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Utilization of Agriculture waste for preparation of Biocarbon/LDPE Composite films

Ekansh Agnishekhar

ABSTRACT
Biocarbon is the carbon that trees, plants, and healthy soils naturally absorb and store. Plants absorb carbon from the atmosphere through photosynthesis. This helps to reduce CO2 pollution that is changing our climate. It is one such biobased material, produced through a process known as pyrolysis. Rice straw will be chopped in very small pieces and then pyrolysis is be done at specific weight % after preparation of Biocarbon from rice straw further it undergoes for testing process to examine Biocarbon with the help of FTIR. Biocarbon give the highest heating value (27-32MJ/Kg), highest energy density, bulk density as compared to coal. Here we have the addition of Biocarbon in Low density Polyethylene (LDPE), which is important for the study of various physical and chemical properties, and future applications. It was found that prepared LDPE film would be applicable in various packaging area that will often new direction of Plastic blending. The film was prepared by blown film extrusion machine. The modified LDPE films were found with enhanced thermal properties and Mechanical strength. Soil burial test were also carried out for 15 days and studied in terms of tensile strength of prepared compounded LDPE film. It was found with respect to results obtained that decrease in tensile strength were highest in case of modified LDPE film prepared by 2% of Biocarbon and tensile strength reduces up to 57.45 after 15 days.

Key words- *Rice straw, Pyrolysis, Biocarbon, LDPE film*

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I. INTRODUCTION

Indiaproducesalotofagriculturalwaste,includingcropwastes,asthesecond-largestagro-basedeconomy with year-round crop farming. In India, 92 appears like a very little amount of metrictons of crop waste are burned annually, resulting in high particulate matter emissions and airpollution.Thishappensbecausethereareinsufficientsustainablemanagementmeasuresinplace.Burningcropresiduehasgrowntobeasignificantenvironmentalissuethataffectshumanhealthandaccelerates global warming.The smoke from a burn causes the ozone layer to burst, allowing ultraviolet rays whichcan be fatal to the skin to directly reach the ground. This is because the ozone layer isbursting with carbon monoxide and carbon dioxide gases. Eye discomfort is brought onbyitssmoke.Inadditiontothebreathingissue,lungailmentsaredeveloping.Theperiodwhen parali is burned coincides with Diwali, which raises pollution levels and causespoor air quality. The burning of parali (in Punjab and Haryana) has been blamed for theair pollution in Delhi. To shorten the processing time between harvest and sowing,farmers in the aforementioned states typically burn Tonnes of grain trash around the endof September and beginning of October following harvesting. A “toxic atmosphere” iscreated in Delhi asa result ofthe smoke produced by this burning,leading to anemergency due to air pollution. According to one study, burning crop residue resulted inemissions of 149 million Tonnes of CO2, 9 million Tonnes of CO, 0.25 million tons ofSOX,and 1.28 millionTonnes ofPM [1].The need to meet the rising global energy demand brought on by a growing population andimproving living standards is one of the most contentious concerns of this century. The primarysourceforsupplying thisenergy needisfossilfuels,buttheyalsocontributeglobalwarmingbyEmitting greenhouse gases[2]. Technologies that would reduce greenhouse gas emissions and use bioenergy as a backupenergy source need to be implemented in order to reduce the concentration of gases like CO2 in the atmosphere.With all these issues we have decided to work on parali which is a threat for an environment as well as humans, to make economically sustainable material. Living creatures or their waste products, such as solid biomass (such as wood or, liquid biomass, (such as bioethanol and biodiesel), and biogas, are the source of biofuels (such as wood or charcoal),liquid biomass(such as bioethanol and biodiesel),and biogas, are the source of biofuels (such as methane producedfromsewage).Due to its advantages for storage,transportation and versatility in applications like combustion engines, boilers, turbines etc. [3]. Pyrolysis has become more popular method for converting biomass to bioenergy. The biomass is heated during pyrolysis to create a gas that canbe utilized to produce electricity as well as a solid byproduct called biochar. Making carbon sequestration adsorbent materials with this biochar is an efficient use of the resource. The production of bioenergy in conjunction with carbon sequestration would provide a workable solution to the problem of global warming.Utilizing effective carbon capture and storage technology is another option to reduce there lease of greenhouse gases into the environment.The CCS technology can be broken down into three categories: (I) membrane-based process, (ii)sorbent-based process,and (iii)solvent-based process.The source and make up of the gas stream, as well as the kind of CO_2 collection process-pre-or post-combustion-all play a role inselecting an appropriate technique. Because the solvents have a high energy requirement, absorption techniques,including those involving aqueous amines,are energy-intensive.Corrosion and solvent degradation are two additional significant drawbacks.Solid adsorption procedures,which primarily use carbonaceous materials like biochar, are now being developed as a practical replacement for the liquid solvent-based approach.The solid adsorbent's extremely low regeneration energy is these technique's most important benefit[4].Since it uses adsorbents with a highly porous structure and large surface area,adsorption by carbonaceous materials is advantageous. Additionally, because the adsorbents are made from naturally occurring resourceslike biomass, they are fairly affordable. Adsorption is therefore a very common technology for CO_2 capture applications because it offers large adsorption capacities,rapid CO_2 adsorption rates,and simple adsorbent renewal The most widely used method for turning biomasses to biochar ispyrolysis, which involves a thermo-chemical decomposition process under high temperature andanoxygen-freeenvironment[5].Thecarbon-richsolidbyproductofthisprocessiscalledbiocharor char, and secondary reactions of the primary pyrolysis products result in the formation of secondary tar and charas well as a mixture of non-condensable and volatile condensable organic products into low-molecular-weight-gases.The volatile fraction of pyrolysis is partially condensed to a liquid fraction known as tarorbio-oil[6].Pyrolysis processes can be divided into three groups, depending on the circumstances: slow pyrolysis (long-term, slow heating rates,pyrolysis can occur at low temperatures (below 300°C), average temperatures (between 300 and500°C), or high temperatures (over 500°C) quickly. According to the literature, the temperatureat which primary cracking and secondary breakdown begin during biomass pyrolysis, as well as the creation of oxygen functional groups, is between 400 and 500°C. Therefore, 500°Cisthoughtto be an appropriate temperature for start of pyrolysis and the creation of char. The surface area,pore architectures, surface functional groups, and elemental compositions of biochar are allaffected by the pyrolysis temperature. The emission of volatiles at high temperatures duringpyrolysis can be credited with having an impact on these properties. Numerous investigationsrevealed that greater pyrolysis temperatures resulted in higher pH, more C than N content, andincreasedbiocharsurfacearea.Thus,acompromisebetweenthesurfaceandchemicalpropertiesis made while choosing an appropriate pyrolysis temperature. The ideal range for pyrolysistemperature is typically thought to be between 500 and 800°C when creating biochar. Thesorptioncapacityofbiocharisdrivenbythecombinationoftheseproperties[7].Therefore,efforts have been undertaken to enhance the chemical functionality and textural qualities through physical and chemical alterations. While modification of biochar aims to enhance surface characteristics. A new physical activation method, ultrasound therapy, has been developed as an alternative to high-temperature stream or air oxidation. During the alternating compression and rarefication cycles of ultrasound, ultrasonic irradiation causes the creation and collapse of vapor-filled microbubbles, which results in the exfoliation of the layered structure of graphitic clusters. By Stankovich et al., the relationship between ultrasonic waves and graphitic structure was first revealed. They discovered that giving graphite oxides in water a gentle ultrasonic treatment[8].

II. Material and Method

Materials

The following materials were used in preparation of composite and film are LDPE andBio-carbon(extractedfromricestraw).

S.no.	**Material**
1	LDPE
2	RiceStraw
3	Bio-carbon

Low Density Polyethylene was purchased from Shift trading company Lucknow andmanufacturedbyRelianceIndustrieslimitedGujarat,India. LDPEpurchasedhasapuritylevel99%i.e., itis anextrapure formofLDPEof gradeSF040.Rice straw was borrowed from farmers of Pratapgarh from paddy fields. When the rice is harvested, rice straw is produced as a byproduct. During harvest, rice straw is separated from the rice grains and is either the field depending on whether it was gathered manually or by machines.Biocarbon is the light, black residue comprised of carbon and ashes that remains after biomass is burned in a pyrolysis process. The International Biochar Initiative defines biocarbon as “the solid substance derived from the thermo chemical reduction of biomass in an oxygen-limited environment.” Biocarbon is a stable solid that contains pyrogenic carbon and can remain solid for a very long time.

Formulations

Six Samples of different composition were produced for the work. The formulations according to weight % is listed below in the table 1 . The sample code S0, S1, S2 and S3 for Film and sample code S4 and S5 for Injection molded samples.

Sample Code	**LDPE%**	**BIOCARBON%**
S0	100	0
S1	99	1
S2	98	2
S3	97	3
S4	96	4
S5	95	5

Methods

PREPARATIONBEFORECOMPOUNDING

Before compounding, LDPE were pre-heated in hot air oven at 60°C for 4hrs to removemoisture content from the materials. After pre heating, mixture of all the materials i.e.,LowDensityPolyethyleneBio-carbonwasformedwithdifferentweightratioinaccordance with the formulation chart. After mixing the materials together the mixturewasextrudedusingtheinterconnectedtwinscrewextruderwithscrewdiameterof21mm, L/D ratio is 40:1. Twin screw extruder machine manufactured by Specific Engineering, Vadodara, India. The temperature was maintained between 100°C to 160°C for differentheatingzonesinsidetheextruder. Thescrewspeedmaintainedat 35rpm.Themater passed from the heating zones properly mixing the mixture and the extrudate passed through the die and dipped into the water tank. The extrudate solidified in the tank. The solidified extruded material was formed into pellets using the pelletizer[23].

Compounding by twin screw extruder

Twin Screw Extruder machine was used to form compounding. Twin screw Extruder machine manufactured by Specific Engineering Vadodara, India. Model no ZV-20.

Samples with six different compositions of (0%, 1%, 2%, 3%, 4% and 5%) for LDPE/BioC were developed. The compounding of the samples was performed on a specialized engineering and automates twin screw extruder co-rotating extruder. The extruder is equipped with a 5.5 kW motor and has a length of up to 40:1 diameter. The key parameters that affect the mixing process in an extruder are machine temperature, screw speed, and fast speed. The temperature varied from 100°C, 120°C, 130°C, 150°C, 155°C, 160°C to the feed zone to die zone of the extruder in the mounting manner. The screw speed and feed speed are controlled by the respective main motor speed and feed motor. Prior to compounding all the materials were dried in a hot air oven at 60°C for 4 hours remove any moisture from it. The calculated quantity of all the materials as per the different formulation given in (Table.2) is fed through the hopper of the twin screw compounding machine. The material then goes into the main barrel by means of a rotating small screw mounted in the hopper. The material is melted in barrels which were equipped with band heaters. The material was passed through a die and passed through a coldwater, which solidifies the molten extrudate, which were then cut into pellets with the help of pelletizer machine [24].

Feed zone	Compression Zone		Metering Zone	Die Temperature	
Zone-1	Zone-2	Zone-3	Zone-4	Zone-5	Zone-6
100°C	120°C	130°C	150°C	155°C	160°C

Table.2 -Twin Screw Extruder Temperature zone

PREPARATIONOFFILMANDSAMPLESBEFOREBLOWNFILMEXTRUSIONANDINJECTIONMOULDING

After compounding and pelletization pellets were kept in an oven to remove themoisturecontentfromthe materialsuchthatittomakeuniformthicknessfilmandsheetwith no voids and air trapped in it formed samples. Thus, it was heated in the oven ataround80°Cfor2hours priorto blown filmextrusionandInjection Moulding.

Preparation of film by Blown Film Extrusion Machine

The Blown film Extrusion Machine Manufactured by Konark Plastomech Pvt. Ltd.Gujarat, India. This machine has a screw diameter of 35mm and barrel length of1200mm. Film samples were prepared by blown film extrusion machine. The materialpassesthroughthebarrelwherethe materialissubjectedtoheatatthreedifferentzone i.e., feed zone, compression zone and metering zone where the material thoroughlymixed using screw and is melted and make hot bubbles by extrusion die. The hotbubbles are pass to the nip roller by collapsing frame to maintain the thickness of filmandthen collectfilmbywindersofblown filmextrusion machine.

FeedZone	CompressionZone		MeteringZone	DieTemperature	
Zone-1	Zone-2	Zone-3	Zone-3	Zone-4	Zone-5
140°C	145°C	150°C	155°C	160°C	165°C

Table.2 -BlownfilmExtrusiontemperaturezone

Figure.1 Samples made by Blown film Extrusion machine

Testing And Characterization

FOURIERTRANSFORMINFRAREDSPECTROSCOPY(FTIR)

FTIRtestwasdonefromBBAU,Lucknow.FourierTransformInfraredSpectroscopy(FTIR)isausefuldeviceforfindingthesortsofnaturalbondsininorganicandnaturalmoleculesbymakinganaggravatedintriguesothatresemblesanundetectable“thumbprint”. It can be connected to distinguish the modules of an uncertain mix. It canbe valuable for the investigation of fluids, gases and solids. It is a very simple techniqueand nowadays is widely used to studyand resolve of plastic/polymer construction.Today’s FTIR tools attached with advanced computer makes them quicker and veryprecisethan theoldertools.

THERMOGRAVIMETRICANALYSIS (TGA)ASTM E1131, ISO 11358

Thermogravimetric Analysis (TGA) is a method used to find the composition of the material, its kinetics of degradation and its lifetime. It is a process of thermal analysis in which percentage weight loss over temperature is calculated weight loss over temperature is calculated.Thermogravimetric utilizes heat to carry out the reaction and physical changes in materials. As the temperature increases the material tends to lose weight due to degradation of materials. As the temperature increases the material starts to lose moisture and volatile content, then it losses filler and additive content, then virgin material degradation and finally turns to ash degradation of all these substances are distinguished through curves at corresponding temperatures. Trademark thermogravimetric analysis diagrams are accommodated sore materials and compound substance in light of interesting arrangement from physicochemical responses occurring over specific temperature range and heating rates. These characteristics have a place with sub-atomic structure of sample.

DIFFERENTIAL SCANNING CALORIMETRY ASTM D3418

Differential scanning calorimetry (DSC) is a thermoanalytical method that evaluates temperature as a function of how much heat is predicted to raise the temperature of a sample relative to a reference. Throughout the test, the sample and reference are both maintained at about the same temperature. The temperature program for a DSC test is often setup with the intension that the sample holder temperature will rise steadly overtime. The reference test should have a thermal limit that is particularly characterized for the temperature range that will be examined.

SCANNING ELECTRON MICROSCOPY

SEM analysis was done by CIPET, Lucknow, Uttar Pradesh. It is a device that creates images of the sample by scanning it with a laser-focused electron beam. With the aid of electromagnetic lenses, the electron beam is focused. Different types of signals are produced by the interaction of an electron with a sample, and these signals convey information about the surface structure and composition When an electron beam strikes the surface of the sample the energy is transferred to the sample due to which some emissions are produced.

DART IMPACT TEST ASTMIS2508

The falling dart impact tester was used to assess the impact of the darts. According to ASTM IS2508, a test standard, the procedure was followed. A free-falling 70gm dart was released from a predetermined height of 66cm on to the test specimen in the falling dart impact test. Smooth, polished aluminum or stainless steel were used to make the dart's hemispherical head. The dart was fired using a centering device and an electromagnetic, air separate, or other mechanical release mechanism. Additionally, along enough shaft was included with the dart. The sample was held using a two-piece annular specimen clamp.

SOILBURIALTEST

FOR LOSS IN TENSILE STRENGTH: - First of all 15 samples of each LDPE were cut size 150mm length and 25mm width and samples were buried in a pit of 20cm depth, 25cm length and 25cm width. Then the sample were covered by soil for 15days, after written duration the samples were taken out from soil and washed with water and placed in an oven at 50°C to dry for 2hours.The tensile strength was continued over a period of 15days from JUNE 20,2022 to JULY5,2022.The percentage of decreasing tensile strength of the specimen was calculated as given below-

Loss of Tensile Strength= $[(TS^0 – TS^1)/TS^0] x 100\%$

Where,

TS^0 – The tensile strength of the films before test.
TS^1 – The tensile strength of the films after test.
As well as the, the effect of biodegradation upon the tensile strength of before and after degradation, degradable mulching films was tested by weighing scale and Universal testing machine.

III. RESULTS AND DISCUSSION

DART IMPACT TEST

From the Table.3 the data depicts, the dart impact strength of LDPE and modified LDPE films with different composition of Biocarbon shows enhanced results when compared with neat LDPE film. These results might be because of uniform distribution of Biocarbon filler into LDPE matrix.

Sr. No.	**Failure load**	**Sample Name**
1	90 gm	S_0
2	111 gm	S_1
3	100 gm	S_2
4	115 gm	S_3

Table.3 Dart impact strength of film

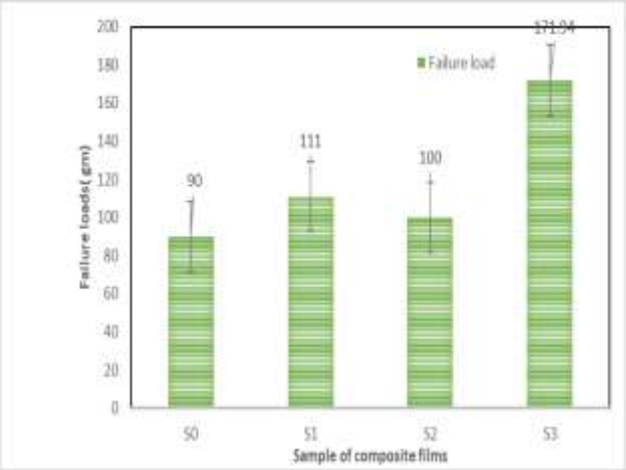


Fig.2 Dart Impact strength of films.

TENSILE STRENGTH

SAMPLE CODE	LDPE%	BIOCARBON %	Tensile Strength(MPa)	Elongation @break (%)
S_0	100	0	16	250
S_1	99	1	18.18	232.62
S_2	98	2	14.293	178.31
S_3	97	3	10.996	171.94

Table4-Tensile strength of composite film

From the above data listed in table.4 it is depicted that tensile strength value of S0 i.e., virgin LDPE sample S1 shows maximum tensile strength when compared with virgin other formulated samples S2 and S3 shows decrease in results were compared with virgin film. This might be the agglomeration of Biocarbon in LDPE.

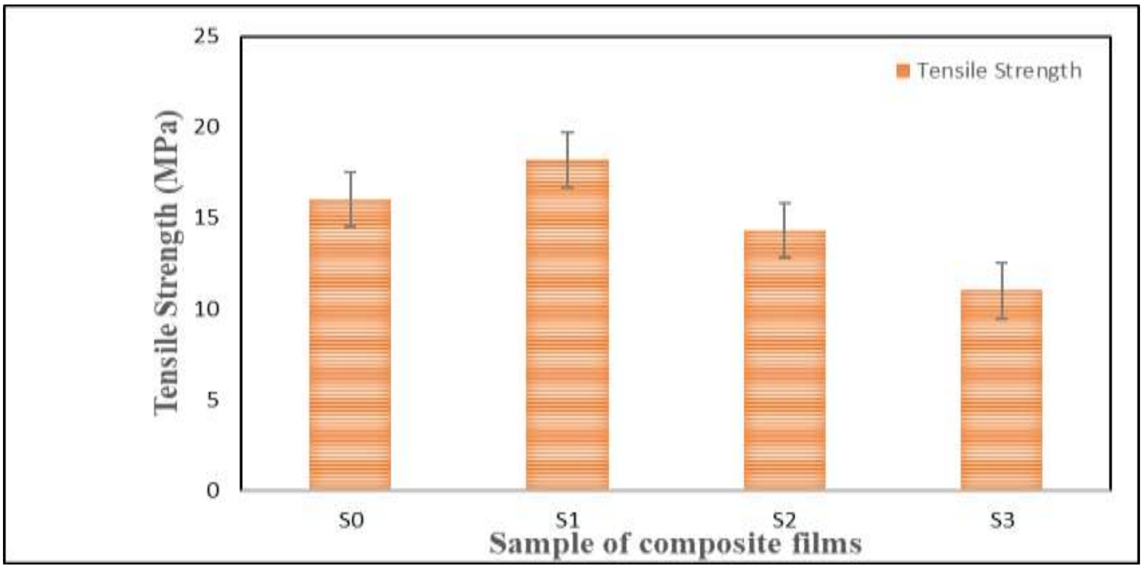


Fig.3 Graph of tensile strength of composite film

SOIL BURIAL TEST

SampleCode	LDPE%	BIOCARBON %	TENSILE STRENGTH(MPa)	Tensile Strength@Max. Load (MPa)	Elongation@ break (%)	Loss in tensile strength (%)
S0	100	0	16	14	102	12.50
S1	99	1	18.18	12.21	45.93	32.83
S2	98	2	14.29	8.88	46.11	37.85
S3	97	3	10.99	4.56	35	58.50

Table.5 Tensile strength of Composite film after 15days of soil burial.

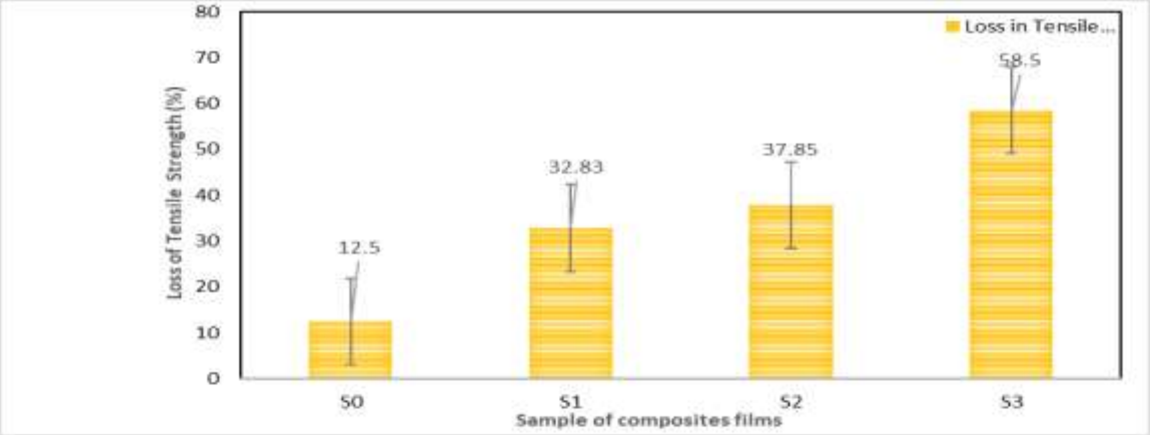


Fig.4. Tensile graph of composite film after soil burial test.

The loss of tensile strength in percentage is dependent upon quantity of Biocarbon %, time duration of soil burial test (15 days) and nature of LDPE used. The Biodegradation of virgin LDPE is slow when compared to S1, S2 and S3 composite film. It was observed through data that, when the weight percent of Biocarbon was increased a significant effect was found in Biodegradation of prepared composite film when undergo tensile test from S0to S3. The tensile strength of Biodegradable composite film was decreased with increasing Biocarbon. The loss in tensile strength of S2 sample is high as compared to virgin LDPE, S1 and S3 it clarifies that the microorganisms consume Biocarbon and create pores in LDPE composite film [34].

FTIR ANALYSIS

BIOCARBON

The extracted biocarbon was characterized by FTIR which is shown in Fig.5 The analysis was done in the range of 4000-500 cm^{-1}. In this graph a sharp and strong absorption band with transmittance 3416.4 cm^{-1} that represent the existence of OH stretching of hydroxyl group and peak 2928.6 cm^{-1} are corresponding to the existence of C-H stretching. Similarly, band 1599.5 cm^{-1} and 1378.7 cm^{-1} shows C=O and C=C stretching. The characterization of extracted biocarbon from rice straw gave relevant peaks that confirming the quality of biocarbon [25].

1% BIOCARBON COMPOSITE FILM

The prepared film was characterized by FTIR which is shown in Fig.5 According to analysis peak 2915.7 cm^{-1} shows C-H stretching and peak 2147.7 cm^{-1} corresponding to the existence of C=C stretching. Similarly, peak 1460.9cm^{-1},1354.7cm^{-1} and 1296.5cm^{-1} were attributed to the C-H bending and C=0 stretching. There is a band at 1066.1 cm^{-1} and 477.8 cm^{-1} which represent the C-O-H deformation and Si-O-Si bending [26].

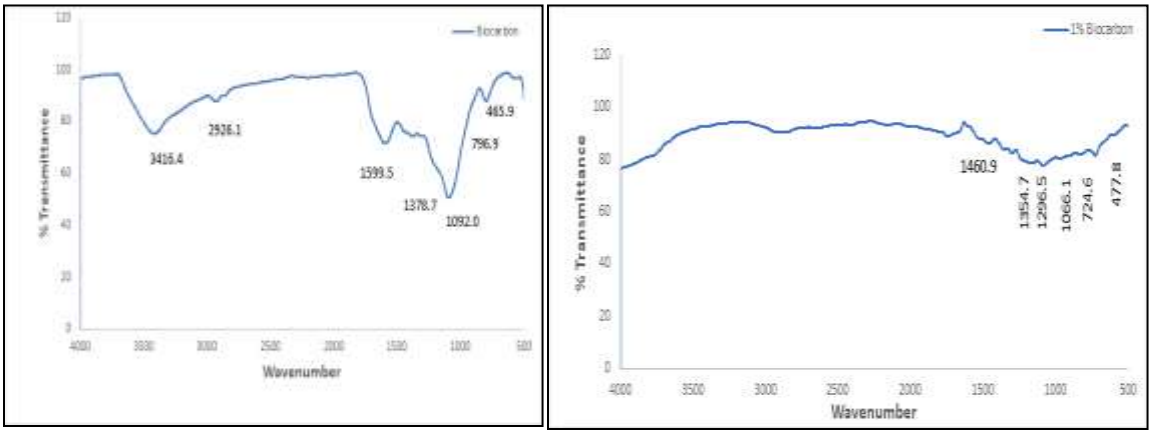
2% BIOCARBON COMPOSITE FILM

The prepared film was characterized by FTIR which is shown in fig.5 According to the result the peak at 2835.1 cm-1 represents the C-H stretching that was provided by LDPE and Biocarbon. The peak at1747.8cm^{-1}, 1463.4

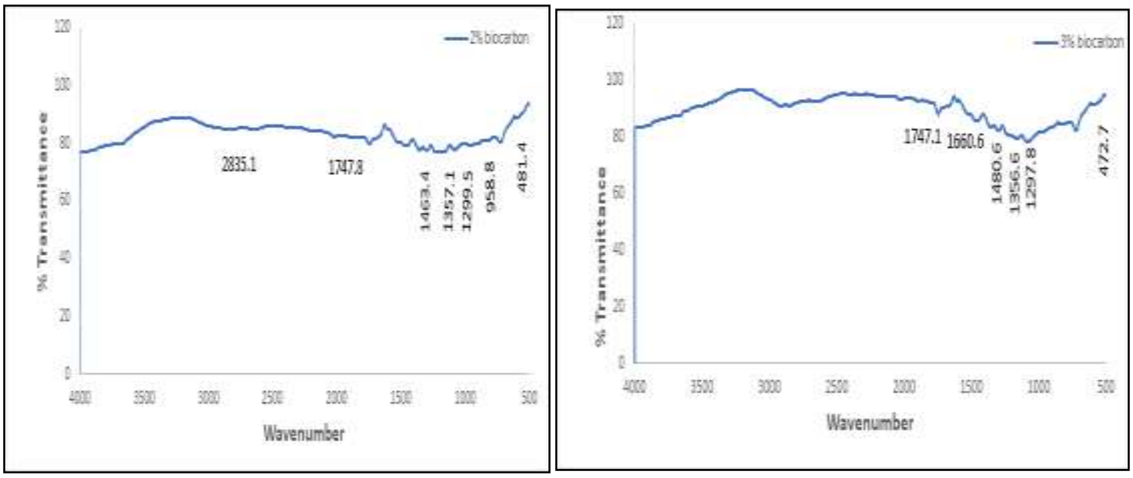
cm $^{-1}$ and 1299.5cm $^{-1}$ correspond to C=O vibration, -C=O stretching and CH_2 bending. Shows the existence of Biocarbon. Peak at 1299.5 cm-1shows C-N bending attributed to amide-III band and peak 958.8 cm $^{-1}$ correspond to C=C and C=N stretching [26].

3% BIOCARBON COMPOSITE FILM

The prepared film was characterized by FTIR which is shown in Fig.5 The peak at 2850.2 cm^{-1} correspond to the C-H stretching given by HDPE and Biocarbon in composite film. The peak at 1747.1 cm^{-1}, 1606.6 cm^{-1} and 1480.6 cm^{-1} shows C=O, C-O and –C=O stretching. The peak around 1356.6 cm^{-1}, 1297.8 cm^{-1} and 472.7 cm^{-1} attributed to CH2 bending, CN stretching of amide-III band and Si-O-Si bending vibration[26].



Biocarbon **1% Biocarbon**



2% Biocarbon **3% Biocarbon**

Fig.5 FTIR graph of biocarbon, 1% biocarbon, 2% biocarbon & 3% biocarbon of composite film.

TGA (Thermogravimetric Analysis)

The thermal behavior of LDPE, LDPE/ BioC were investigated by thermogravimetric analysis (TGA) by using Perkin Elmer's PYRIS 1 TGA thermogravimetric Analyzer. This TGA plots the graph of weight loss % at different temperatures. Graphs were recorded from ambient to 600°C with a warming rate 10°C/ min. In the presence of N_2 (inert atmosphere). The thermal analysis of all the samples which mentioned are shown in the following figure illustrated below.

TGA graph for Biocarbon

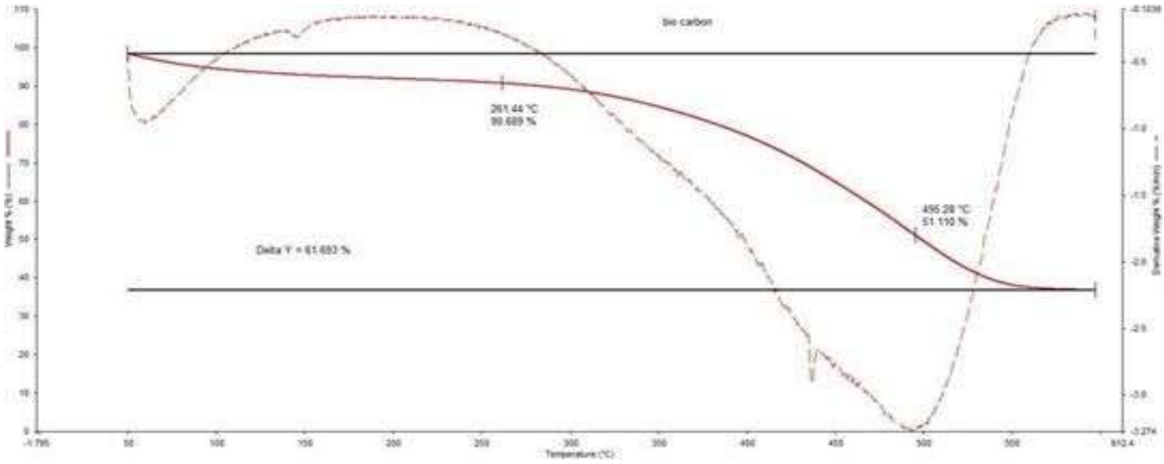


Fig.6 TGA graph of Biocarbon.

Figure.6 shows thermal degradation of Biocarbon the result shows that 1 step degradation at 380°C it starts degradation and at 550°C it degrades completely with 3% residue.

TGA graph of pure LDPE film

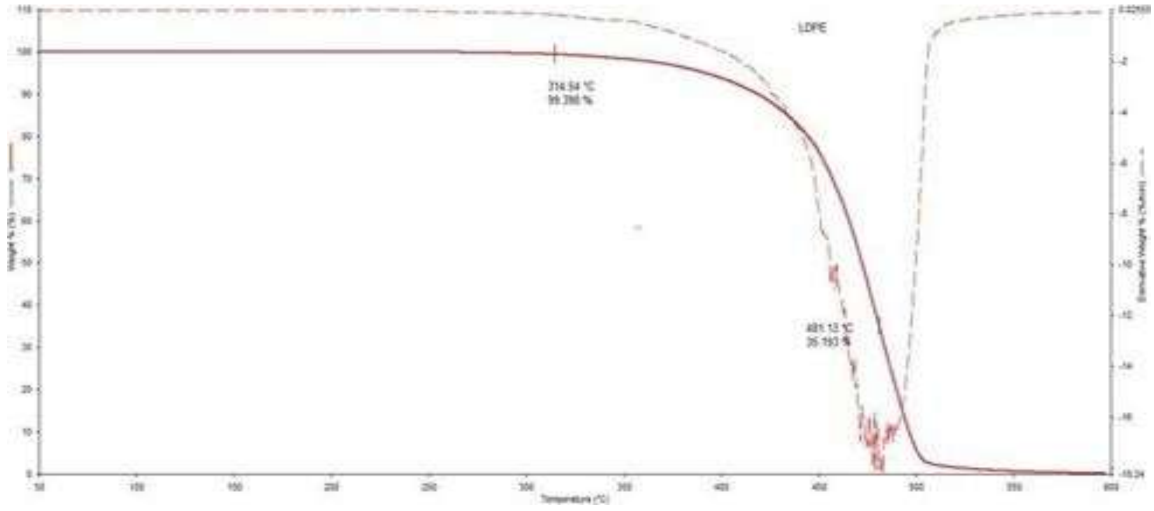


Fig.7 TGA graph of S0 sample.

Figure.7 shows Thermal degradation of pure LDPE material from this graph was observed.
That the material is stable at 400°C after it start to degrade at around 585°C material is degraded completely.

TGA graph for composite film

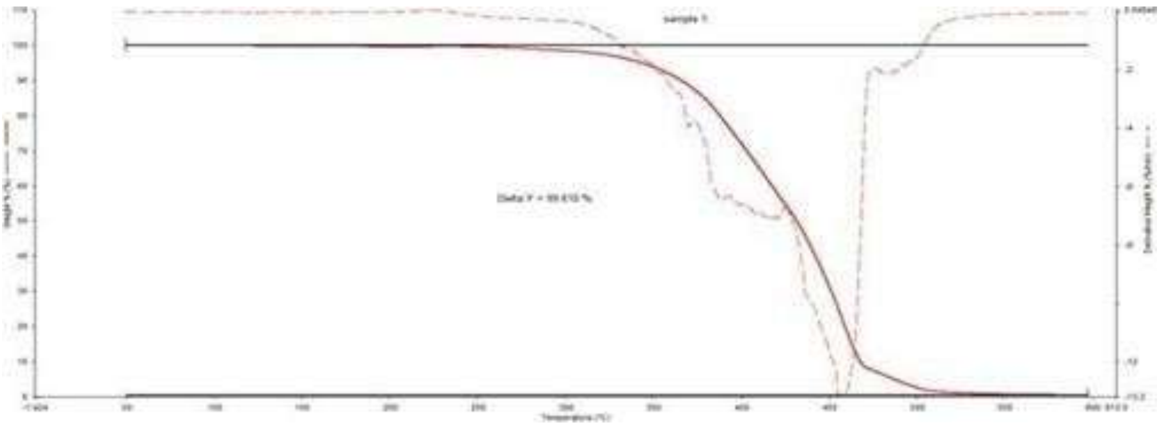


Fig.8 TGA graph of S1 sample.

Figure.8 shows thermal degradation of specimen S1 which have 1% Biocarbon at 350°C specimen start to degrade and 550°C specimen degrade completely.

DIFFERENTIAL SCANNING CALORIMETRY

The DSC analysis was carried out at 10°C/min from room temperature (25°C) to 300°C. Four samples were tested of different composition and obtained the best result for the samples. The obtained result for the DSC analysis of four samples is given below. The graph given below points out the Tg as well as other transition temperatures of the sample. The graph shows the complete analysis for all the samples.

DSC graph of composite film

The best obtained peak for sample S1 is at 118.43°C.

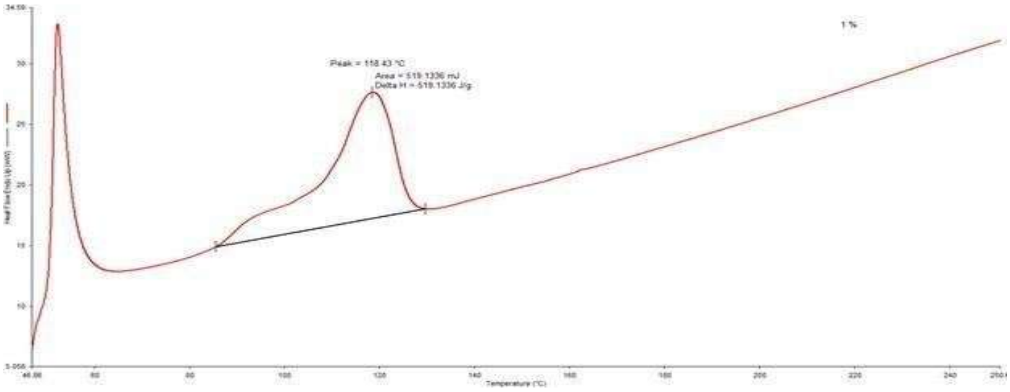


Fig.9 DSC graph of S1 sample.

DSC graph of composite film

The best obtained peak for sample S2 sample is at 116.15°C.

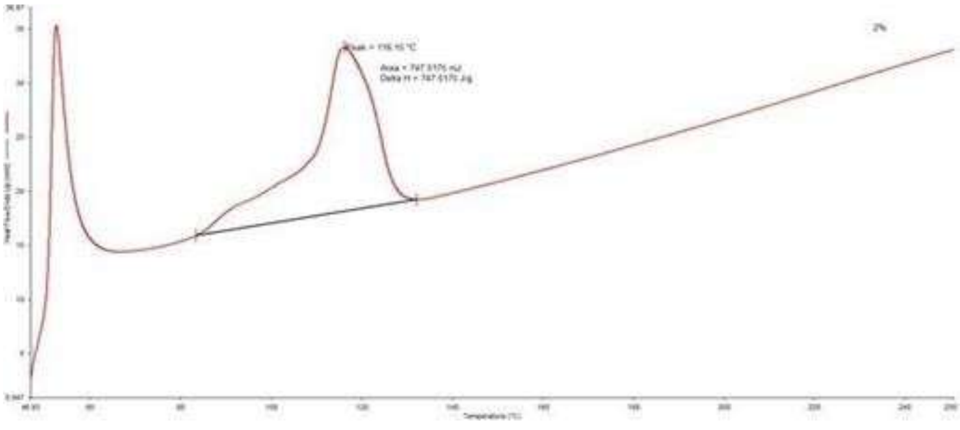


Fig.10 DSC graph of S2 sample.

DSC graph of composite film

The best obtained peak for sample S3 is at 115.05°C.

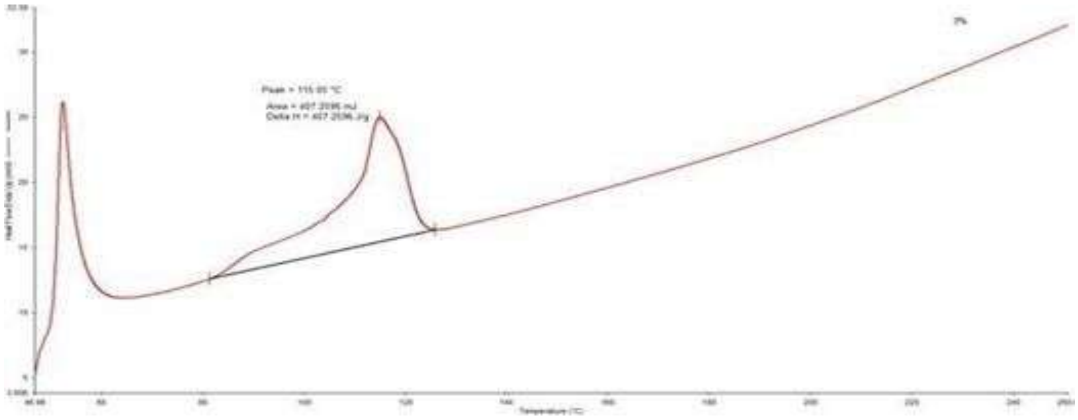
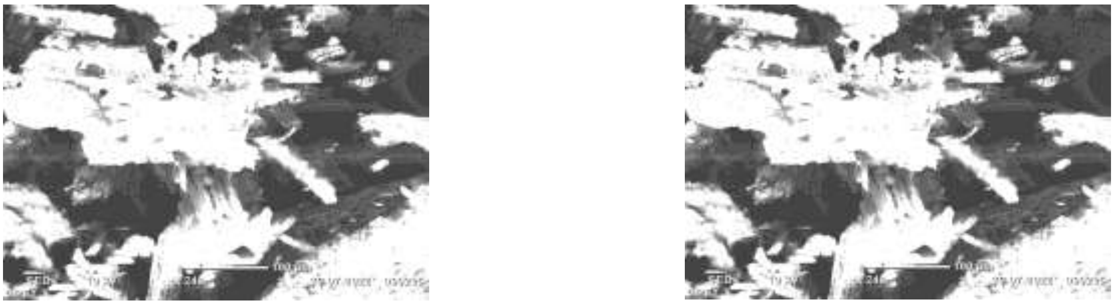


Fig.11 DSC graph of S3 sample.

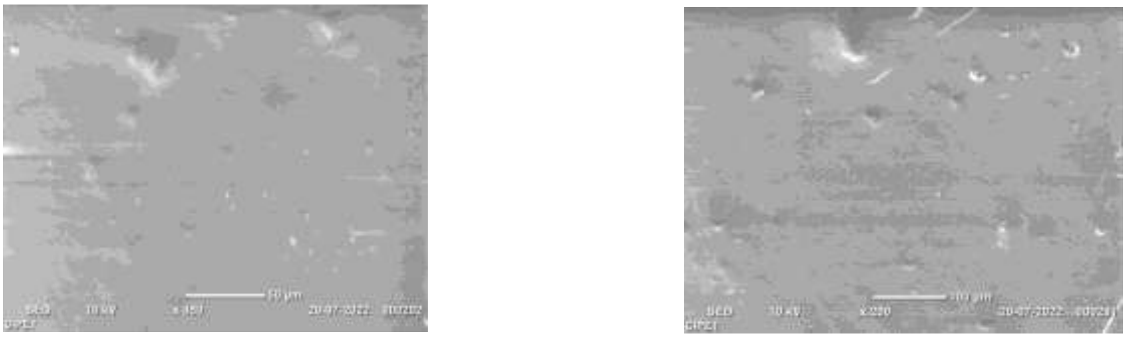
From above graphs we get to know the DSC value of Sample 1 i.e., virgin LDPE shows lowest obtained peak compared to all tested sample. Thus, its shows improvement in other formedsamples with respect to virgin LDPE the enhancement of DSC values in S1, S2 and S3 sample iscompared to virgin LDPE that means the enhancement in DSC values by increasing the wt.% of Biocarbon. The enhancement in DSC value is directly depend upon the wt.% of Biocarbon. Theobtained peak for S0 sample is 114.45°C, S1 sample 118.43°C, S2 sample is 116.15°C and S3 is115.05°C that means the weight % of Biocarbon at S1 sample is 1% and the peak is maximum as compared to virgin LDPE, S2 and S3[29].

SCANNING ELECTRON MICROSCOPY

SEM micrographs for film show smooth surface characteristic of Biocarbon Immobilized LDPE film. No separate agglomerates are evident. There is no difference in the morphology with different times from the micrograph it is evident that of biocarbon inside the composite has not done any serious effect of the composite film [30]. shown in Fig.12



Neat Biocarbon



1% Biocarbon **2% Biocarbon**

Figure.12 SEM images of Biocarbon and 1% & 2% Biocarbon composite film

IV. Conclusion

1. Biocarbon is successfully extracted from Rice straw/Parali.

2. The FTIR analysis of biocarbon shows the relevant peaks that confirms the biocarbon as well as quality of Product.

3. The LDPE-Biocarbon film were found with enhanced the mechanical and thermal properties.

4. The incorporation of biocarbon up to 3% in LDPE founds remarkable results when compared with neat LDPE films when goes through dart impact test.

5. Best results with respect to tensile strength in soil burial test was found after 15 days in sample S2 which was prepared by 2% Biocarbon.

6. The modified LDPE film sample S2 undergoes photodegradation at 72 hours. That allow excellent degradation of 70.39%.

7. The modified LDPE film exhibited potent Biocarbon that may be an alternative for carbon black used as packaging in LDPE & PE'S film.

8. The modified LDPE film undergoes Soil burial test that allows excellent degradation.

FUTURE SCOPE

- The Biocarbon LDPE film is used in our daily life like garbage bags for domestic purpose.
- Bio carbon LDPE film is applicable for EMI shielding application.
- Filaments for 3D printing as well as rigid packaging.
- Biocarbon reinforcing as filler with nylon and it is applicable for automotive industry.
- Biocarbon is mainly used as insulating agent in a variety of rubber, Wire coating application and also act as pigment, U.V. Stabilizer.
- The LDPE film can be transparent or colorful: black film protects from UV and also the incorporation of Biocarbon due to its nature film can easily degrade in ecosystem.

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