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A Study of Properties of Carbon Fibre

Lavpreet Singh

Department of Mechanical Engineering, Galgotias University, Yamuna Expressway Greater Noida, Uttar Pradesh, India

Email Id: punstu@gmail.com

ABSTRACT: Basic materials, commonly dependent on metal, have been continuously subbed by elite composites dependent on carbon strands, inserted in a polymer lattice, due to their capability to give lighter, more grounded, and progressively sturdy arrangements. In the most recent decades, the composites industry has seen a continued development, particularly because of dispersion of these materials in key markets, for example, the development, wind vitality, flight, and car divisions. Carbon strands are, by a long shot, the most generally utilized fibre in superior applications. This significant innovation has huge potential for the future and it is relied upon to have a critical effect in the fabricating industry inside Europe and, in this manner, coordination and vital road-mapping activities are required. To lead a further drive to build up the capability of composites into new segments, it is critical to set up key road-mapping activities, including the advancement of business and cost models, supply chains execution, and improvement, appropriateness for high volume markets what's more, tending to innovation the board. Europe as of now has a lively and hostile composites industry that is upheld by a few research focuses, however for its situating in a cutting edge position in this innovation, further difficulties are as yet required to be tended to.

KEYWORDS*:* Carbon Fibre, Carbon fibre reinforced polymers, PolyAcryloNitrile (PAN), Road-Mapping.

I.INTRODUCTION

Carbon fibre [1], [2] is characterized as a fibre containing at any rate 92 wt. % carbon, while the fibre containing at least 99 wt. % carbon is generally called a graphite fibre. Carbon filaments for the most part have fantastic ductile properties, low densities, and high heat and synthetic secure qualities without oxidizing specialists, great heat and electrical conductivities, and magnificent downer obstruction. They have been broadly utilized in composites as woven materials, prepares, ceaseless filaments/roving's, and hacked filaments. The composite parts can be delivered through fibre winding, tape winding, pultrusion, pressure forming, vacuum packing, fluid trim, and infusion shaping.

Lately, the carbon fibre industry has been developing relentlessly to fulfil the need from various enterprises, for example, aviation (airplane and space systems), military, turbine cutting edges, development (non-auxiliary and basic systems), light weight chambers and weight vessels, seaward ties and boring risers, medicinal, vehicle, outdoor supplies, and so on. For the car industry, fibre fortified polymeric composites offer diminished weight and prevalent styling. Carbon elements can discover applications in body parts (entryways, hoods, deck tops, front end, guards, and so on.), skeleton what's more, suspension systems (e.g., leaf springs), drive shafts, etc. A relentless increment in both generation and utilization later on can be anticipated. Indeed, a large portion of the carbon fibre producers have plans for development to satisfy the market need. In any case, the huge volume use of carbon fibre in car industry has been obstructed because of the high fibre cost and the absence of rapid composite creation strategies.

The present carbon fibre advertise is overwhelmed by "polyacrylonitrile (PAN) [3]" carbon filaments, while the rest is pitch carbon filaments and a modest quantity of rayon carbon fibre materials. Various antecedents produce carbon elements with various properties. Despite the fact that delivering carbon filaments from various antecedents requires diverse preparing conditions, the basic highlights are fundamentally the same as. For the most part, carbon filaments are produced by a controlled pyrolysis of settled antecedent elements. Antecedent filaments are first balanced out at around 200–400°C in air by an oxidization procedure. The infusible, balanced out filaments are then exposed to a high temperature treatment at around 1,000°C in a latent environment to evacuate hydrogen, oxygen, nitrogen, and other

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non-carbon components. This progression is frequently called carbonization. Carbonized elements can be further graphitized at a much higher temperature up to around 3,000°C to accomplish higher carbon content and higher Young's modulus in the fibre heading. The properties of the resultant carbon/graphite filaments are influenced by numerous elements, for example, crystallinity, crystalline dispersion, atomic direction, carbon content, and the measure of deformities. Prior to bundling, the moderately latent surfaces of the carbon/graphite elements are present treated on improve their grip to composite networks.

As far as last mechanical properties, carbon filaments can be generally arranged into ultra-high modulus [4] (>500 GPa), high modulus (>300 GPa), middle of the road modulus (>200 GPa), low modulus (100 GPa), and high quality (>4 GPa) carbon filaments. Carbon elements can likewise be grouped, based on conclusive thermal treatment temperatures, into type I (2,000°C heat treatment), type II (1,500°C heat treatment), and type III (1,000°C heat treatment). Type II "poly-acrylic-nitrile (PAN)" Carbon filaments are typically high quality carbon elements, while the greater part of the high modulus carbon filaments have a place with type I. Actuated carbon filaments contain a lot of open pores and are principally utilized for gas retention applications. This theme won't be canvassed in this audit.

II.LITERATURE REVIEW

The capability of carbon elements with respect to their thermomechanical properties [5] is a long way from being depleted in the present business, since the profoundly perplexing components of structure development in fibre generation and the procedure parameter–structure–property connections have so far as it were been examined in the scholarly field. With the focused on control of the properties from the atomic structure to the composite, totally new applications are possible notwithstanding the noteworthy improvement of existing composite materials for lightweight applications. These incorporate new accident engrossing structures in car building, progressively proficient gas dissemination structures for power modules , adsorptive filaments for hydrogen high-pressure tanks, cutting edge energy stockpiling systems, cell-perfect filaments to supplant nerve tracts in paraplegia, prosthetics with customized properties to stay away from pressure protecting, and some more. Specifically, minimal effort carbon filaments (CFs) are especially fascinating as support structures for carbon concrete or for wind turbine rotor cutting edges, since environmental and budgetary angles assume an especially significant job in the CF amounts required there. In any case, fundamental research is expected to empower a huge scale use of multifunctional CF in asset proficient insightful development strategies.

This is correctly where new methodologies come in, beginning from the innovative work of forerunner materials and proceeding to the turning generation forms, through focused adjustment, carbonization, graphitization, and surface functionalization to close to the arrangement of the last composite materials. This gives unequivocal experiences along the whole procedure chain and the fundamental establishments for multifunctional materials and along these lines flexible developments of things to come with characterized customizable properties, for example, quality, solidness, energy ingestion limit, flexibility, and energy stockpiling limit just as heat and electrical conductivities with altogether improved asset productivity.

The advancement of keen materials and clever structures with improved properties and functionalities will address the current mechanical difficulties at the worldwide level and the utilization of keen materials will permit enhancements for the personal satisfaction of society. The improvement of parts with damage detecting and self-recuperating properties creates items with higher advantage, lower support, and expanded security for the end-client, diminishing the general financial effect in this application. Weight decrease of auxiliary segments and ensuing energy/fuel investment funds due to the utilization of lightweight "carbon fibre reinforced polymer composite (CFRP) [6]" materials can be accomplished through Nano modification [7]. Also, the profitability and aggressiveness of "carbon fibre reinforced polymer composite" items will be upgraded with the Nano modification and add to its more extensive scope of uses. By this applied research and joint efforts among the scholarly community and industry will be upgraded, so that the discoveries of each accomplice can fill in as a premise that potentiates further advancements.

The European Commission (EC), as indicated by the Paris Agreement, expects to diminish ozone harming substance outflows by 80% beneath 1990 levels in 2050. For that, the EC is unequivocally driving electrical systems to special positions, which notwithstanding the previously mentioned points of interest appear high efficiencies of energy transformation, low commotion outflow, high dependability, or low support costs, among different benefices. In any case, the truth of the matter is that it isn't just important to create energy yet additionally store it. This test is turning out

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to be increasingly basic these days because of the high and developing interest of energy made by the versatile electric advancements (compact hardware, ground and air vehicles, and so on.), yet in addition because of the need to help the closer future requests where huge zap is expected in an armada of air and ground vehicles.

There is an expanding drive to diminish ozone depleting substance emanations and asset utilization emerging from the assembling and utilization of items over a wide scope of businesses. The present economy is seen as straight and intrinsically unfeasible, with a 'take–make–arrange' theory in which materials are separated, made into items, and disposed of toward the finish of life. Composite materials are innately hard to reuse and regularly landfilled toward the finish of life. Reusing centers around recuperating fibre and disposed of system stage, which is in fact at the last chain or the circle. The last advance to consider for a full circularity is the fixing of "carbon fibre reinforced polymer composite" structures during their activity and toward the end of their life. The EC characterizes Agenda 2030, which points around and bio economy model focusing on supportability by lessening waste and keeping assets at their most noteworthy worth where conceivable (Figure 1).

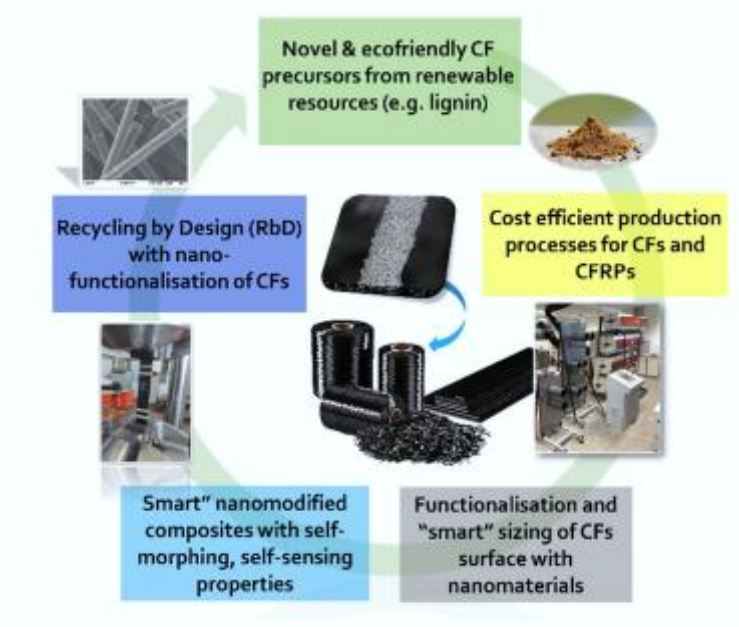

Fig. 1: Composite Material Circular Economy

III.PRINCIPLE OF OPERATION

"Carbon fibre reinforced polymer, Carbon fibre fortified polymer, or carbon fibre reinforced plastic, or carbon fibre reinforced thermoplastic [8]" (CFRP, CRP, CFRTP, or frequently essentially carbon fibre, carbon composite, or even carbon), is an amazingly solid and light fibre-fortified plastic which contains carbon elements. The spelling 'fibre' is regular outside. "Carbon fibre reinforced polymers" can be costly to create however are ordinarily utilized any place high solidarity to-weight proportion and solidness (inflexibility) are required, for example, aviation, superstructure of boats, car, structural building, athletic gear, and an expanding number of customer and specialized applications.

The coupling polymer is frequently a thermoset pitch, for example, epoxy, however other thermoset or thermoplastic polymers, for example, polyester, vinyl ester, or nylon, are now and then utilized. The composite material may contain aramid (for example Kevlar, Twaron), "ultra-high-sub-atomic weight polyethylene (UHMWPE) [9]", aluminium, or glass elements notwithstanding carbon filaments. The properties of the last "Carbon fibre reinforced polymer" item can likewise be influenced by the sort of added substances acquainted with the coupling network (gum). The most widely recognized added substance is silica, yet different added substances, for example, elastic and carbon nanotubes can be utilized. The material is likewise referred to as "graphite-reinforced polymer" or "graphite fibre-fortified polymer (GFRP is less normal", as it conflicts with glass-(fibre)-reinforced polymer [10]).

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"Carbon fibre reinforced polymers" are composite materials. For this situation the composite comprises of two sections: a system and a support. In CFRP the support is carbon fibre, which gives the quality. The grid is typically a polymer sap, for example, epoxy, to tie the fortifications together. Because "Carbon fibre reinforced polymers" comprises of two unmistakable components, the material properties rely upon these two components. Fortification invigorates "Carbon fibre reinforced polymers" it's and unbending nature, estimated by pressure and versatile modulus separately. Dissimilar to isotropic materials like steel and aluminium, CFRP has directional quality properties. The properties of "Carbon fibre reinforced polymers" rely upon the designs of the carbon fibre and the extent of the carbon elements comparative with the polymer. The two unique conditions overseeing the net versatile modulus of composite materials utilizing the properties of the carbon filaments and the polymer lattice can likewise be applied to carbon fibre fortified plastics. The accompanying condition,

$$E_c = V_m E_m + V_f E_f$$

Is substantial for composite materials with the filaments situated toward the applied burden. E_{c} is the complete composite modulus, V_ {m} and V_ {f} are the volume parts of the system and fibre separately in the composite, and E_ {m} and E_ {f} are the versatile module of the network and elements respectively. The other outrageous instance of the flexible modulus of the composite with the filaments situated transverse to the applied burden can be discovered utilizing the accompanying equation:

$$E_c = \left(\frac{V_m}{E_m} + \frac{V_f}{E_f} \right)^{-1}$$

The break durability of carbon fibre fortified plastics is administered by the accompanying systems: 1) deboning between the carbon fibre and polymer grid, 2) fibre pull-out, and 3) delamination between the "Carbon fibre reinforced polymers" sheets. Typical epoxy-based CFRPs show essentially no pliancy, with under 0.5% strain to distress. In spite of the fact that "Carbon fibre reinforced polymers" with epoxy have high quality and flexible modulus, the weak crack mechanics present novel difficulties to engineers in distress location since distress happens catastrophically. As such, ongoing endeavours to toughen "Carbon fibre reinforced polymers" incorporate adjusting the current epoxy material and discovering elective polymer lattice. One such material with high guarantee is PEEK, which displays a request for size more noteworthy sturdiness with comparative versatile modulus and tractable strength. However, PEEK [11] is considerably harder to process and more expensive.

Regardless of its high starting solidarity to-weight proportion, a plan constraint of "Carbon fibre reinforced polymers" is its absence of a perceptible weariness limit. This implies, hypothetically, that pressure cycle distress can't be precluded. While steel and numerous other basic metals and combinations do have admirable weakness or perseverance constrains, the mind boggling distress methods of composites imply that the exhaustion distress properties of CFRP are hard to anticipate and plan against. Subsequently, when utilizing "Carbon fibre reinforced polymers" for basic cyclic-stacking applications, architects may need to structure in impressive quality security edges to give reasonable segment unwavering quality over its administration life.

Natural impacts, for example, temperature and stickiness can affect the polymer-based composites, including most "Carbon fibre reinforced polymers". While CFRPs show magnificent erosion obstruction, the impact of dampness at wide scopes of temperatures can prompt corruption of the mechanical properties of "Carbon fibre reinforced polymers", especially at the grid fibre interface. While the carbon filaments themselves are not influenced by the dampness diffusing into the material, the dampness plasticizes the polymer matrix. The epoxy lattice utilized for motor fan sharp edges is intended to be impenetrable against fly fuel, grease, and downpour water, and outer paint on the composites parts is applied to limit harm from bright light.

The carbon filaments can cause galvanic consumption when CRP parts are connected to aluminium.

IV.WORKING PRINCIPLE

1. Novel Materials and Optimized Processing

1.1. Carbon Fibre Conversion Technologies

Three diverse improvement headings have been distinguished for the carbon fibre change advancements:

- The improvement of carbon fibre properties by upgrading the carbon fibre transformation advances;

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- The age of extra functionalities for carbon filaments;
- The decrease of energy utilization during the carbon fibre transformation while keeping up the CF properties.

More financially savvy CFs are especially fascinating for ventures in which the utilization of carbon filaments is presently impossible for financial or biological reasons. Hence, various ongoing investigations have concentrated not just on the utilization of option, more affordable antecedents of "poly-acrylic-nitrile (PAN)" yet in addition on lessening energy costs during CF transformation. In the field of heater innovation, late work has demonstrated that it is conceivable to lessen energy costs by up to 90% in a few cases. What's more, elective change advances, for example, laser-, plasma-, or e-bar based transformation are engaged. With a significant extensive logical entrance of the procedure steps of thermomechanical transformation or elective change advancements for various antecedents, in specific the right now massively high-energy utilization and ecological contamination can be altogether diminished, and the procedure speeds expanded. Toward this path, the accompanying difficulties happen:

- Understanding the procedure parameter–structure–property connections during thermomechanical transformation;
- Process impact on custom-made CF properties for multifunctional applications;
- Mechanisms of crosslinking of forerunner elements inside laser-, plasma-, and e-bar adjustment furthermore, their effect on the basic change during transformation to carbon elements;
- Energy conditions for asset effective CF structure arrangement.

So as to overthrow the previously mentioned difficulties, between research centre correlations of carbon fibre properties together with upscaling of existing scholastic carbon fibre lines and assembling of a lot of filaments to approve the capability of multifunctional elements, should be considered. By this, the development of European fibre businesses will be expanded, since the item range and quality will be enlarged. This will help the inception of totally new businesses for CFs, with multi-functionality, that may bring down likewise the ecological effect (from creation to definite use), getting from increasingly proficient items. The mechanical effect will offer an achievement of CF and CFRP in cost-sensitive segments like breeze energy or structural building.

1.2 Semi-Product Development and Supply Chain

Commonly, the filaments are utilized as semi-items, to be specific pre-impregnated (prepreg) [12] sheets. A prepreg is the regular term for a fortifying fibre that has been pre-impregnated with a gum system that is in a halfway relieving stage. Therefore, the prepreg is prepared to layup without the expansion of some other segments. The diminished number of providers of claim to fame elements and related semi-products for appeal applications has, in any case, been called attention to as a significant constraint for the aggressiveness of European composites industry.

It is fundamental to make the capacity to deliver carbon filaments and carbon fibre semi-products in Europe, empowering not just the space business to have free access to these materials, however conceivably boosting different segments that can profit if lower expenses would be achieved. A bigger stock system can build materials' accessibility and progressively proficient assembling techniques can diminish the cost of forte evaluation carbon filaments. This would add to improve Europe's overall fierceness in the field of superior CFRP structures. Moreover, new semi-items types and structures are developing, requiring additionally the limit of having a supportable worth chain to make them open to the last composites' producers. Actually, new support texture structures, distinctive material mixtures and crude materials change could be the course for boosting an effective European industry. For example, preforms made by 3D weaving give a few significant focal points in composite assembling, particularly in manufacturing thick composites, because of critical decreased timings, as one or just a couple three-dimensional handles to comparable 2D textures are fit for supplanting numerous layers of two-dimensional texture handles.

From the perspective of prepreg properties, there is additionally a requirement for lower areal weight textures, empowering the likelihood to additionally enhance mass reserve funds dependent on the lay-up plan. Expanding the scope of prepreg semi-products is additionally a fascinating probability; for example, thermoplastic networks are picking up intrigue, normally a result of lower preparing times required, reusing/reusing probability, and longer time spans of usability. The airplane business perceives thermoplastic composites give striking costs investment funds when created at rates contrasted with conventional thermoset-based composites also, propelled metals. These investment funds are particularly critical on littler parts, where last wrapping up chip away at parts shaped from different materials can altogether increment per-part cost. Carbon fibre producers were required to refresh their portfolio, presently offering the likelihood to buy filaments with thermoplastic-good estimating. Their transformation into semi-items and extension of mixture and items structures is additionally a significant driver for future gains on composites execution.

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Europe's overall intensity in the field of elite CFRPs is for the most part associated to the carbon fibre-based semi-items producing by European organizations in European offices, because of a low number of providers and constrained R&D limit. In addition, then again, lower cost and all the more ecologically well-disposed carbon fibre antecedents, new fibre structures, for example, preforms made by 3D weaving, reusing diverse material mixes for improved properties, hence expanding the scope of monetarily accessible semi-products, are themes of enthusiasm for improving the European CFRP composites industry.

1.3 Upgraded Process Throughput for High Volume Applications

Vehicle light-weighting is an especially significant methodology because of the mass de-compounding that may happen as diminished essential vehicle weight empowers optional mass decreases. Answers for the high-volume assembling of composite body structures without losing the abilities and information gained from steel creation are profoundly required. As might be concurred, 2015 imprints the year that the material goes into genuine high-volume creation. The test with actualizing carbon fibre composites is to make them practical for high volume creation. Therefore, the material must be changed so it very well may be mechanically dealt with to stay away from expensive wasteful aspects while using existing handling hardware. Be that as it may, high volume creation for the carbon fibre composite body structure in a car isn't only a financially savvy creation. The body structure interfaces with each other segment on the vehicle. There are as yet numerous cases that show the composite material structure being mediocre compared to steel parts. For example, while going into a composite arrangement one needs to consider how to reuse the great stuff into something that is less acceptable. One goes in with focus on expenses' nevertheless the yield isn't going to be 100% so one will have engineer scrap. On a present steel vehicle, it has thirty extraordinary evaluations of steel. Each and every part, or it appears each and every part, has been enhanced for a specific evaluation of steel. The car body structure configuration has been developing throughout the previous 100 years and all of these truly elevated quality steel structure manuals and steel preparing plan rules are great, extremely difficult for composite materials to rival.

V.CONCLUSION

The overall development of composites take-up in parts, for example, aviation, and the potential for huge development in propelling markets, for example, in the car and energy parts, is on-going. The development of the CFRP showcase, for instance, is driving enormous interests in cutting edge mechanical offices. Regardless of the promising highlights of CFRP based items, the entrance of preparing advances in certain ventures, with extraordinary spotlight on SMEs, is frustrated by huge difficulties. In volume-concentrated ventures, for example, the car, poor economies scale and learning increment costs, keeping most applications in specialty or premium markets. Combined with an absence of mindfulness about composite applications, appropriate structure norms, and a suffering metals-based plan culture, CFRP advances are restricted for far reaching use across parts. Dissipated information about composites preparing innovations influence the exhibition of supply chains, since the lead time for innovation reception, to be specific the securing of hardware and establishments, might be not exactly the time expected to acclimatize specialized information. Novel plans of action for composite items and administrations should be advanced, arranged essentially to SMEs, established by upgraded joint effort and data trade among the on-screen characters in broadened esteem chain, and empowered by a computerized and smart foundation that supports cross-sectoral commitment and information move. Advancement of information, innovations, and apparatuses to share what's more, dissect applicable information and requests from clients will completely empower collective building in the generation organize, enabling all entertainers to propose inventive arrangements and improve their comprehension of end clients' necessities by composite makers. Responsiveness and readiness of supply systems will be additionally improved, organized by an advanced stage that empowers interoperable data streams over the whole life cycle of the CFRP applications industry in Europe. As indicated by this, item improvement particularly for SMEs will be quickened and add to the maintainability of the European CFRP store network through nearby sourcing and reutilization of CFRP items at their finish of-life, along these lines decreasing the general natural impression and simultaneously supporting financial action and occupation creation. At long last, it appears to be significant to expand the collaboration between inquire about establishments, the scholarly world, and the business to help end-clients in growing new creative arrangements and focused items, actualize savvy high-volume creation forms, and diminish the time-to-market and life-cycle costs.

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