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ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 5, May 2017

CCC (Carbon-Carbon Composites) Recent Development, Application and Fabrication Methods

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Abstract: CCC (Carbon-Carbon Composites) or C-C (Carbon Carbon) or CFRC (Carbon Fiber Reinforced Carbon) is an extraordinary composite material consisting of carbon filaments embedded in a carbonaceous structure. The carbon-carbon composite's low weight, high thermal conductivity and genius mechanical properties at hoisted temperatures, originally produced for aviation applications, make it a perfect tool for flying machine braking, rocket spouts and re-entry nose tips apart from a few industrial, aeronautical and biomedical uses. The breakthrough in carbon products is adaptable and provides adaptability in design. Without major deformation, it can tolerate temperatures above 1900 °C. This paper analyses significant advances in the manufacturing process advancement of Carbon-Carbon composites and depicts them. This paper also talks about the carbon-carbon discovery and their use. Improving properties by various procedures and reducing the cost of manufacturing make this category of materials more appealing to design applications, production application, especially high temperature applications.

Keywords: Application of CCC, CCC, Development of CCC, Fabrication properties.

INTRODUCTION

Composite structures are composed of a mixture of two or more components with distinct mechanical, chemical, or body properties. As with all other plastic objects, CCC combines major factors such as carbon fibers and the carbon matrix. The CCC houses are significantly advanced and especially suitable for many applications[1]. Due to their low weight, high stiffness, resilience, superior thermal coefficients and excessive speed friction resistances, CCC is preferred over different substances as they maintain stability and work structurally at maximum temperature. CCC materials have been developed for full aerospace and defense systems in the US in the last three decades. CCC blends superb mechanical property with weight ratios and magnificent refractory properties making them the chosen substances for extreme and daunting environmental programs like atmospheric re-entry, solid rocket motor exhaust and disk braking in high-performance military, commercial aircraft, speed trains and race cars[2], [3].

CCC COMPONENTS

CCC is notable for its incredible properties. Such properties depend on a specified collection of pieces, and how they are organized and facilitated. Two notable elements of a CCC structure are section matrix and segment fiber. For example, fibers can be in the type of single strands, abundant strands or plated in different structures. Controlling capability in determining the characteristics of the experienced composite case is the bearing and layering of the chosen material. Within the composite form, the matrix architecture plays a notable role. The network structure is responsible for keeping the strands in their appropriate region and also sharing the mess, worrying between the strands. It also serves as a barrier from the antagonistic position and from the physically scraped spot secures the filaments. The matrix also offers a remarkable upgrade in numerous mechanical properties, making the composite structure extremely solid in contrast to a traditional solitary material[4], [5].

ISSN (Online) 2394-2320

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CCC powers most composite materials to preserve mechanical properties, such as longevity and high quality above 2900 °C at high temperatures. The three allotropic forms of carbon used in CCC are diamond, graphite, and completeness. Every type of these carbon frames has its own critical use in the production and modern fields. Graphite with an evaluated thickness of 2.1 g/m3 can be accessible in substantial amounts and in various shapes. Carbon materials have a high specific quality of about 49 GPa and maintain this high quality at elevated temperatures above 1400 °C[6].

Because of its weak coefficient of warm extension in the fiber heading (0.2 - 0.4 mm) and (0.4 - 0.7 mm) in the opposite direction and wear levels (0.04 - 0.09 mm) and (0.09 - 0.2 mm) in the fiber heading independently, CCC will maintain warm without defecting[7], [8].

METHODOLOGY

1. Traditional process of Fabrication:

The CCC produced houses are regulated in Fiber orientation and the portion of the fiber in the required course. Fiber structure describes the evolution of preforms in simple plates, circles, rods, contours, innovative surfaces and complex geometries and forms. There are two ways to fill the interstices between the fibers:

- Fuel phase path using the deposition of gas vapors.
- Liquid path using resin or pitch thermosetting.

Fiber orientation and fiber fraction in the necessary route controls the fabricated CCC houses. Fiber type describes the development of preforms in basic blocks, cylinders, cones, contours, transformation surfaces and complicated geometries and shapes.

I. CVD (Chemical Vapour Deposition):

Risky carbohydrates such as carbon, propane, benzene and other low molecular weight products are used as precursors in CVD. A warm decay of the hydrocarbons occurs at the heated carbon fiber floor and carbon deposition takes up space. This pyrolytic approach of depositing carbon onto dry fiber is known as infiltration / deposition of chemical vapor.

II. Impregnation Process:

Here impregnation is finished with impregnated fluids such as coal tar or oil pitches and thermosetting gums producing high burn. The manufacture of CCC can include various impregnations for apparent thickness, trailed by hot isostatic squeezing at temperatures of 650 °C and 99 MPa. This is trailed at 900 °C by carbonization and at 2650 °C by graphitization. Carbon reactivity to oxygen above 400 °C is of genuine concern, so it is necessary to obtain a reasonable obstacle to oxidation. Strategies include CVD-using surface coatings, asphalt packaging and so on. Some of these are SiC coatings and sol-gel methods, inorganic salt impregnation, a fuse of oxidation inhibitors and so on.

2. Change in Conventional Fabrication Methods:

A few changes to the conventional fluid stage impregnation can be reported as discussed below:

- Before fluid impregnation, the filaments are pre-impregnated with tar or pitch and carbonized at 250-700 °C under 99 MPa weight. Impregnation of the fluid stage (LPI) in a vacuum requires more pitch and gum which will create the thickness and the strength of the laminar shear. Graphitization at 2100 - 2900 °C opens the shut pores, and higher thickness is followed by further impregnation.
- Hot isostatic weight impregnation carbonization (HIPIC) is yet another development that links a high weight of 99 MPa while at 550 – 900 °C carbonization and impregnation. It creates the carbon yield and holds a compact stage leading to more fragile sections. It is then graphitized without weight at temperatures above 1900 °C. It yields higher thickness of CCC.
- Hot pressing is another development where carbonization at 550 – 900 °C and 69 Mpa from a latent reducing or vacuum setting is followed at 2100-2900 °C without weight by graphitization.

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3. Advance Method of Fabrication:

I. PY (Performed Yarm) Method:

Fig. 1 shows the PY method flow chart, dissimilar to ordinary assembly techniques such as impregnation and CVD, a 2 to 3 mm wide, 150 to 900 mm long Preformed Yarn (PY) was set by Matsuzaki, Ryosuke et al. [9] in strategy for the PY. PY has carbon fiber centered on PAN as the backbone, coke powder and oil mesophase pitch (cover) as the antecedent grid and polypropylene globules as the polymer that covers the carbon fiber and intervening frame. A PY square was rendered at that stage by unidirectional changing PY sheets which were set up by heaping up chopped PYs. Hot pressing of the PY obstacle in a metal form was achieved at 500 °C (8 °C / min) which was then subjected to 700 °C carbonization and 1900 °C graphitization to achieve the last CCC.

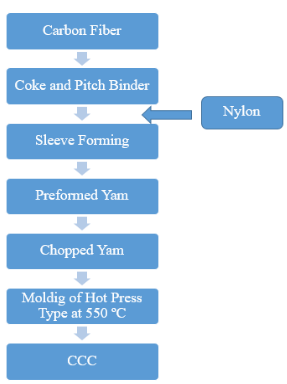

Figure 1: Flow Chart of CCC Production

- 3-point twisting tests showed better flexural consistency and modulus than that achieved by a factor of 1.3 by standard techniques.
- Small-scale simple investigations showed the impression of strong fiber / lattice carrying a minimum number of pores.

Sugano, Kaoru et al.[10] Improved the methodology and used carbon fiber (PAN-based) as support and pitch, coke and nylon-6 as lattice materials in the PY method for the manufacture of CCC for the use of aircraft brake cushions.

The PY distributed here was a box of fiber containing coke and supplying which was containing Nylon-6. Three kinds of experiments were produced with a fiber weight range of 29%, 39% and 49%. This was followed by 500 ºC hot squeezing and 1700 ºC moist handling. A process of pitch impregnation was conducted on the examples by hot isostatic pressing to dispense with porosity and achieve the necessary thickness.

As carbon fiber volume percent was extended, improved mechanical properties were obtained from the hardness test, pressure test, impact the test and crack strength test. The thickness of the steel obtained rose from 1.45 g/cc to 1.50 g/cc, while the carbon fiber extended from 25 to 35 percent, again reflecting a rise to 1.55 g/cc where carbon fiber was half. In the instances of hardness, compressive quality, flexural quality, affect the quality and flexural modulus, the comparative pattern was seen.

II. Nuclear Reactors of CCC:

Through impregnation technique, Venugopal. R et al. produced CCC in which presentations made using PAN carbon strands were stacked to 2D preform using phenol formaldehyde tar. Rectangular green performance at 900 ºC was sliced and carbonized to obtain a very permeable example that was then densified using two cycles of fluid formaldehyde pitch impregnation under strain in steps.

The following ends were drawn:

- CCC was collected with a thickness of 1300 kg/m3.
- XRD found that the alloy was essentially shapeless.
- Lower weight of impregnation reduces porosity.
- X-beam tomography demonstrated decrease in splits and improved frame pitch retention at higher weights.
- SiC covering by CVD technique improved situation oxidation obstruction, warm stun

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properties and heat ingestion solidity making it ideal for low-temperature reactors.

RECENT DEVELOPMENT

1. CNT and CNF as Reinforcements:

Because of their predominant mechanical properties, T.Shyong et al. selected carbon nanotubes (CNT) and carbon nano strands (CNF) as composite fortifications. Ultrasonification to combine CNT and phenolic tar was followed through a hot pressing vacuum pack to create phenolic tar composite. This was followed to turn into CCC by warm medicines (carbonization at 900 ºC in Ar climate, and then at 1300 ºC in He clima).

The 3-point bending test was used to determine the mechanical properties and cracking behavior. Contemplating the improvement in flexural efficiency, CNF has also proven to be favoured fortifications over CNT due to better interfacial holding with a superior result for modulus estimation. For CCC, enhanced CNT help (carbonized at 900 ºC and 1300 ºC) showed favored outcomes over CNF. Nevertheless, the temperature of the CCC handled at 2300 ºC showed great qualities for flexural consistency.

2. PAN CFF (Carbon Fiber Felt) and CFF as Reinforcements:

Kurumada. A et al. produced two composites CCA (47 wt percent carbon felt) and CCB (34 wt percent carbon felt) with an anticipated increase in the mechanical consistency, crack toughness and warm pressure protected properties. These were obtained by reinforcing and wrapping, carbon pitch felt and coal tar pitch PAN steel felt. Rigidity, break strength, Young's modulus, and warm stun blockage were tentatively decided by reasonable tests at 2300 ºC. By heaping up 12 layers of rayon carbon fiber materials and an isostatic ally shaped fine grain oil coke graphite IG-11 these properties were contrasted and as of now arranged plate composites CCC. As revealed, as compared with that of IG-11, CCB has 19 percent higher than CCA twice.

IMPORTANCE & APPLICATION

Many of the CCCs actually being produced are in the form of rocket and military plane additives. The overall essential items for a navy plane include reentry heads, rocket nozzles, and escape cones for strategic rockets, and brake disks. Recently a commercial aerospace technology has evolved to be popular in which brake disks were shielded for the shipping aircraft. The use of CCC brake disks on commercial transport aircraft will turn out to be a significant business and is expected to grow in the coming years.

Specific advanced army packages consist of hot segment components for restrained-lifestyle missile engines, exhaust elements for brand new fighter aircraft, fuselage for hypersonic vehicles and wing additives, and satellite area protection systems. The use of CCC as braking materials such as lightweight applications, inertness with other materials and high mechanical performance are many advantages. Similar to other components such as a metal or synthetic brakes, CCC has a potential to absorb a lot of energy in a short timeframe. CCC choosing planes, trains and racing cars are a metal option since CCC eliminates friction by using components that work at a lower weight. In fact, the low density of CCC combined with a lower cost propensity makes it ideal for transport or machinery applications.

CONCLUSION

A comprehensive review on CCC is given in this paper dealing with manufacturing techniques, developments in manufacturing techniques, properties, and applications. CCC is an exceptional organization with composite materials that continues to use its houses against other materials at high temperatures, light weights, inertness and extreme durability. Such characteristics make CCC suitable for the most cutting-edge mechanical engineering programs. The threats that hinder CCC's production and growth are processing techniques that are used and oxidation is rapid in surroundings at temperatures above 300 ºC.

CCC used as brakes, temperature exchangers and furnace elements within the business sectors are restricted as rocket materials, jet engine parts and brakes by means of price unlike in military fields. Over the coming years CCC will remain the very best overall output compounds.

In any industry of any kind, particularly in windmills, compressed herbal gasoline storage, transportation and gasoline cells, the future of CCC is very evident. CCC has a bright future in electric gasoline cars, too. In a very excessive call for creation and infrastructure, it extends to apply. For use in the age of earthquake protection and precast concrete with a moderate weight. In the oil industry, CCC has a first-rate destiny, especially in kill strains, drill pipes, and deep sea drilling platforms.

High costs of manufacturing processes have limited the ample use of CCC and, thus, there is always a greater opportunity for researchers to develop new manufacturing techniques that will effectively reduce manufacturing costs without losing the extra genius properties of this composite form.

REFERENCES

[1] K. M. Liew, M. F. Kai, and L. W. Zhang, “Carbon nanotube reinforced cementitious composites: An overview,” *Composites Part A: Applied Science and Manufacturing*, vol. 91. pp. 301–323, 2016.

[2] L. C. Tang *et al.*, “The effect of graphene dispersion on the mechanical properties of graphene/epoxy composites,” *Carbon N. Y.*, 2013.

[3] M. Zhi, C. Xiang, J. Li, M. Li, and N. Wu, “Nanostructured carbon-metal oxide composite electrodes for supercapacitors: A review,” *Nanoscale*, 2013.

[4] *Composite Materials Handbook Volume 5: Ceramic Matrix Composites*. 2017.

[5] J. W. Zondlo, “Graphite: Structure, properties, and applications,” in *Graphite, Graphene, and Their Polymer Nanocomposites*, 2012, pp. 1–58.

[6] T. Chen and L. Dai, “Carbon nanomaterials for high-performance supercapacitors,” *Materials Today*. 2013.

[7] K. Acatay, “Carbon fibers,” in *Fiber Technology for Fiber-Reinforced Composites*, 2017.

[8] H. Peterlik, “Carbon Fibers,” in *Ceramic Matrix Composites: Materials, Modeling and Technology*, vol. 9781118231166, 2014, pp. 27–39.

[9] R. Matsuzaki *et al.*, “Three-dimensional printing of continuous-fiber composites by in-nozzle impregnation,” *Sci. Rep.*, 2016.

[10] K. Sugano, M. Kurata, and H. Kawada, “Evaluation of mechanical properties of untwisted carbon nanotube yarn for application to composite materials,” *Carbon N. Y.*, 2014.

[11] P Durga, S Jeevitha, A Poomalai, M Sowmiya, S Balamurugan, “Aspect Oriented Strategy to model the Examination Management Systems”, International Journal of Innovative Research in Science, Engineering and Technology , Vol. 4, Issue 2, February 2015

[12] RS Venkatesh, PK Reejeesh, S Balamurugan, S Charanyaa, “Further More Investigations on Evolution of Approaches and Methodologies for Securing Computational Grids”, International Journal of Innovative Research in Science, Engineering and Technology , Vol. 4, Issue 1, January 2015

[13] V M Prabhakaran, S Balamurugan, S Charanyaa, “Developing Use Cases and State Transition Models for Effective Protection of Electronic Health Records (EHRs) in Cloud”, International Journal of Innovative Research in Computer and Communication Engineering, 2015

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 5, May 2017

[14] Uttam Singh Bist, Manish Kumar, Anupam Baliyan, Vishal Jain, "Decision based Cognitive Learning using Strategic Game Theory", Indian Journal of Science and Technology, Volume 9, Issue 39, October 2016, page no. 1-7 having ISSN No. 0974-6846 .

[15] Vishal Jain, Gagandeep Singh, Dr. Mayank Singh, "Implementation of Data Mining in Online Shopping System using TANAGRA Tool", International Journal for Computer Science Engineering (IJCSE), USA, January 2013 page no. 47-58 having ISSN No. 2278-9979.

