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Fabrication and Testing of TiBA Polymer Composite

M. Eswar Teja[1], N. Gowthami[2], K. Jahnavi[3], Y. Veenamrutha[4], D. Gowthami[5], G. Mounika[6]

[1] *Asst Prof Department of Mechanical Engineering & Vignan's Institute of Engineering for Women*
[2,3,4,5,6] *UG Students, Department of Mechanical Engineering & Vignan's Institute of Engineering for Women*

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Abstract - The modern environment is demanding more and more creative composite materials that provide high mechanical and thermal qualities. Composites are favored over traditional materials because they improve the properties of the base material and have a broad range of applications. One of the primary benefits of utilizing composite materials over conventional materials for components is weight reduction. Composite materials can be stronger than conventional materials even though they are lighter. Chemical resistance and electrical insulation qualities are two more benefits of choosing a composite material over a traditional kind. The objective of the current study is to assess the mechanical and thermal properties of Areca and Basalt fibers that have been reinforced using epoxy and matrix, with and without filler in the form of titanium dioxide powder. The mechanical properties of composites, such as their hardness, tensile, compression, flexural, and impact strengths, are assessed by varying the weight percentage of filler material. TGA, DTG, and DTA thermal properties are also assessed. The composite plate with 10g of TiO_2 powder filer achieved excellent strength.

Key Words**:** BCF (Basalt Continuous Fiber) DTG (Derivative Thermogravimetry), DTA (Differential Thermal Analysis), TGA (Thermal Gravimetric Analysis), FRCC (Fiber reinforced cementitious composites)

1.INTRODUCTION

In essence, a composite is a material made up of two phases a continuous phase called the binder and a discontinuous phase called the fiber filler that serves as reinforcement. The polymer composites matrix assists to maintain the reinforcement's correct orientation and position. Composites toughness is attributed to a polymeric resin that has a higher ductility and a lower hardness. Embedded within the matrix, reinforcement is more durable than the matrix itself. By introducing its characteristics into the matrix, reinforcement—the material responsible for bearing load—strengthens composites. Composites can be categorized according to both the reinforcement and the matrix. composites are the three categories based on matrix. Metal matrix composites, ceramic matrix composites, and polymer matrix. Because polymer processing does not require high temperatures or pressures, and because the types of equipment required for composite fabrications are basic, the manufacturing of polymer matrix composites is much simpler than that of metal matrix and ceramic matrix composites. There are three subcategories of polymer matrix composites: thermoset, thermoplastic elastomeric, and thermoplastic polymer. There are three types of composites: particle, fibrous, and laminate, depending on the shape of the reinforcement. There are two types of fibrous composites: long fiber (continuous) and short fiber (discontinuous) reinforced polymer composites. One more, fibrous composites can be divided into two categories based on the presence of fibers: natural fiber-reinforced composites and synthetic fiber-reinforced composites. Over past several years, lots of work has been done in the field of development of natural fiber reinforced polymer composites; where the focus is more on cellulose based fibers which is naturally available, is incorporated into the polymer matrix to form bio-composites. These cellulose fibers have properties like high strength, specific stiffness, availability, light weight, non-hazardousness, renewability, non-abrasiveness, which reduces wear in processing equipment, and biodegradability. Whereas the synthetic fibers such as Kevlar, carbon, glass, etc. even though have got very high strength and stiffness, but the problems associated with them like biodegradability, recyclability, initial processing cost, health hazards made to find an alternative source for the production of composites. Hence these composites with high strength could be extensively used in marine applications, constructive industry, transport and automotive industry, etc. [1,2,7]. The use of natural fibers as a reinforcement material for manufacturing composites increasing day by day because of their lower cost, light weight, high specific strength low thermal conductivity and environmental benefit. All most all the natural fibers such as jute, betel nut, kenaf, coconut, flax, abaca, bamboo, sisal, hemp and coir fibers etc. exhibit the good mechanical properties. An understanding of the thermal properties of the natural fiber reinforced polymer composites is extremely important in different applications. [1,2,7]. Areca leaf sheath fiber plate is made from the Areca palm tree whose scientific binomial name is Areca catechu. The sheath is attached to the areca nut leaf which covers the areca nut fruits. The raw material that is the areca sheaths are collected and it is first surface cleaned to remove impurities and other microbial actions. Leaf sheaths acquired are highly heterogeneous having deviations in its structure, size, shape and depth. It is thicker ends and thinner at the edges. The thickness of the samples from the center to the edges ranges from 2.5mm to 9.5 mm; an average of 5.0 mm is obtained from most of the samples. [7]. Adding fibers to concrete mixture can significantly improve its engineering properties such as tensile strength, flexural strength, impact and fatigue strength, as well as ductility, toughness and post-cracking capacity. In recent years, fiber reinforced concrete (FRC) and fiber reinforced cementitious composites (FRCC) have had a wide spread usage in civil engineering infrastructures and military applications including roads pavement, bridges, tunnels, slabs, airports, resorts, explosives storages and so on. FRCCs are in fact kind of compounds with appropriate uniformity and cohesion, capable of creating a ductile concrete.[3]. Basalt fibers, which are considered modern fibers with industrial potentials and less harmful for environment, have become a suitable alternative in the composites industries. Considering their physical and mechanical properties, basalt fibers are considered serious rivals for industrial fibers such as carbon and glass. Recently, industrial production of these fibers, which are obtained directly by melting basalt stone, has led to building factories across the Europe and USA. Considering its properties including: greener, lighter, and reduction of reinforcement bars corrosion, basalt fibers have good potential for development of application in other industries. Basalt fiber is a mineral matter with no environmental hazards, plus non-toxic and decomposable. Considering high silica content in basalt stone structure, fibers made from it have become a suitable alternative, compatible with cementitious matrix. The tendency to use mineral basalt fibers in basalt fiber reinforced polymer (BFRP) is increasing and there have been different researches about the BFRPs. [3,4].

1.1 Advantages of using Natural Fibers

There are various reasons why natural fiber polymer composites are becoming more and more popular.

Environmental Concerns: A trend toward sustainable materials is occurring as environmental issues gain more attention. Natural fibers minimize environmental effect and reduce reliance on non-renewable resources because they are biodegradable, renewable, and frequently derived from waste materials or agricultural byproducts.

Regulatory Pressures: Because synthetic materials have an adverse environmental impact, governments and regulatory agencies are placing tighter restrictions on their use. This has increased demand for natural fiber composites by prompting industry to look for substitute materials that adhere to sustainability norms.

Customer Preference: Demand for environmentally friendly items is rising. Natural fiber composites are a more environmentally friendly option for conventional materials, which appeals to customers that value sustainability when making judgments about what to buy.

Technological Developments: Improvements in material science and processing techniques have enhanced the strength, durability, and versatility of natural fiber composites, putting them on par with synthetic materials.

Cost-effectiveness: Companies seeking to cut costs without sacrificing product quality and sustainability standards find natural fiber composites to be a compelling choice due to their low cost. Their attractiveness across a variety of industries is attributed to their local availability, low processing requirements, affordability, and alignment with sustainability objectives.

In general, the emergence of natural fiber polymer composites is indicative of an increasing awareness across a range of industries of the need for sustainable solutions, driven by technological, economic, regulatory, and environmental concerns.

2.Materials and Method

2.1 *Description of materials*

These materials were chosen due to their special qualities, potential for improved composite performance, and relevance to the development of sustainable materials. This section describes the experimental processes for fabricating composites, the material specifications, and the technique used to analyze the mechanical and thermal properties of the composite materials.

Areca Fiber:

Areca fiber, a naturally occurring fiber that is frequently found in tropical locations, is obtained from the Areca palm. These areca palms yield slender, stiff, and long-lasting fiber with special mechanical qualities, such as high tensile strength and stiffness, that make them appropriate for a range of industrial uses. Areca fiber is a desirable alternative for a sustainable composite material because it is renewable, biodegradable, and environmentally benign.

BCF (Basalt Continuous Fiber):

The process of melting basalt rocks and turning the melted material into fibers yields basalt fibers. Rocks of igneous origin are called basalts. The majority of the energy used in the process of preparing basalt raw materials for fiber production occurs naturally. Continuous, staple, ultra-thin fibers made of basalt are created and utilized. Basalt continuous fibers (BCF) are utilized in the manufacturing of fabrics, non-woven materials, and composite goods as well as reinforcing components. Staple fibers from basalt are used to make materials for thermal insulation.

Titanium Dioxide:

Because of its exceptional UV-blocking properties, titanium dioxide is used as a filler material in situations where protection from UV radiation is required. Composites with titanium dioxide have increased strength, stiffness, and toughness. Consequently, we have selected it. Overall, titanium dioxide may be a better filler material choice for mechanical reinforcement and UV protection.

Epoxy:

Epoxy resin is a multipurpose thermosetting polymer that is well-known for its superior mechanical strength, chemical resistance, and adhesive properties. Because of its propensity to fuse with different reinforcements and filler to generate a robust and long-lasting composite structure, it is frequently utilized as a matrix material in composite materials. In this instance, epoxy resin acts as the composite's matrix material, offering a solid and long-lasting framework for the addition of fillers and reinforcement fibers.

Hardener:

When combined with epoxy resin, hardener also referred to as a curing agent or catalyst initiates the curing process, which results in the formation of a cross-linked polymer network that gives the composite its final properties. Hardener is an essential component of the epoxy resin system and is used in the fabrication of composites. In this procedure, the hardener is essential for starting the epoxy resin matrix's curing process, which helps to create a robust and long-lasting composite material.

2.2 *Hand Layup Method*

Hand lay-up is a special method of making composite products that enables inexpensive tooling, minimal equipment investment, and rapid design modifications. The following are advantages of the FRP hand lay-up process:

- Design Flexibility.
- No need for sophisticated equipment
- Tooling cost is low.
- Sandwich constructions are possible.
- Reliability in quality is possible.
- The time and cost are minimal.

2.3 *The Hybrid Composites Creation*

The hand layup procedure is described as follows:

The first step involves taking a transparent film, applying mansion wax polish all over it, and then applying the first layer of epoxy liquid and fiber to the film. Following the application of the second layer epoxy and fiber to the film, the fiber layer is carefully brushed with a thick layer of epoxy resin that has been properly mixed with the hardener at a ratio of 1:10. The second layer of fiber is layered on top of the epoxy layer. This procedure is repeated until the composite plate reaches the desired thickness. Once the plate reaches the desired thickness, a second clear film that has already been mansion wax polished is applied to the other side of the plate. Squeezers are employed in hand layup methods for eliminating the air bubbles.

Table-1: *Relative weights of fiber and resin*

S.NO.	STACKING OF SEQUENCES OF FIBERS	NOMENCLATURE	NUMBER OF LAYERS	WEIGHT OF FIBER(210X210) (g)	WEIGHT OF RESIN + HARDENER (g)	WEIGHT OF TiO_2 (g)	WEIGHT PERCENTAGE OF TiO_2 (%)
1.	A/A/A/A/A	AF	5	58 gm	192	-	-
2.	B/B/B/B/B	BF	6	83 gm	192	-	-
3.	A/B/A/B/A/B	HF	3+3	76	192	-	-
4.	A/B/A/B/A/B + TiO_2	HF (0.025)	3+3	76	192	5	2.5
5.	A/B/A/B/A/B + TiO_2	HF (0.05)	3+3	76	192	10	5

Table -2: *Composition of prepared composites*

S.NO	FIBER NAME	COMPOSITION OF COMPOSITES BY (WEIGHT%)
1.	Areca Fiber With (E+H)	Areca =23.2% + (E+H)=76.8%
2.	Basalt Fiber With(E+H)	Basalt=30.18% + (E+H)=69.81%
3.	Hybrid Fiber with (E+H)	Areca=13.05% + Basalt =15.29% + (E+H)=71.64%
4.	Hybrid Fiber with 5gm Filler and(E+H)	Areca=12.83% + Basalt=15.01% + (E+H)=70.32% + Filler=1.83%
5.	Hybrid Fiber with 10gm Filler and (E+H)	Areca=12.58% + Basalt=14.74% + (E+H)=69.06% + Filler=3.59%

3. Experimental Investigation

3.1 *Testing of mechanical behavior of hybrid composite:*

The following tests are performed on fabricated hybrid composite material:

1. Tensile test
2. Compression test
3. Flexural test
4. Charpy impact test
5. Brinell's hardness test

Table -3: *Specimens as per ASTM standards*

Type of test	ASTM standard	Dimension (length×width×thickness) mm
Tensile Test	D3039	165x20x4
Compression Test	D3410	135x15x4
Flexural Test	D709	200x20x4
Charpy Impact Test	D256	57x12x4
Brinell's Hardness Test	E10	25x25x4

4. Mechanical Properties

In this work, the experimental data obtained on the basic mechanical characteristics of Areca and Basalt fibre reinforced hybrid composite is presented.

4.1 Tensile Test:

The readings acquired in the tensile test shows that the tensile strength for Hybrid (Areca & Basalt fiber) Composite with 10gm of filler material is 165.25 MPa which is greater than the other four specimens & the results are presented in the table 4.

Table -4: *Tensile Test Results*

S.NO	SPECIMAN NAME	LOAD (KN)	CHT (Cross Head Travel) (mm)	TENSILE STRENGTH (MPa)	TENSILE STRAIN	TIME TAKEN TO BREAK (Sec)
1.	ARECA	7.93	4.25	99.125	0.006	82
2.	BASALT	8.54	5.24	103.230	0.008	84
3.	ARECA+BASALT	10.79	6.18	134.870	0.006	88
4.	ARECA+BASALT (TiO_2)5gm	10.90	5.56	136.250	0.012	91
5.	ARECA+BASALT (TiO_2)10gm	13.22	7.18	165.250	0.018	83

From the values that are obtained from Universal Testing Machine, the graphs are plotted.

Fig-1: *Tensile Test*

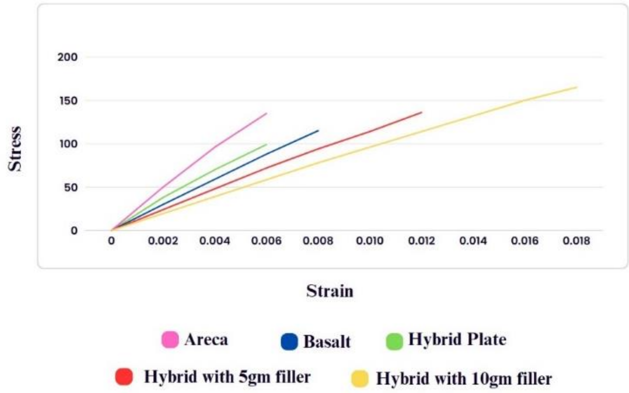

Fig-2: *Stress Vs Strain curve for tensile test*

4.2 Compression Test:

It has been observed that hybrid composite with 10gm of filler material got high compression strength up to 2.9 MPa. This is because of addition of filler in hybrid composite and the results are presented in the table 5.

Table -5: *Compression test results*

S.NO	SPECIMAN NAME	MAXIMUM LOAD (N)	COMPRESSIVE STRAIN	CHT (mm)	TIME TAKEN TO BREAK (sec)	YOUNG'S MODULUS (MPa)	COMPRESSIVE STRENGTH (MPa)
1.	ARECA	5680	0.992	5.09	67	2.82	2.80
2.	BASALT	5700	0.994	5.12	74	2.87	2.82
3.	ARECA+BASALT	5760	0.992	12.43	144	2.86	2.84
4.	ARECA+BASALT (TiO_2)5gm	5920	0.985	10.45	117	2.96	2.923
5.	ARECA+BASALT (TiO_2)10gm	5930	0.977	9.96	135	2.99	2.928

From the values that are obtained from Universal Testing Machine, the graphs are plotted.

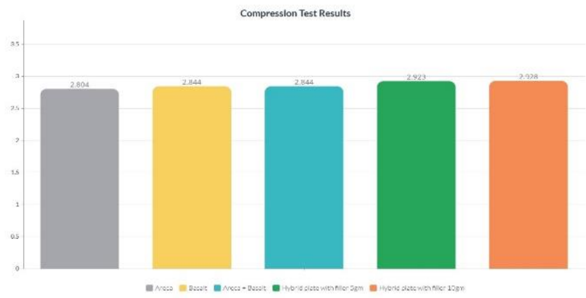

Fig-3: *Compression Test*

4.3 Flexural Test:

Flexural stress of Hybrid composite with 10gm of filler material is higher than the other composites because of its high strength and high resistance feature which can withstand more stresses and the results are presented in the table 6.

Table -6: *Flexural test results*

S.NO	SPECIMAN NAME	MAXIMUM LOAD (N)	STRESS (N/mm^2)	STRAIN	MODULUS (N/mm^2)
1.	ARECA	5240	1.31	1.005	1.12
2.	BASALT	5300	1.32	1.001	1.23
3.	ARECA+BASALT	5320	1.33	1.01	1.31
4.	ARECA+BASALT (TiO_2)5gm	5500	1.37	1.015	1.34
5.	ARECA+BASALT (TiO_2)10gm	5560	1.39	1.025	1.356

Fig-4: *Flexural Strength*

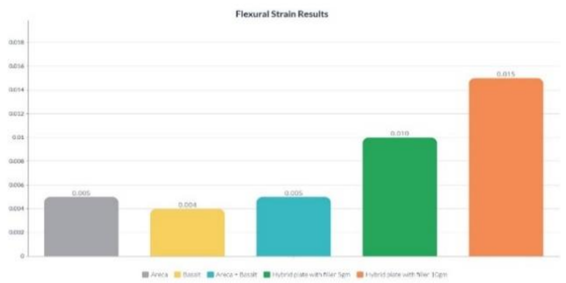

Fig-5: *Flexural Strain*

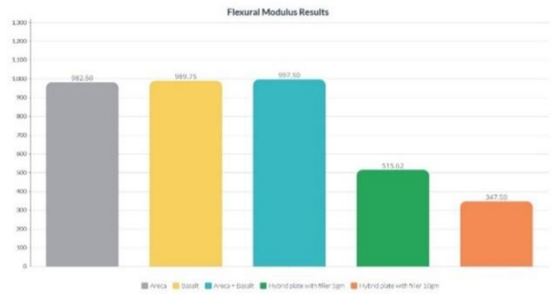

Fig-6: *Flexural Modulus*

4.4 Charpy Impact test result:

The influence of fibre and filler parameters on impact strength of composites are shown below in table 7.

Table -7: *Impact test results*

S.NO	SPECIMAN NAME	CROSS SECTIONAL AREA (mm²)	INITIAL ENERGY (J)	READINGS AFTER IMPACT (J)	ACTUAL ENERGY (J)	TOUGHNESS (J/mm²)
1.	ARECA	684	300	60	240	0.35
2.	BASALT	684	300	62	238	0.367
3.	ARECA+BASALT	684	300	62	238	0.347
4.	ARECA+BASALT (TiO_2)5gm	684	300	60	240	0.350
5.	ARECA+BASALT (TiO_2)10gm	684	300	64	236	0.345

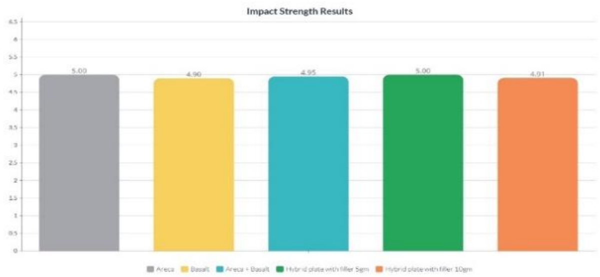

Fig-7: *Impact Strength*

4.5 *Brinell's Hardness Test:*

The effect of fibers and filler on hardness of composites is shown in fig 8 and the results are presented in the tables 8&9.

Table -8: *Brinell's Hardness test results for load 981N*

S.NO	SPECIMAN NAME	LOAD APPLIED (N)	AVERAGE DIAMETER OF INDENTATION d (mm)	BRINELL'S HARDNESS NUMBER (BHN)
1.	ARECA	981	0.51	100
2.	BASALT	981	0.63	96
3.	ARECA+BASALT	981	0.38	91
4.	ARECA+BASALT (TiO_2)5gm	981	0.42	74
5.	ARECA+BASALT (TiO_2)10gm	981	0.36	98

Table -9: *Brinell's Hardness test results for load 1471N*

S.NO	SPECIMAN NAME	LOAD APPLIED (N)	AVERAGE DIAMETER OF INDENTATION d (mm)	BRINELL'S HARDNESS NUMBER (BHN)
1.	ARECA	1471	0.44	102
2.	BASALT	1471	0.45	100
3.	ARECA+BASALT	1471	0.48	81
4.	ARECA+BASALT (TiO_2)5gm	1471	0.50	94
5.	ARECA+BASALT (TiO_2)10gm	1471	0.50	80

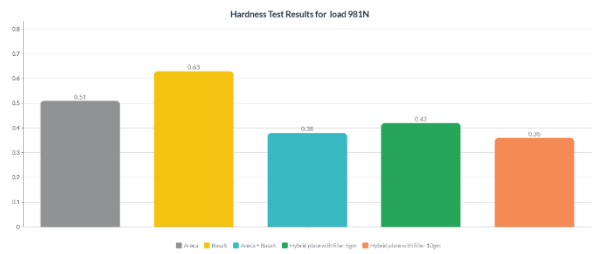

Fig-8: *Brinell's Harness Test*

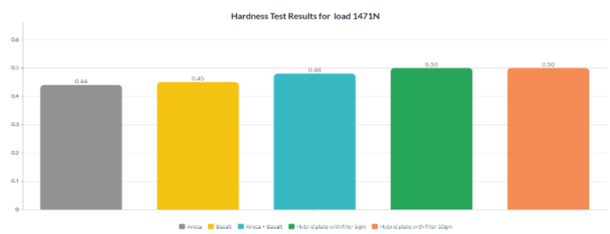

Fig-9: *Brinell's Harness Test*

5. Thermal Properties:

In the present chapter, the experimental data obtained on the basic thermal characteristics of Areca and Basalt fiber reinforced hybrid composite is presented.

5.1 *Differential Thermal Analysis (DTA):*

Phase transitions, reactions, and the thermal behavior of materials are studied in materials science and chemistry using the thermal analysis approach known as differential thermal analysis, or DTA. When two materials are heated or cooled under controlled conditions, the temperature difference between the samples and the reference material is measured. This method aids in the understanding of how a material's structure and qualities alter with temperature. Metals, ceramics, polymers, and composites are just a few of the materials that can be studied with the flexible DTA approach. In materials research, the method is especially helpful for characterizing phase transitions, melting and solidification processes, and material thermal stability. The thermal characteristics of materials, such as specific heat capacity, thermal conductivity, and thermal diffusivity, can be ascertained using DTA.DTA's remarkable sensitivity to material thermal changes is one of its key advantages.

This method is an effective tool for material characterization because it can identify even minute variations in heat flow that are linked to phase transitions. With basic tools and techniques needed for sample preparation and analysis, DTA is also a reasonably simple procedure to carry out. The capacity of DTA to offer both qualitative and quantitative data regarding the thermal behavior of materials is another benefit. The phase transitions that take place in a sample and the temperatures at which they do so can be determined using the DTA curve. The enthalpy changes connected to these transformations can also be found using this technique, and this information can reveal how much energy is needed for a phase transition.

5.1.1 *Applications of DTA:*

Differential Thermal Analysis (DTA) has several applications, such as:

Phase Transitions: Melting, crystallization, glass transitions, and chemical reactions are examples of material phase changes that can be detected with DTA.

Thermal Stability: By identifying variations in heat capacity and enthalpy linked to structural alterations or breakdown, it aids in determining the thermal stability of materials.

Quality Control: DTA is used in quality control procedures to guarantee the dependability and uniformity of materials used in a variety of sectors, such as metals, polymers, medicines, and ceramics.

Purity Analysis: By identifying impurities or phase shifts that take place at particular temperatures, DTA can be used to evaluate the purity of materials.

Material Characterization: It helps characterize materials and comprehend how they behave at various temperatures by offering useful information about their thermal characteristics.

Research and Development: By analyzing the thermal behavior of novel materials, scientists and researchers can enhance their qualities and create new materials tailored to particular uses.

All things considered, DTA is an effective method for examining the thermal behavior of materials, offering vital data for a variety of academic, industrial, and scientific uses.

The DTA Vs TGA Curves are shown in the above figures:

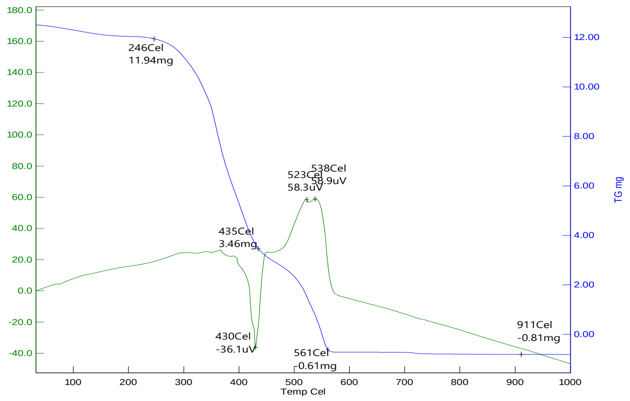

Fig-10: *DTA Vs TGA Curve for Areca plate*

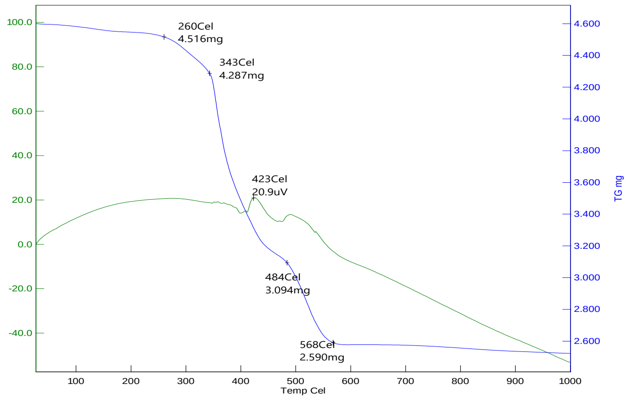

Fig-11: *DTA Vs TGA Curve for Basalt plate*

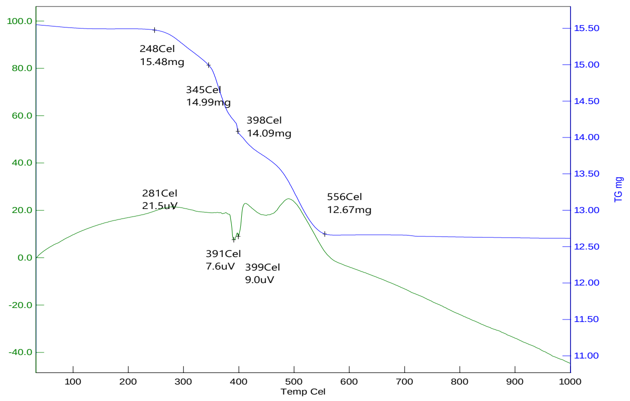

Fig-12: *DTA Vs TGA Curve for Hybrid plate*

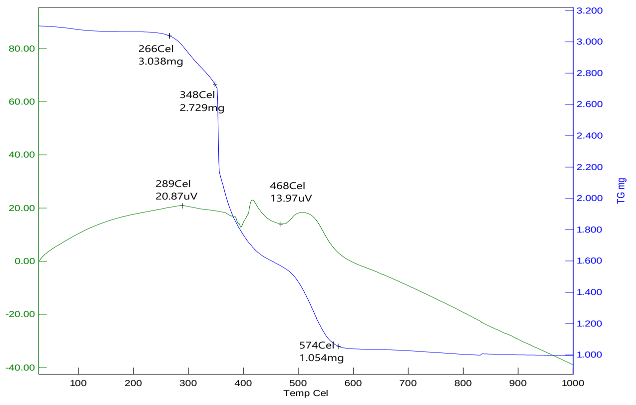

Fig-13: *DTA Vs TGA Curve for Hybrid plate with 5gm of filler*

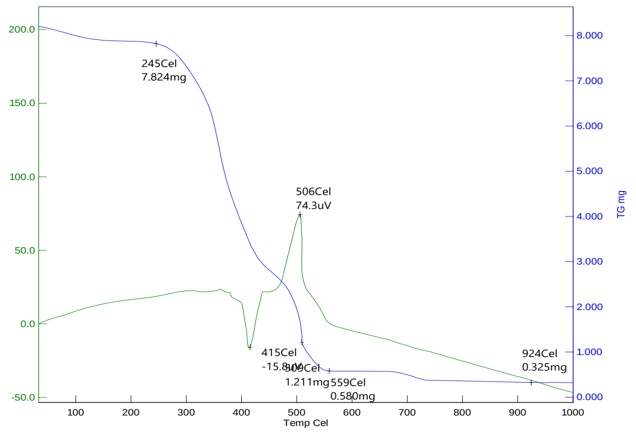

Fig-14: *DTA Vs TGA Curve for Hybrid plate with 10gm of filler*

5.2 *Thermal Gravimetric Analysis (TGA):*

Thermo gravimetric analysis is a technique used to measure the changes in mass of a sample as a function of temperature or time.It involves heating a sample in a controlled environment while continuously monitoring its mass. TGA is commonly used to study the decomposition, oxidation, dehydration, and other thermal behaviors of materials. By examining distinctive decomposition patterns, a TGA can be utilized to characterize materials. The study of polymeric materials, such as thermoplastics, thermosets, elastomers, composites, plastic films, fibers, coatings, paints, and fuels, benefits greatly from this technique.In thermogravimetric analysis, mass, temperature, and time are regarded as base measurements from which many other values can be obtained.

TGA is employed in polymer analysis. Considering that polymers typically melt before they break down, TGA is mostly utilized to look into the thermal stability of polymers. Before 200 °C, most polymers melt or break down. TGA can be used to examine a class of thermally stable polymers, which can tolerate temperatures of at least 300 °C in air and 500 °C in inert gasses without losing strength or undergoing structural alterations. A material's thermal stability can be assessed using TGA. If a species is thermally stable, no changes are observed. The maximum use temperature of a material is also provided by TGA. The material will start to deteriorate above this temperature as changes will occur within the target temperature range. TGA offers accurate mass change measurements, enabling quantitative examination of sample composition. TGA is capable of identifying various thermal phenomena in materials, such as desorption, sublimation, and decomposition. A full range of information regarding sample properties can be obtained by combining certain TGA instruments with other analytical techniques such as FTIR, MS, or DSC for simultaneous analysis. TGA is capable of analyzing a wide range of materials under various settings due to its ability to withstand temperatures ranging from ambient to high.

5.2.1 *Applications of TGA:*

Thermal Gravimetric Analysis (TGA) has several applications, such as:

Polymer Analysis: To investigate composition, stability, and degradation temperatures, TGA is widely employed in polymer research.

Pharmaceuticals: It is employed in the analysis of drug stability, purity, and kinetics of degradation.

Environmental Science: TGA is used in environmental science to investigate the thermal behavior of biomaterials, the breakdown of organic contaminants, and soil organic matter.

Catalysis: TGA is useful for researching the stability, deactivation mechanisms, and characterisation of catalysts.

Food Industry: TGA is used to examine the kinetics of food ingredient degradation, shelf-life estimation, and food stability.

Materials Science: It is used to characterize metals, ceramics, composites, and nanomaterials in order to comprehend their behavior and thermal characteristics under various circumstances.

5.3 *Derivative Thermogravimetry (DTG):*

In materials science and chemistry, derivative thermo gravimetry (DTG) is a technique used to examine changes in a sample's weight and thermal characteristics as a function of temperature or time. In DTG, the weight change of the sample in relation to the reference is measured as a function of temperature or time after the sample and a reference material undergo the same thermal treatments. This method is useful for researching phase transitions, breakdown, and other heat processes in materials.

5.3.1 *Applications of DTG:*

Derivative Thermo Gravimetry, or DTG, is utilized for a few purposes such as:

Characterizing Thermal Properties: DTG offers insights into phase transitions, breakdown, and other thermal phenomena and aids in understanding how a material's weight varies with temperature.

Quality Control: It is used to evaluate the composition, stability, and purity of materials in quality control procedures.

Material Analysis: To comprehend the thermal behavior of polymers, ceramics, metals, medicines, and other materials, DTG is utilized.

Research and Development: DTG is used by scientists and researchers to examine novel materials, look into their thermal stability, and adjust their characteristics for certain uses.

Process Optimization: By comprehending the thermal behavior of the materials involved, DTG aids in process optimization in sectors like manufacturing and medicines.

Testing for Compatibility: This process determines whether two materials are compatible or not.

Considering all things, DTG is an adaptable instrument for comprehending the thermal properties of materials, which is essential for a number of industrial, scientific, and quality control applications.

DTG Vs Temperature Curves are shown in the below figures:

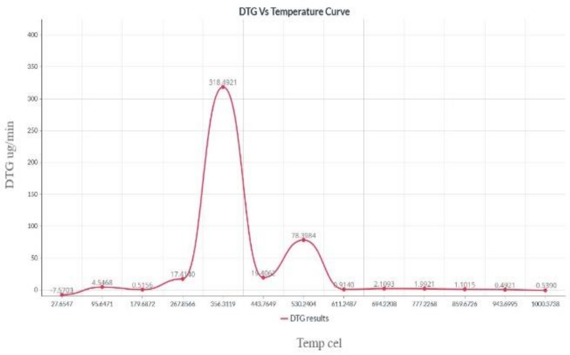

Fig-15: *DTG Vs Temperature Curve for Areca plate*

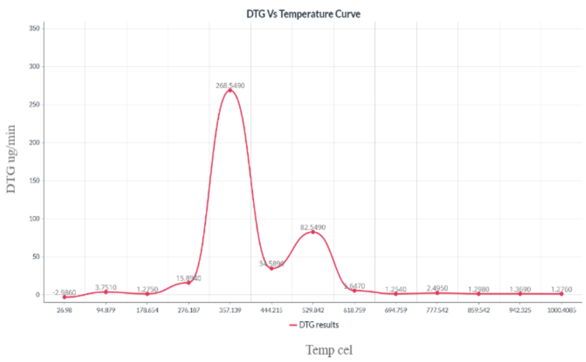

Fig-16: *DTG Vs Temperature Curve for Basalt plate*

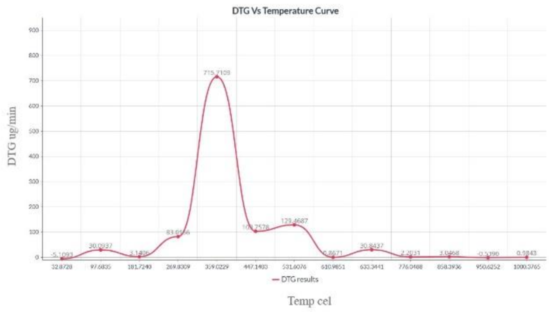

Fig-17: *DTG Vs Temperature Curve for Hybrid plate*

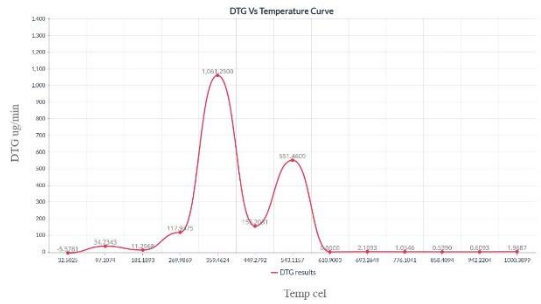

Fig-18: *DTG Vs Temperature Curve for Hybrid plate with 5gm of filler*

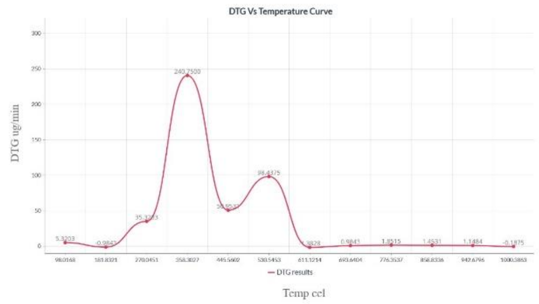

Fig-19: *DTG Vs Temperature Curve for Hybrid plate with 10gm of filler*

6. CONCLUSION

In the present research, mechanical and thermal properties of areca and basalt fiber reinforced with epoxy resin and titanium dioxide as a filler was studied. Hybrid composites along with 10gm of filler have superior mechanical properties than the individual fiber reinforced composites. Composites of basalt also showed promising results as compared to areca fiber reinforced material. Hence from the obtained results, availability of areca fiber, basalt fiber,affordable cost of fiber, these composites positively considered as alternative material for the fabrication of Automotive Parts like interior trims,body panels ,and also in Aerospace Components like fairings,interior panels and non structural parts, Marine applications,Sports equipment, Construction elements, Consumer goods,etc.

7. FUTURE SCOPE

In the realm of composite materials, the research conducted on composites made with areca and basalt fiber, epoxy reinforcement, and titanium dioxide filler reveals promising avenues for future exploration. Firstly, there is a need for optimizing composite properties, focusing on enhancing strength, stiffness, impact resistance, and thermal conductivity through experimentation with varying compositions and manufacturing processes. Additionally, the pursuit of novel applications such as renewable energy, additive manufacturing, and biomedical engineering could expand the horizons of composite usage. Durability and environmental impact assessments are crucial for ensuring sustainability, necessitating long-term studies on weathering resistance, chemical stability, and recyclability. Scaling up production and refining manufacturing processes are vital steps towards industrial viability, while exploring multi-functionalities like self-healing or electromagnetic shielding adds layers of innovation. Advanced characterization techniques offer deeper insights into material behavior, while interdisciplinary collaboration fosters holistic approaches to addressing complex challenges. By delving into these future scopes, researchers can propel the development and application of areca and basalt fiber composites towards greater efficiency, sustainability, and functionality.

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GUIDE: MR.M.ESWAR TEJA