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Department of Mechanical Engineering, PSG College of Technology – Coimbatore, Tamilnadu, India.

CHARGES STORED ON THE SURFACE OF THE AIRPLANE USING BUCKYPAPER

Sureshmohan.M*[1,a], Sathishkumar.S[2,b], Giridharan.D[3,c] , Senthil Kumar. M[4,d]

[1, 2, 3] B.E Students, [4]Asst.Professor (SRG)

Department of Aeronautical Engineering

Kumaraguru College of Technology, Coimbatore-49, Tamilnadu, India.

ABSTRACT

Buckypaper is the new composite material for energy efficient transport. It is not an ordinary paper, but thin layers of composite material strengthened with carbon nanofibers to be stronger than steel, and as light as silk. It has amazing flexibility and strength and weight. Since from their discovery, decades ago as buckyball and nanotubes these peculiar molecules have been integrated with composite compounds. Bonding thousands of these ultrathin sheets together has created the ultimate lightweight super strong material for aircraft skins and automobile panels. It also conducts electricity and disperses surface heat. It is 10 times stronger than the iron and it is half the weight of the current composites. Lightning strike is one of the major problems in today's aircraft. By using buckypaper, lightning strike can be overcome by distributing the charges equally over the airplane. In addition, the surface of buckypaper stores charges like a battery. So there will be no need of batteries in aircraft. So that the weight of the aircraft is reduced. Platinum used in the fuel cell is 1/4th the platinum used in buckypaper fuel cell. The nanotubes have atomic bonds which is enough to make them twice as hard as diamond. But the biggest benefit of all, is the cost saving for the traveller. In future, commercial aircrafts can be made of buckypaper and it would be perfectly safe.

Keywords: *Buckminsterfullerene, Fire protection, Lightning strike, Single-wall nanotubes, Weight reduction.*

INTRODUCTION

Buckypaper is a macroscopic aggregate of carbon nanotubes, or "buckytubes". It owes its name to the buckminsterfullerene, which is 60 carbon fullerene. The molecule was named after Richard Buckminster ("Bucky") Fuller, who among a myriad of inventions. Nanotubes have very broad range of electronic, thermal and structural properties [1]. It can be thought of as being a sheet of graphite, which is rolled into a cylinder and closed at either end with caps containing pentagonal rings (Fig.1). There are two different classes of nanotubes, they are small diameter, single wall-nanotubes (SWNTs, ~1nm) and large diameter, multi–wall nanotubes (MWNTs, ~10nm). SWNTs are the fundamental cylindrical structure, and can be used as building blocks for both multi-wall nanotubes. In multi-wall nanotubes, there are several concentric tubes of carbon, which are nested inside each other. Carbon nanotubes naturally tend to entangle themselves into disordered ropes and

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bundles which are held together by vanderwaals forces (Fig.2). By using Raman spectroscopy, they were characterized. By using phase shift microscope and an atomic force microscope the physical characteristics of MWNTs and SWNTs were obtained [2].

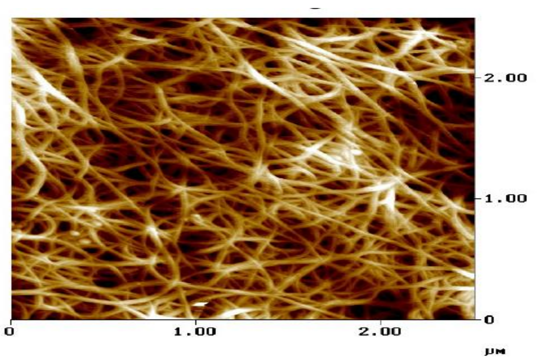

Fig.1 AFM image of buckypaper

Fig.2 Normal buckypaper

MANUFACTURING PROCESS

Both single walled carbon nanotube and multi-walled nanotube based buckypaper-gold composites can be prepared by adding 0.035 g of each type of CNTs to 0.01 M $HAuCl_4$ $3H_2O$ solution in N-Methyl-2-pyrrolidone. The suspensions were sonicated in a sonic bath for 3 hours to ensure that the CNTs were evenly dispersed through the gold-NMP solution [3].

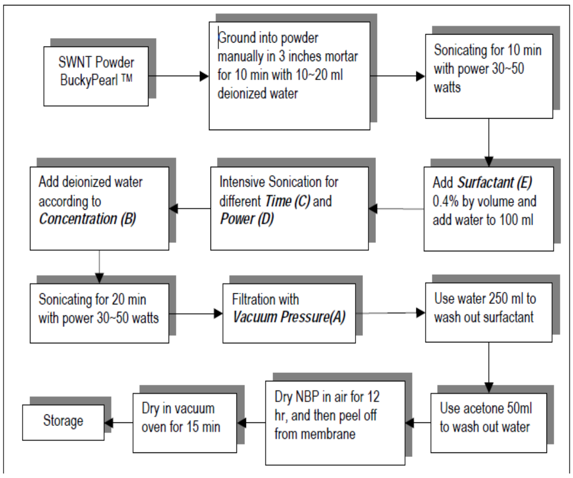

Fig.3 Overall processing method

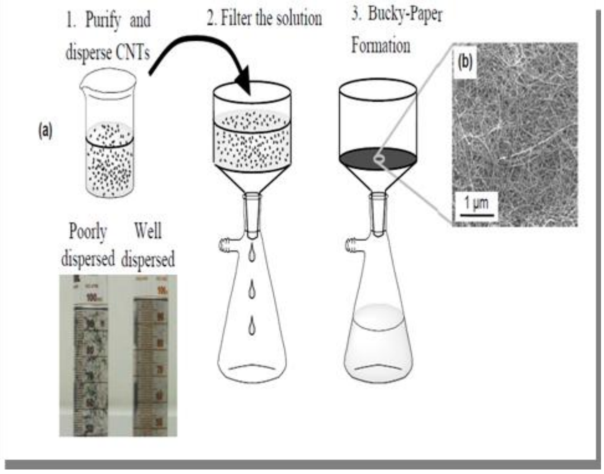

Fig.4 Synthesis of Carbon

To achieve a flat homogeneous sheet of buckypaper the nanotubes were vacuum filtrated through a porous alumina membrane and washed with deionised water and ethanol (Fig.4). The free standing buckypapers were peeled from the membrane and left to dry at 40^{o}C. When the films were dried they were cut into strips of width ~3 mm and lengths of up to 3.5 cm. Film thickness was between 100 µm and 120 µm [4].

STRUCTURE OF BUCKYPAPER

The fourth form of pure carbon (after graphite, diamond and amorphous carbon) was discovered (Fig.5) known as a buckyball. It is a large hollow, cage-like molecule with a distinct arrangement of 60 carbon atoms (C_{60}) that form a spherical shape – a truncated icosahedron, similar to the hexagonal and pentagonal quilt patchwork pattern of the soccer ball, only with carbon atoms at its vertices and bonds along the seams. A hollow, cylindrical fullerene that resembled needles of carbon under the high resolution electron microscope [5].

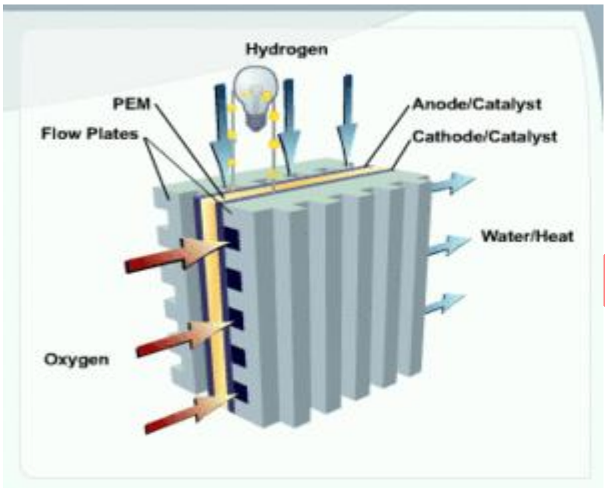

Fig.5 Buckypaper in hydrogen fuel cell

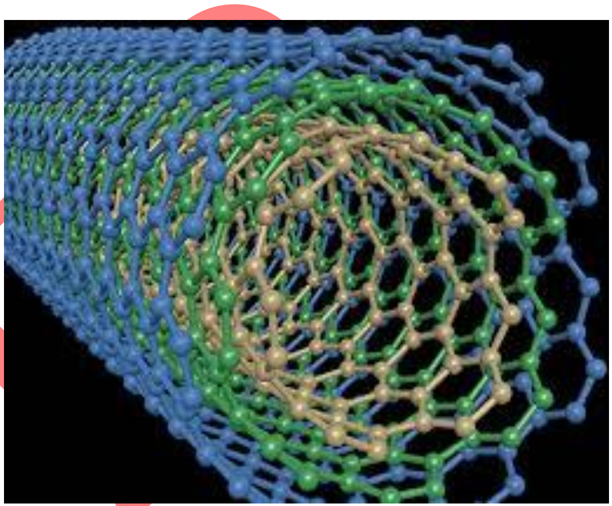

Fig.6 More stronger than steel

It is composed of six-membered, aromatic carbon rings, and each carbon atom in the structure contains a double bond and two single bonds. Thus, each carbon atom displays a hybridization orbital. These covalent bonds account for tensile strength of CNTs, because the bond energy of a C-C double bond (146 kJ/mol) is much greater than that of a C-C single bond (83 kJ/mol). CNTs also have a significantly higher young's modulus than most materials [6]. Various conformations of nanotubes exist – SWNTs, MWNTs; which have concentric shells, doughnut-shaped torus (or nanotorus), and fullerite. Due to unusual properties of fullerenes, their manufacturing and purification are still too complex and expensive for mass production (Fig.6).

APPLICATIONS IN AIRCRAFT

1. Resist lightning strike and less pollution

Buckypaper can be used to reduce the effect of lightning strike in the aircraft (Fig.7). Copper and aluminium are used only because of its low weight and charge distribution capacity. But there is a chance of developing hole due to lightning. Aligned buckypaper will distribute all the charge [7].It will also reduce the pollution (Fig.8).

Fig.7 Lightening strike in normal aircraft

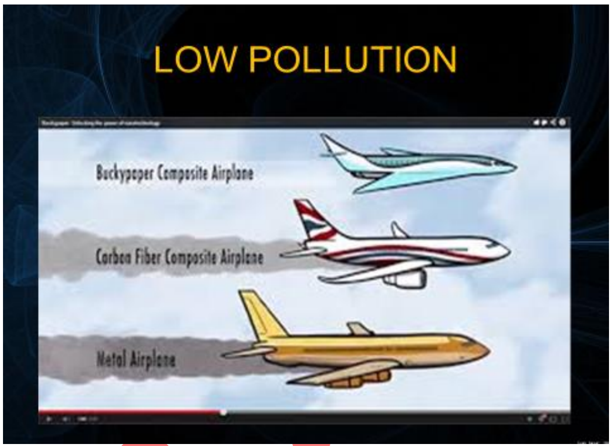

Fig.8 Eco friendly buckyplanes

2. Weight reduction and electrical properties

Buckypaper weighs only 15 percent as much as copper and only thin strips are required [8]. Nanotubes exhibit unrivalled strength, flexibility, unique electrical properties, making the most conductive fibre known, can function as semiconductors, and are the most efficient thermal conductors. It uses for electromagnetic interference shielding and lightning-strike protection on aircraft [9].

3. Fire protection

Covering material with a thin layer of buckypaper significantly improves its fire resistance due to the efficient reflection of heat by the dense, compact layer of carbon nanotubes or carbon fibres [10]. If exposed to an electric charge, buckypaper can also be used to illuminate computer and television screens (Fig.9). It could be more energy-efficient, lighter, and could allow for a more uniform level of brightness than current cathode ray tube (CRT) and liquid-crystal display (LCD) technology.

PROPERTIES

Buckypaper is one tenth the weight yet potentially 500 times stronger than steel when its sheets are stacked to form a composite (Fig.10). It could disperse heat like brass or steel and it could conduct electricity like copper or silicon sheets of buckypaper stacked and pressed together form a composite. It has very high thermal conductivity [11]. Conductors are essential to today's modern computer. Buckypaper can be cut with scissors, like notebook paper. The increased glow may increase global warming. Making it, is a very time consuming it take a few days to make a single role of a few meters buckypaper [12].

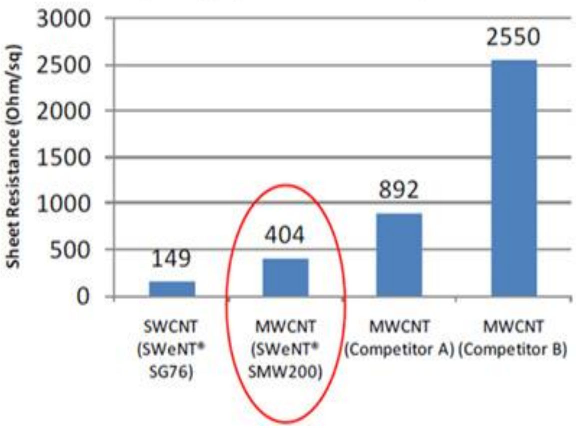

Fig.9 Electrical resistivity of CNT materials

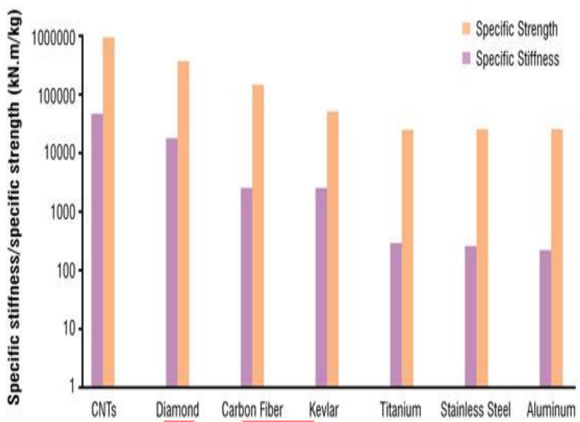

Fig.10 Strength and stiffness of materials

CONCLUSION

In this paper, a new fabrication technique to produce SWNT-reinforced epoxy resin matrix nano composites has been reviewed. SWNTs were first fabricated into buckypapers to create continuous SWNT rope network as reinforcement skeleton in the final nano composites. Buckypapers have good strength and flexibility to allow for handling like traditional glass fibre mat. The image of buckypapers showed that the tube network was composed of continuous SWNT ropes, which were the result of tube self-assembly by vanderwaals force during buckypaper filtration. The rope size and porous structure of the buckypapers were uniform, indicating very good tubes dispersion in the suspension. The ropes had an average diameter about 30–60 nm. The buckypaper nanoscale structures had pores with an average opening around 100–200 nm, which are much smaller than those in traditional glass fibre and carbon fibre fabrics or mats. In future, structural analysis, prototype and testing of buckypaper are planned to implement this concept for the production of aircrafts.

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