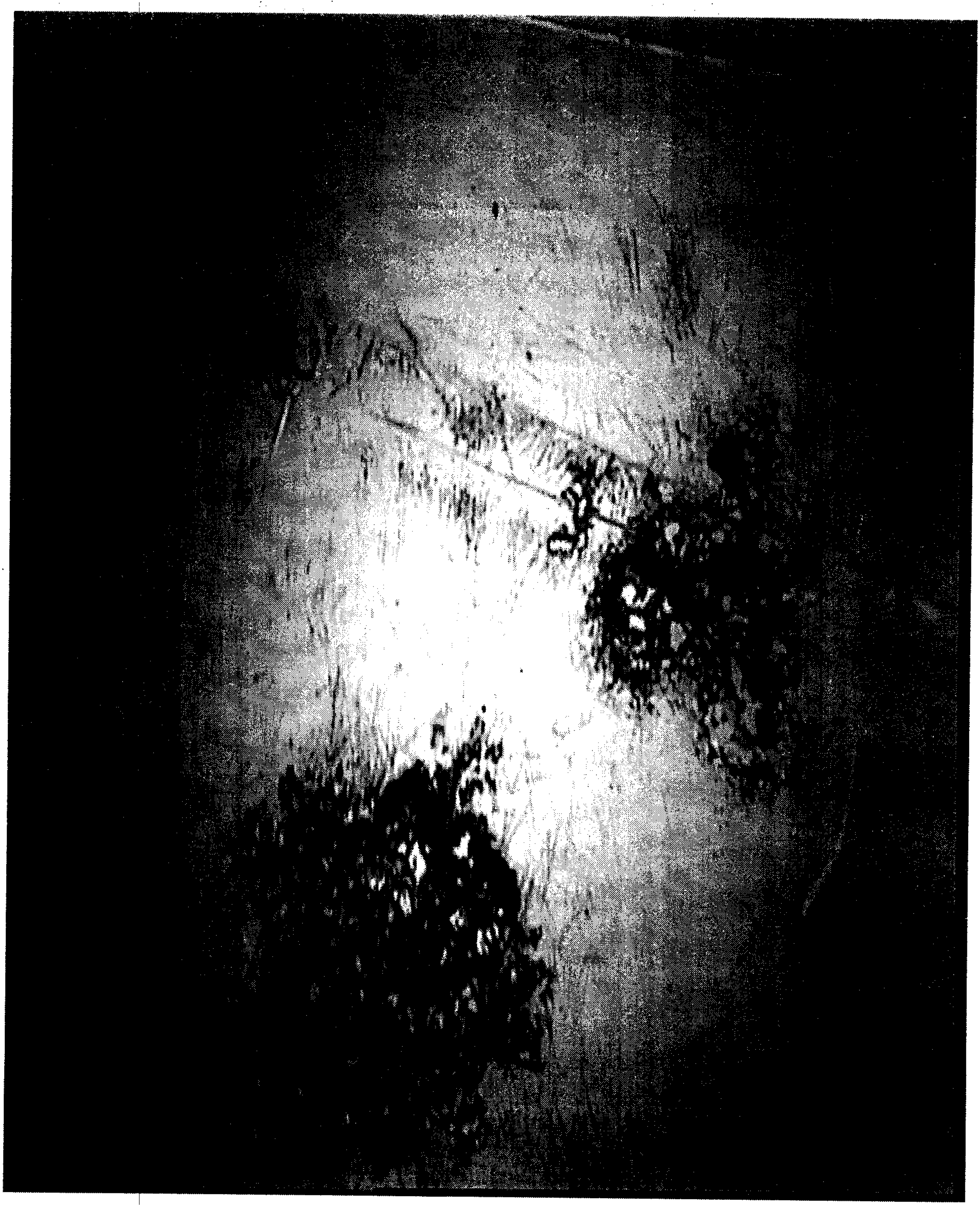
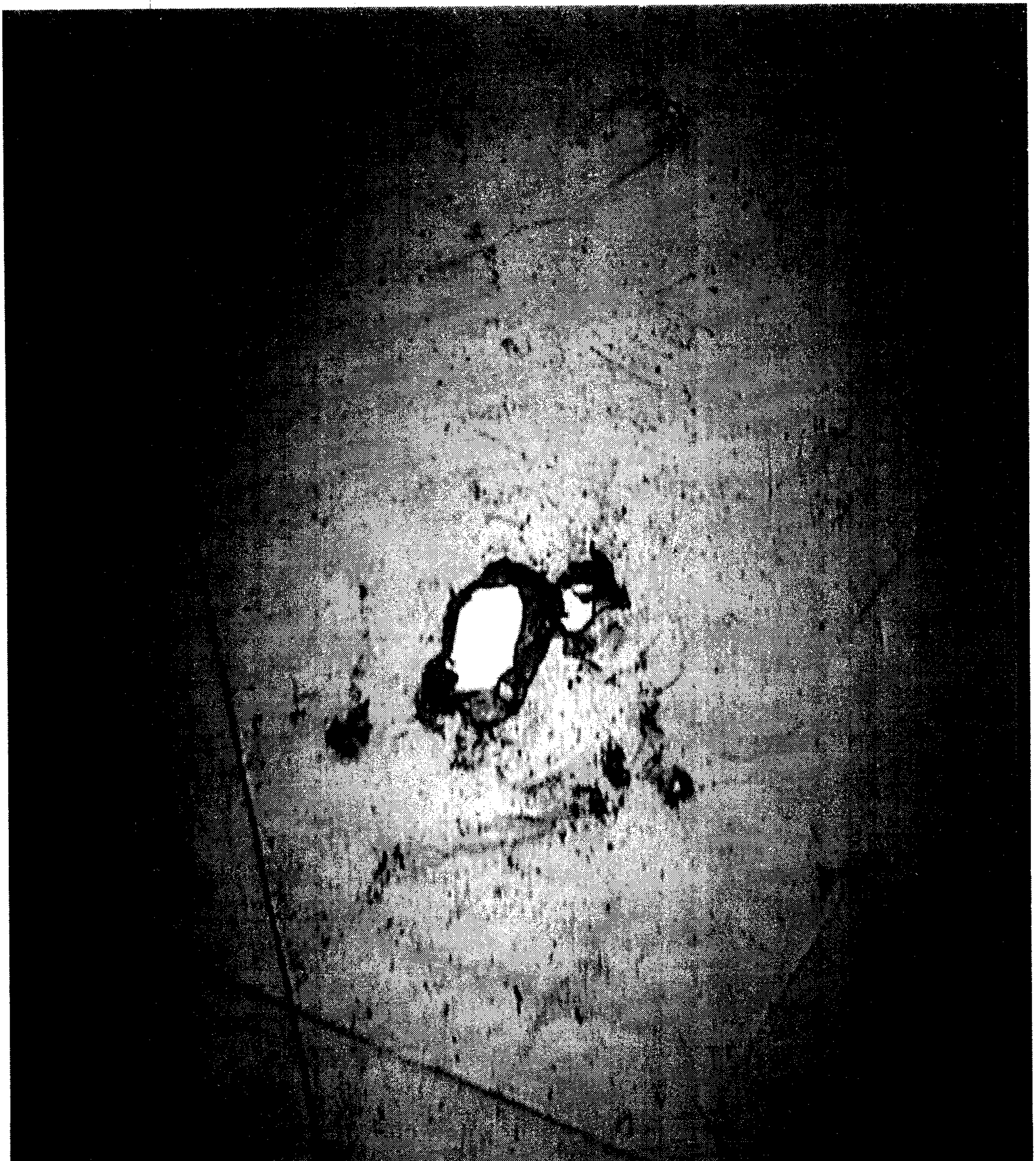
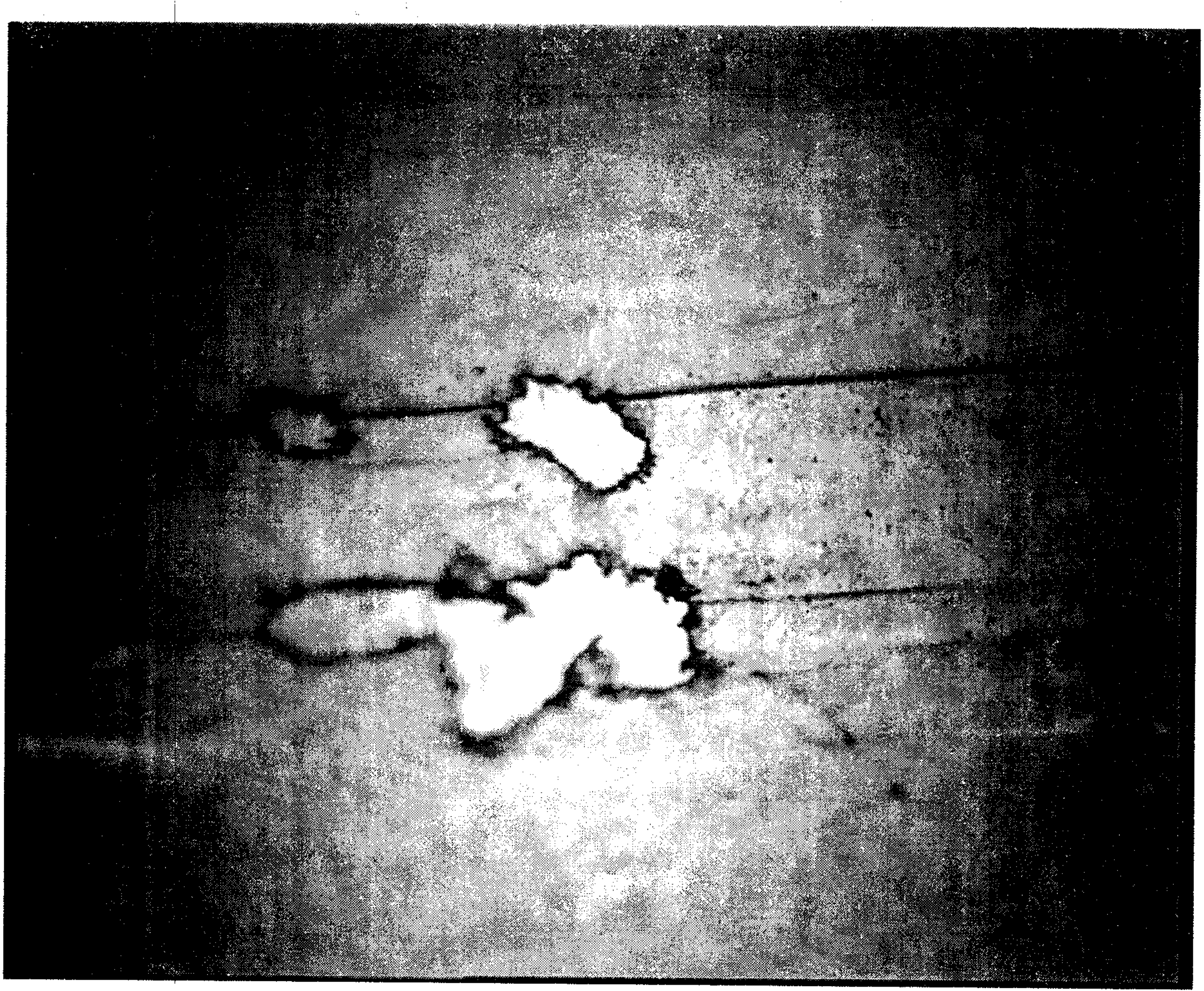


FIG 7 DIFFERENT VIEWS OF DEGRADED SAMPLE:







4.1.2 SEM Views

The results can be well explained in through SEM photography.

The scanning electron microscope (SEM) is a type of electron microscope that images the sample surface by scanning it with a high-energy beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample producing signals that contain information about the sample's surface topography, composition and other properties such as electrical conductivity.

The types of signals produced by an SEM include secondary electrons, back-scattered electrons (BSE), characteristic X-rays, light (cathodoluminescence), specimen current and transmitted electrons.

Secondary electron detectors are common in all SEMs, but it is rare that a single machine would have detectors for all possible signals. The signals result from interactions of the electron beam with atoms at or near the surface of the sample. In the most common or standard detection mode, secondary electron imaging or SEI, the SEM can produce very high-resolution images of a sample surface, revealing details about less than 1 to 5 nm in size. Due to the very narrow electron beam, SEM micrographs have a large depth of field yielding a characteristic three-dimensional appearance useful for understanding the surface structure of a sample. This is exemplified by the micrograph of pollen shown to the right. A wide range of magnifications is possible, from about 10 times (about equivalent to that of a powerful hand-lens) to more than 500,000 times, about 250 times the magnification limit of the best light microscopes. Back-scattered electrons (BSE) are beam electrons that are reflected from the sample by elastic scattering. BSE are often used in analytical SEM along with the spectra made from the characteristic X-rays. Because the intensity of the BSE signal is strongly related to the atomic number (Z) of the specimen, BSE images can provide information about the distribution of different elements in the sample. For the same reason, BSE imaging can image colloidal gold immuno-labels of 5 or 10 nm diameter which would otherwise be difficult or impossible to detect in secondary electron images in biological specimens. Characteristic X-rays are emitted when the electron beam removes an inner shell electron from the sample, causing a higher energy electron to fill the shell and release energy. These characteristic X-rays are used to identify the composition and measure the abundance of elements in the sample.

4.1.2.1 Scanning process and image formation

Schematic diagram of an SEM.In a typical SEM, an electron beam is thermionically emitted from an electron gun fitted with a tungsten filament cathode. Tungsten is normally used in thermionic electron guns because it has the highest melting point and lowest vapour pressure of all metals, thereby allowing it to be heated for electron emission, and because of its low cost. Other types of electron emitters include lanthanum hexaboride (LaB6) cathodes, which can be used in a standard tungsten filament SEM if the vacuum system is upgraded and field emission guns (FEG), which may be of the cold-cathode type using tungsten single crystal emitters or the thermally-assisted Schottky type, using emitters of zirconium oxide.

The electron beam, which typically has an energy ranging from 0.5 keV to 40 keV, is focused by one or two condenser lenses to a spot about 0.4 nm to 5 nm in diameter. The beam passes through pairs of scanning coils or pairs of deflector plates in the electron column, typically in the final lens, which deflect the beam in the x and y axes so that it scans in a raster fashion over a rectangular area of the sample surface.

When the primary electron beam interacts with the sample, the electrons lose energy by repeated random scattering and absorption within a teardrop-shaped volume of the specimen known as the interaction volume, which extends from less than 100 nm to around 5 μm into the surface. The size of the interaction volume depends on the electron's landing energy, the atomic number of the specimen and the specimen's density. The energy exchange between the electron beam and the sample results in the reflection of high-energy electrons by elastic scattering, emission of secondary electrons by inelastic scattering and the emission of electromagnetic radiation, each of which can be detected by specialized detectors. The beam current absorbed by the specimen can also be detected and used to create images of the distribution of specimen current. Electronic amplifiers of various types are used to amplify the signals which are displayed as variations in brightness on a cathode ray tube. The raster scanning of the CRT display is synchronised with that of the beam on the specimen in the microscope, and the resulting image is therefore a distribution map of the intensity of the signal being emitted from the scanned area of the specimen. The image may be captured by photography from a high resolution cathode ray tube, but in modern machines is digitally captured and displayed on a computer monitor and saved to a computer's hard disc.

4.1.2.2 Magnification

Magnification in a SEM can be controlled over a range of up to 6 orders of magnitude from about 10 to 500,000 times. Unlike optical and transmission electron microscopes, image magnification in the SEM is not a function of the power of the objective lens. SEMs may have condenser and objective lenses, but their function is to focus the beam to a spot, and not to image the specimen. Provided the electron gun can generate a beam with sufficiently small diameter, a SEM could in principle work entirely without condenser or objective lenses, although it might not be very versatile or achieve very high resolution. In a SEM, as in scanning probe microscopy, magnification results from the ratio of the dimensions of the raster on the specimen and the raster on the display device. Assuming that the display screen has a fixed size, higher magnification results from reducing the size of the raster on the specimen, and vice versa. Magnification is therefore controlled by the current supplied to the x, y scanning coils, or the voltage supplied to the x, y deflector plates, and not by objective lens power.

4.1.2.3 Resolution of the SEM

The spatial resolution of the SEM depends on the size of the electron spot, which in turn depends on both the wavelength of the electrons and the electron-optical system which produces the scanning beam. The resolution is also limited by the size of the interaction volume, or the extent to which the material interacts with the electron beam. The spot size and the interaction volume are both large compared to the distances between atoms, so the resolution of the SEM is not high enough to image individual atoms, as is possible in the shorter wavelength (i.e. higher energy) transmission electron microscope (TEM). The SEM has compensating advantages, though, including the ability to image a comparatively large area of the specimen; the ability to image bulk materials (not just thin films or foils); and the variety of analytical modes available for measuring the composition and properties of the specimen. Depending on the instrument, the resolution can fall somewhere between less than 1 nm and 20 nm. By 2009, the world's highest SEM resolution at high beam energies (0.4 nm at 30 kV) is obtained with the Hitachi S-5500. At low beam energies, the best resolution (by 2009) is achieved by the Magellan system from FEI Company (0.9 nm at 1 kV).

FIG 8 Untreated Sample

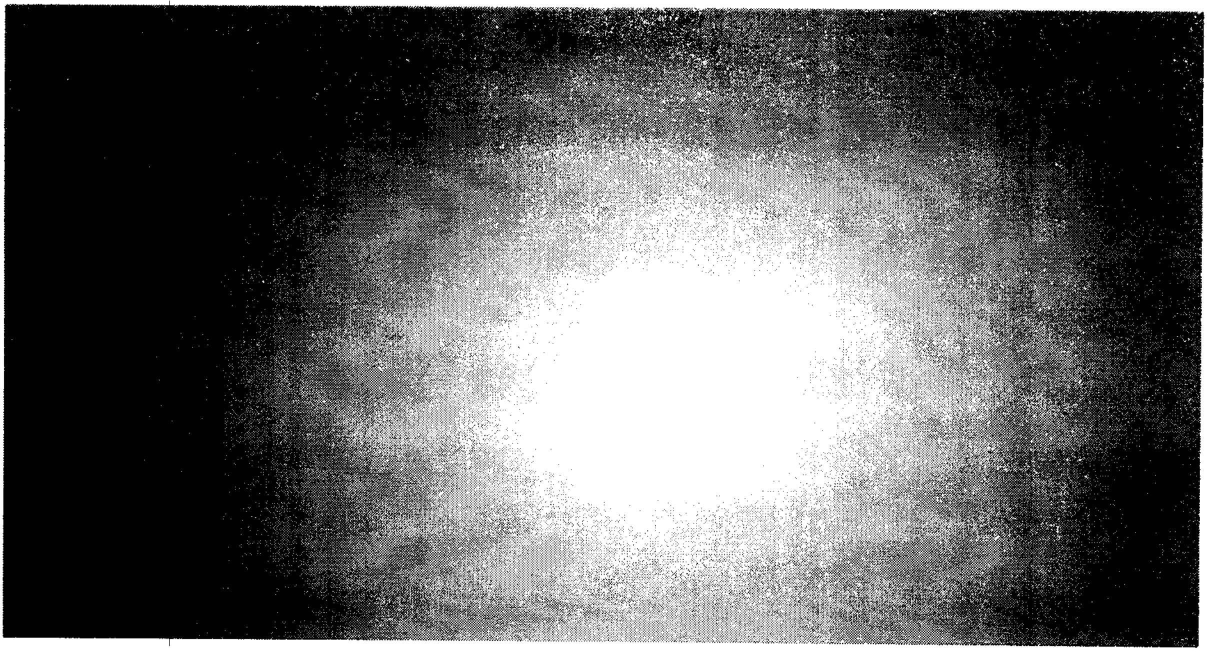


Fig 9 Treated Sample

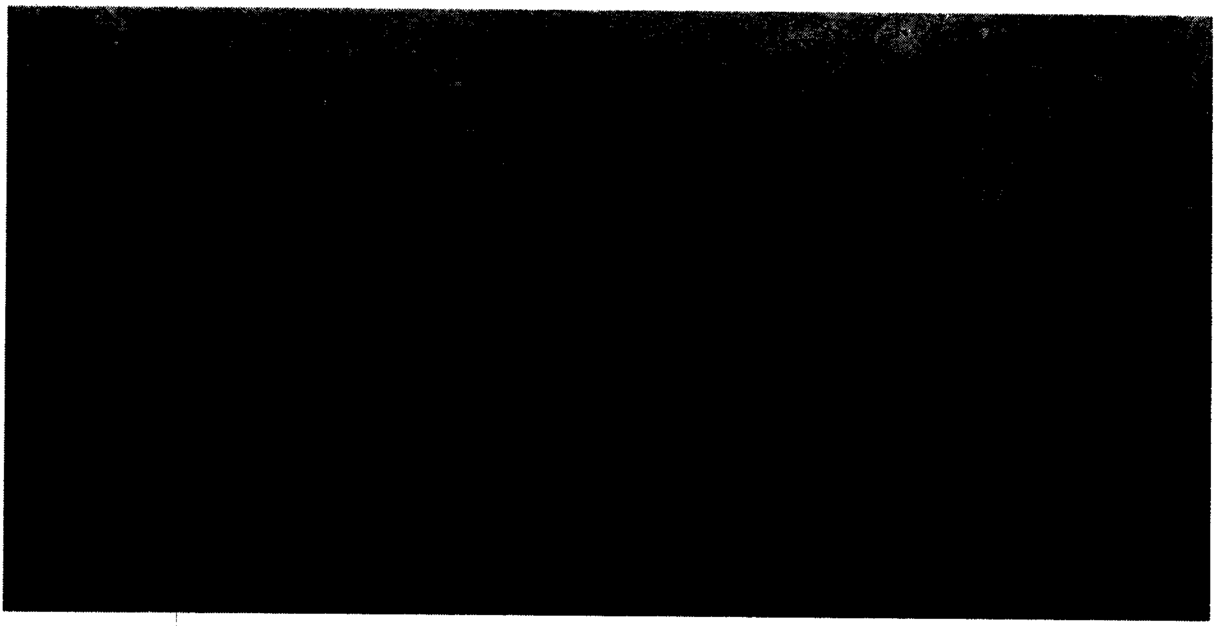
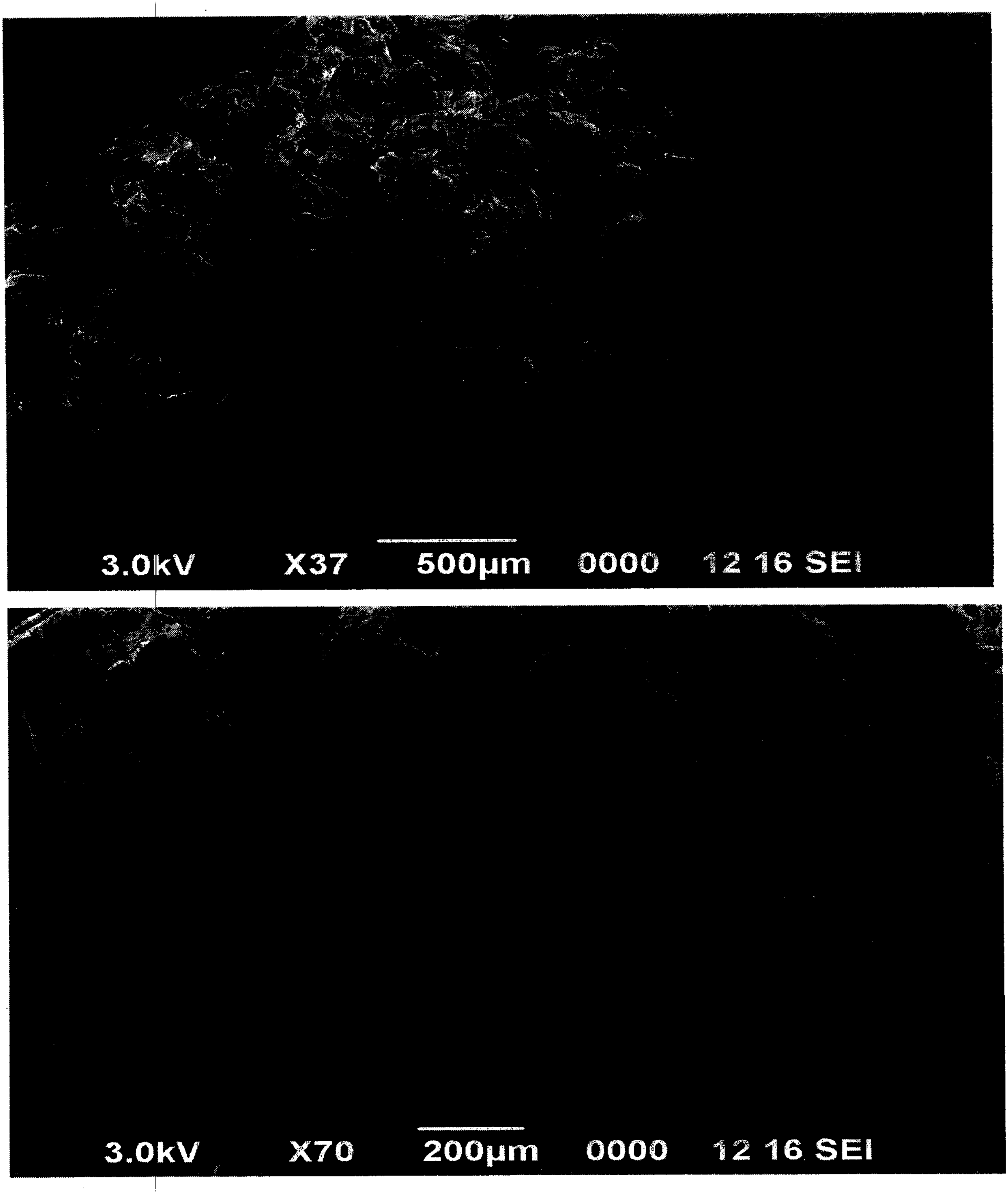
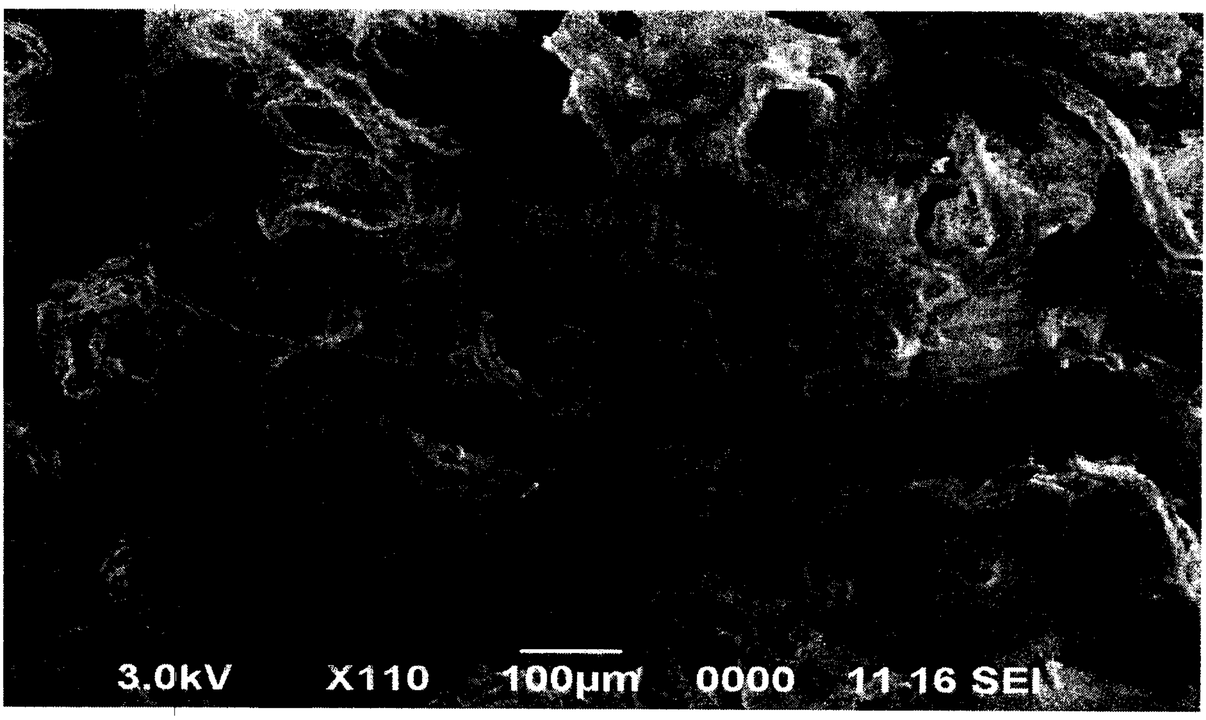
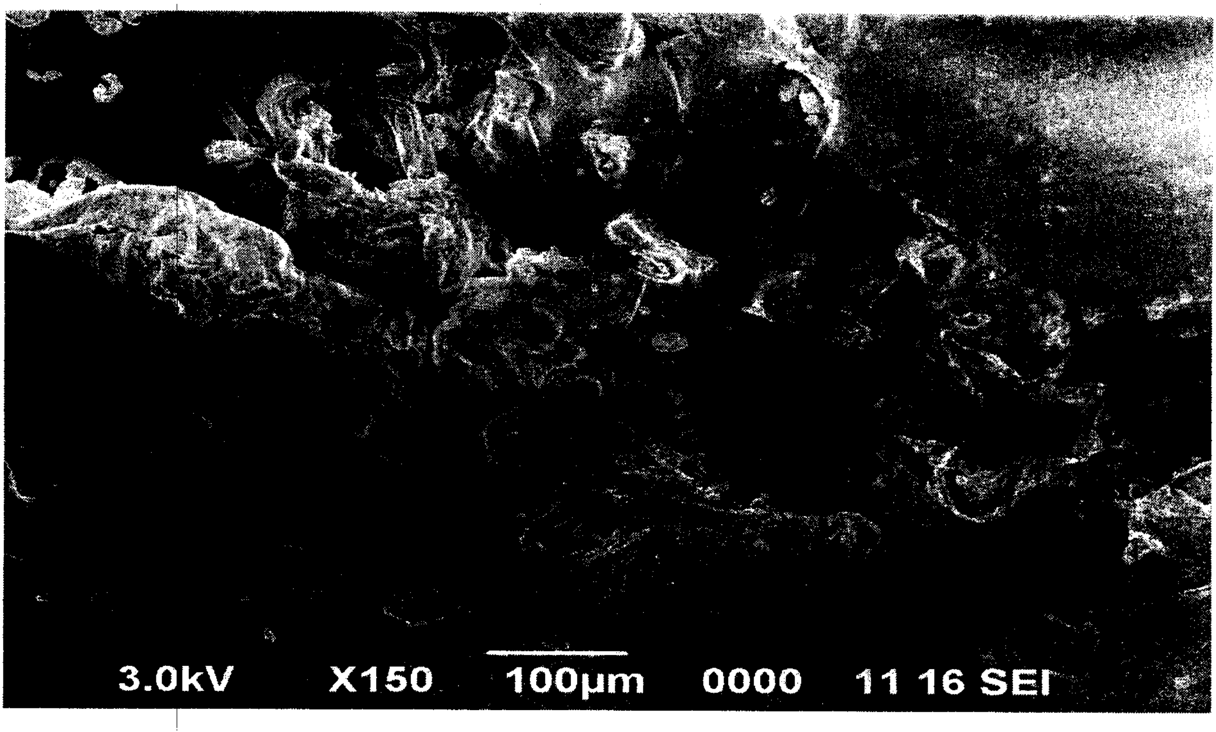


Fig 10 Different views of degraded photos




3.0kV
X110
100µm
0000
11 16 SEI


3.0kV
X150
100µm
0000
11 16 SEI

4.2. Melting test:

Method:

Both the treated and untreated samples are placed in respective crucible and temperature is given up to its melting point.

Results and Discussions:

Brown residue is found in untreated sample while in the treated sample, black residue is formed. This indicates the initiation of carbonization process.

Carbonization:

Carbonization or carbonisation is the term for the conversion of an organic substance into carbon or a carbon-containing residue through pyrolysis or destructive distillation. It is often used in organic chemistry with reference to the generation of coal gas and coal tar from raw coal. Fossil fuels in general are the products of the carbonization of vegetable matter.

Carbonization is often exothermic, which means that it could in principle be made self-sustaining and be used as a source of energy which does not produce carbon dioxide. In the case of glucose, the reaction releases about 237 calories per gram.

When biomaterial is exposed to sudden searing heat (as in the case of an atomic bomb explosion or pyroclastic flow from a volcano, for instance), it can be carbonized extremely quickly, turning it into solid carbon. In the destruction of Herculaneum by a volcano, many organic objects such as furniture were carbonized by the intense heat.

In one study carbonization was used to create a new catalyst for the generation of biodiesel from ethanol and fatty acids. The catalyst was created by carbonization of simple sugars such as glucose and sucrose. The sugars were processed for 15 hours at 400 °C under a nitrogen flow to a black carbon residue consisting of a complex mixture of polycyclic aromatic carbon sheets. This material was then treated with sulphuric acid which functionalized the sheets with sulphonite, carboxyl and hydroxyl catalytic sites.

4.3 Toxicity test.

To prove that the solution does not disturb the toxicity level, IR spectroscopy is taken into consideration.

Principle of IR:

Infrared spectroscopy (IR spectroscopy) is the subset of spectroscopy that deals with the infrared region of the electromagnetic spectrum. It covers a range of techniques, the most common being a form of absorption spectroscopy. As with all spectroscopic techniques, it can be used to identify compounds and investigate sample composition. A common laboratory instrument that uses this technique is an infrared spectrophotometer.

The infrared portion of the electromagnetic spectrum is usually divided into three regions; the near-, mid- and far- infrared, named for their relation to the visible spectrum. The far-infrared, approximately 400–10 cm−1 (1000–30 μm), lying adjacent to the microwave region, has low energy and may be used for rotational spectroscopy. The mid-infrared, approximately 4000–400 cm−1 (30–2.5 μm) may be used to study the fundamental vibrations and associated rotational-vibrational structure. The higher energy near-IR, approximately 14000–4000 cm−1 (2.5–0.8 μm) can excite overtone or harmonic vibrations. The names and classifications of these subregions are merely conventions. They are neither strict divisions nor based on exact molecular or electromagnetic properties.

In physical and analytical chemistry, infrared spectroscopy ("IR spectroscopy") is a technique used to identify chemical compounds based on how infrared radiation is absorbed by the compounds' chemical bonds. This article is an IR spectroscopy correlation table that lists some general absorption peaks for common types of atomic bonds and functional groups. Note that this information is unreferenced, and may not be accurate.

The absorptions in this range do not apply only to bonds in organic molecules. IR spectroscopy is useful when it comes to analysis of inorganic compounds (such as metal complexes or fluoromanganates) as well.

T

Table 1 IR Absorption

Bond	**Type of bond**	**Specific type of bond**	**Absorption peak**	**Appearance**
C—H	Alkyl	methyl	1260 cm^{-1}	strong
			1380 cm^{-1}	weak
			2870 cm^{-1}	medium to strong

			2960 cm^{-1}	medium to strong
		methylene	1470 cm^{-1}	strong
			2850 cm^{-1}	medium to strong
			2925 cm^{-1}	medium to strong
		methine	2890 cm^{-1}	weak
	vinyl	$C=CH_2$	900 cm^{-1}	strong
			2975 cm^{-1}	medium
			3080 cm^{-1}	medium
		$C=CH$	3020 cm^{-1}	medium
		monosubstituted alkenes	900 cm^{-1}	strong
			990 cm^{-1}	strong
		cis-disubstituted alkenes	670–700 cm^{-1}	strong
		trans-disubstituted alkenes	965 cm^{-1}	strong
		trisubstituted alkenes	800–840 cm^{-1}	strong to medium

	aromatic	benzene/sub. benzene	3070 cm^{-1}	weak
		monosubstituted benzene	700–750 cm^{-1}	strong
			690–710 cm^{-1}	strong
		ortho-disub. benzene	750 cm^{-1}	strong
		meta-disub. benzene	750–800 cm^{-1}	strong
			860–900 cm^{-1}	strong
		para-disub. benzene	800–860 cm^{-1}	strong
	alkynes	any	3300 cm^{-1}	medium
	aldehydes	any	2720 cm^{-1}	medium
			2820 cm^{-1}	
C—C	acyclic C—C	monosub. alkenes	1645 cm^{-1}	medium
		1,1-disub. alkenes	1655 cm^{-1}	medium

	cis-1,2-disub. alkenes	1660 cm^{-1}	medium
	trans-1,2-disub. alkenes	1675 cm^{-1}	medium
	trisub., tetrasub. alkenes	1670 cm^{-1}	weak
conjugated C—C	dienes	1600 cm^{-1}	strong
		1650 cm^{-1}	strong
with benzene ring		1625 cm^{-1}	strong
with C=O		1600 cm^{-1}	strong
C=C (both sp^2)	any	1640–1680 cm^{-1}	medium
aromatic C=C	any	1450 cm^{-1}	weak to strong (usually 3 or 4)
		1500 cm^{-1}	
		1580 cm^{-1}	
		1600 cm^{-1}	
C≡C	terminal alkynes	2100–2140 cm^{-1}	weak

		disubst. alkynes	2190–2260 cm^{-1}	very weak (often indisinguishable)
C=O	aldehyde/ketone	saturated aliph./cyclic 6-membered	1720 cm^{-1}	
		A,β-unsaturated	1685 cm^{-1}	
		aromatic ketones	1685 cm^{-1}	
		cyclic 5-membered	1750 cm^{-1}	
		cyclic 4-membered	1775 cm^{-1}	
		aldehydes	1725 cm^{-1}	influence of conjugation (as with ketones)
	carboxylic acids/derivates	saturated carboxylic acids	1710 cm^{-1}	
		unsat./aromatic carb. acids	1680–1690 cm^{-1}	
		esters and lactones	1735 cm^{-1}	influenced by conjugation and ring size (as with ketones)
		anhydrides	1760 cm^{-1}	
			1820 cm^{-1}	

		acyl halides	1800 cm^{-1}	
		amides	1650 cm^{-1}	associated amides
		carboxylates (salts)	1550–1610 cm^{-1}	
		amino acid zwitterions	1550–1610 cm^{-1}	
O—H	alcohols, phenols	low concentration	3610–3670 cm^{-1}	
		high concentration	3200–3400 cm^{-1}	broad
	carboxylic acids	low concentration	3500–3560 cm^{-1}	
		high concentration	3000 cm^{-1}	broad
N—H	primary amines	any	3400–3500 cm^{-1}	strong
			1560–1640 cm^{-1}	strong
	Secondary amines	any	>3000 cm^{-1}	weak to medium
	ammonium ions	any	2400–3200 cm^{-1}	multiple broad peaks

C—O	alcohols	primary	1040–1060 cm^{-1}	strong, broad
		secondary	~1100 cm^{-1}	strong
		tertiary	1150–1200 cm^{-1}	medium
	Phenols	any	1200 cm^{-1}	
	Ethers	aliphatic	1120 cm^{-1}	
		aromatic	1220–1260 cm^{-1}	
	carboxylic acids	any	1250–1300 cm^{-1}	
	Esters	any	1100–1300 cm^{-1}	two bands (distinct from ketones, which do not possess a C—O bond)
C—N	aliphatic amines	any	1020–1220 cm^{-1}	often overlapped
	C=N	any	1615–1700 cm^{-1}	similar conjugation effects to C=O
	C≡N (nitriles)	unconjugated	2250 cm^{-1}	medium
		conjugated	2230 cm^{-1}	medium

	R—N—C (isocyanides)	any	2165–2110 cm^{-1}	
	R—N=C=S	any	2140–1990 cm^{-1}	
C—X	fluoroalkanes	ordinary	1000–1100 cm^{-1}	
		trifluromethyl	1100–1200 cm^{-1}	two strong, broad bands
	chloroalkanes	any	540–760 cm^{-1}	weak to medium
	bromoalkanes	any	500–600 cm^{-1}	medium to strong
	iodoalkanes	any	500 cm^{-1}	medium to strong
N—O	nitro compounds	aliphatic	1540 cm^{-1}	stronger
			1380 cm^{-1}	weaker
		aromatic	1520, 1350 cm^{-1}	lower if conjugated

Results and Discussions:

No peak formation is found in the cyanide region which proves the absence of toxic compound formation.

5.CONCLUSION

From the above test it is concluded that the manufactured packaging material is biodegradable and ecofriendly.

6.SCOPE FOR FUTURE STUDY

The physical and mechanical changes due to biodegradability have been observed and inferred in this project while chemical changes are left for future study.

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