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# Use of Buckypaper in Future Aircrafts

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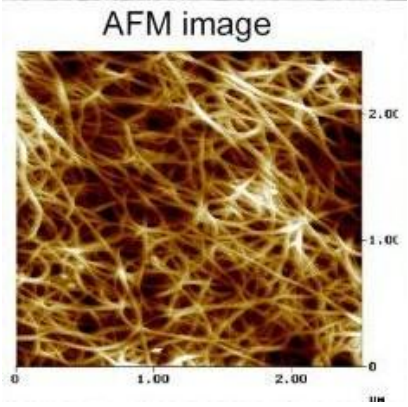
**Abstract:**
Buckypaper is an arrangement of carbon nanotubes. A carbon nanotube is 2 hundred instances stronger than steel at 1/6 the weight. Bonding thousands of these ultrathin sheets collectively creates the closing lightweight extraordinary sturdy material for aircraft skins and vehicle panels. These carbon nanotubes also called as Buckytubes; if organized to particular Pattern, EMI shielding is one of the specific property obtained. If Buckytubes are organized in alignment then it increases its power. It is far round 10 times more potent than iron. Particular arrangement of Buckytubes also beautify its Electro conductivity assets. Buckypaper is super bendy and it's also capable sufficient to come to be twice tough as diamond by way of its atomic bonds. They can also be arranged in a style which could enhance more than one properties at a time like Heat dissipation and energy together, EMI Shielding and Fire Retardancy together which proves to be very useful and vital in aircrafts. Lightning strike is one of the important problems in these days's aircraft. By way of using Buckypaper, lightning strike can be triumph over via distributing the charges in similarity over the plane. Similarly, Storage of charges is also possible using Buckypaper. So there could be no need of batteries in plane, In order that the load of the aircraft is decreased. Most useful gain of Buckypaper is its safety and might bring about price saving most powerful aircraft Material in Future.

**Keywords:** Carbon Nanotubes; Strength; Light weight; EMI Sheilding; Structural integrity

## I. INTRODUCTION

Buckypaper is a macroscopic aggregate of carbon nanotubes, or "Buckytubes". It owes its call to the buckminsterfullerene, that is 60 carbon fullerene. The molecule become named after Richard Buckminster ("Bucky") fuller, who amongst a great number of inventions. Nanotubes have very extensive range of electronic, thermal and structural homes [1]. It is able to be thought of as being a sheet of graphite, that's rolled right into a cylinder and closed at either end with caps containing pentagonal earrings (fig.1). There are unique classes of nanotubes, they may be small diameter, single wall nanotubes (SWNTs, ~1nm) and huge diameter, multi–wall nanotubes (MWNTs, ~10nm). SWNTs are the essential cylindrical shape, and can be used as constructing blocks for both multi-wall nanotubes. In multi-wall nanotubes, there are numerous concentric tubes of carbon, which might be nested inside eachother. Carbon nanotubes obviously have a tendency to entangle themselves into disordered ropes and bundles which might be held together by using Vanderwaals forces (fig.2). By means of the usage of Raman spectroscopy, they have been characterized. with the aid of the usage of section shift microscope and an atomic force microscope the physical characteristics of MWNTs and SWNTs are obtained [2].

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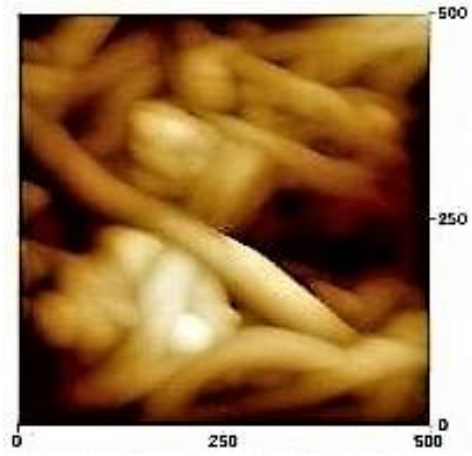



**(b)**

**Figure.1. AFM image of Buckypaper**

**Figure.2. Buckypaper Sheet**

## II.MANUFACTURING PROCESS

Each Single walled carbon nanotube and multi-walled nanotube based totally buckypaper-gold composites can be

organized through adding 0.035 g of every form of cnts to 0.01M HAucl4 3H2O Solution in N-Methyl-2-pyrrolidone. The suspensions then sonicated in a sonic bath for three hours to ensure that the CNTs were evenly dispersed thru the gold-NMP solution [3].

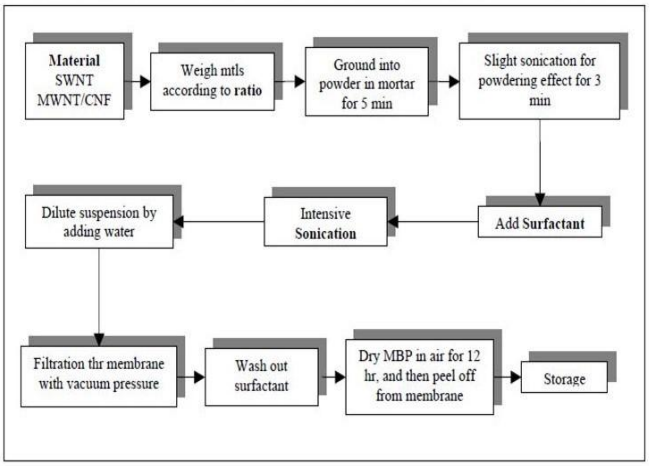



**Figure.3. Manufacturing Mixed Buckypaper**

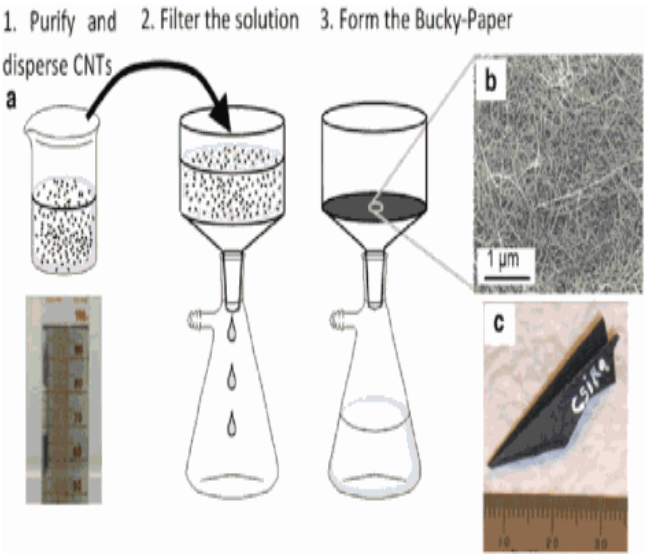
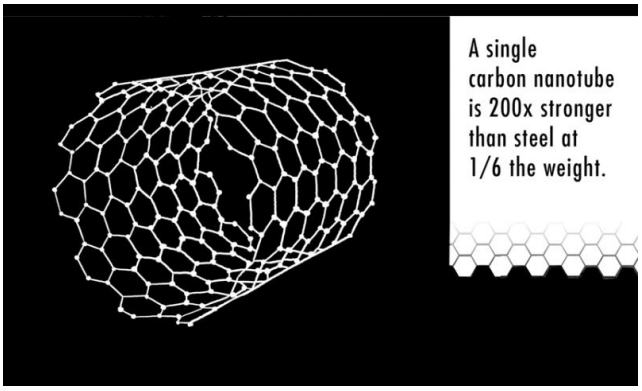



**Figure.4. Synthesis Process of CNTs**

To gain a flat homogeneous sheet of Buckypaper the nanotubes had been 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 400C. After Drying of films, they were cut into strips of width ~3 mm and lengths of up to 3.5 cm. Film thickness obtained was in range of 100 µm and 120 µm [4].

## III. PROPERTIES OF BUCKYPAPER

Buckypaper is one 10th the burden but doubtlessly 500 instances stronger than steel whilst its sheets are stacked to shape a composite (fig.5). it is able to disperse warmness like brass or metal and it may conduct energy like copper or silicon sheets of buckypaper stacked and pressed collectively form a composite. it has very excessive thermal conductivity [5]. conductors are essential to today's modern pc. Buckypaper can be cut with scissors, like pocket book paper. the increased glow can also boom worldwide warming. making it, is a completely time consuming it take a few days to make a single role of some meters buckypaper [6].

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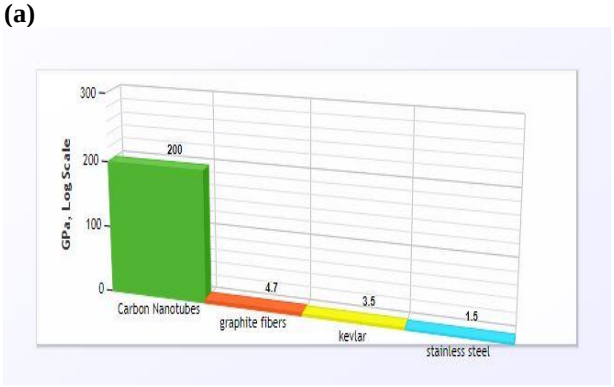



**(b)**

**Figure. 5. Comparison to steel (a) Strength Comparison (b)**

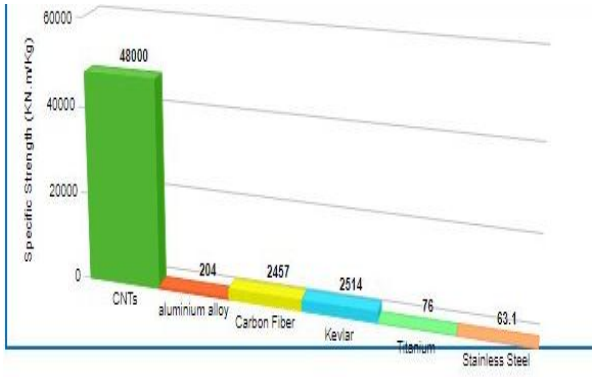
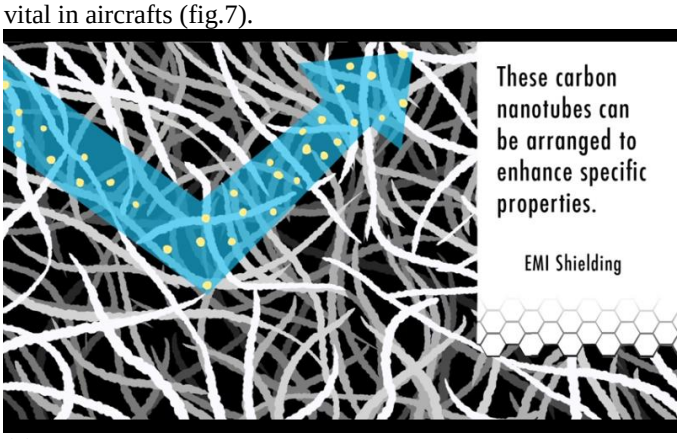



**Figure. 6. Comparison of Specific Strength**

If Buckytubes are organized to a particular Pattern, EMI shielding is one of the specific properties obtained. If Buckytubes are organized in alignment then it increases its Strength. Particular arrangement of Buckytubes also beautifies its Electro conductivity assets. They can also be arranged in a style which could enhance more than one property at a time like Heat dissipation and Energy together, EMI Shielding and Fire Retardancy together which proves to be very useful and vital in aircrafts (fig.7).

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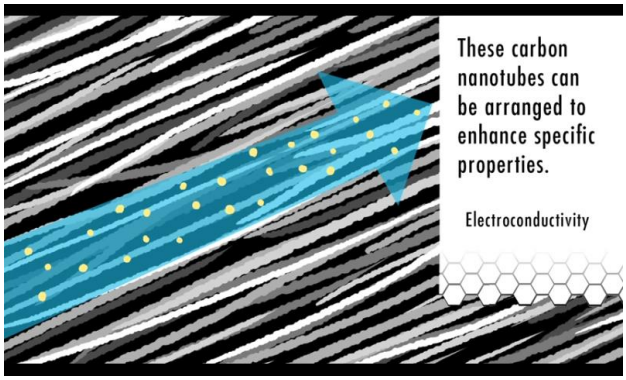


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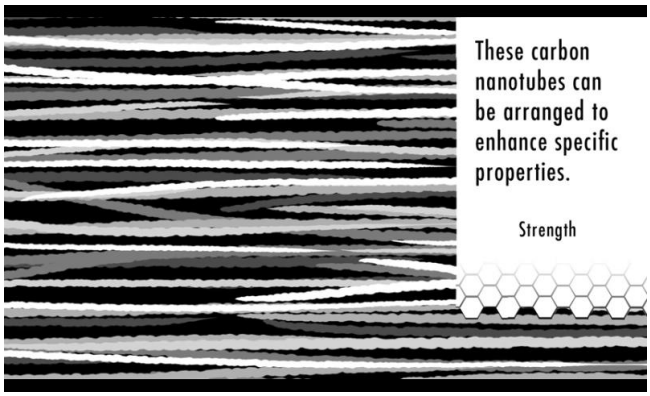


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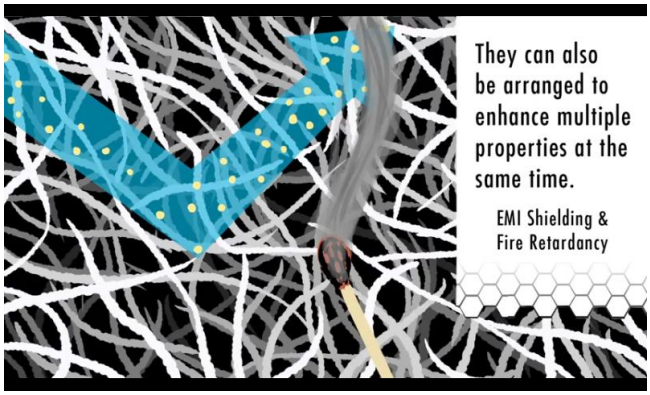


**(e)**

**Figure.7. Specific Properties of Buckypaper**

## IV. STRUCTURE OF BUCKYPAPER

The fourth Type of pure carbon (after graphite, diamond and amorphous carbon) turned into observed (fig.8) called a buckyball. It's far a big hole, cage-like molecule with a wonderful arrangement of 60 carbon atoms ($C_{60}$) that shape a spherical form – a truncated icosahedron, just like the hexagonal and pentagonal cover patchwork pattern of the football, with carbon atoms at its vertices and bonds alongside the seams. a hollow, cylindrical fullerene that resembled needles of carbon below the excessive resolution electron microscope [7].

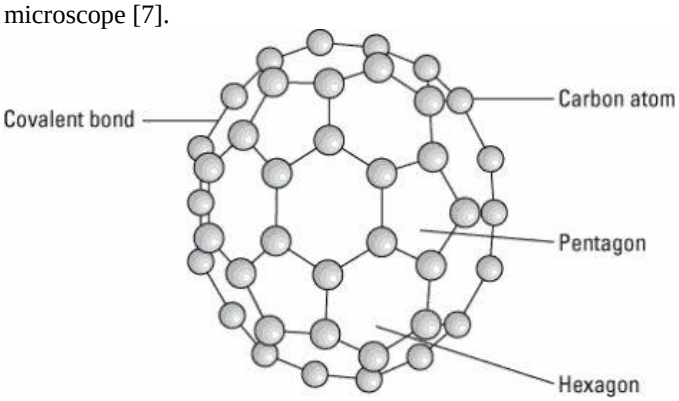


**Figure. 8. Buckyball Atomic Structure**

It's far composed of 6-membered, aromatic carbon rings, and every carbon atom inside the structure includes a double bond and single bonds. Consequently, each carbon atom shows a hybridization orbital. These covalent bonds account for tensile strength of CNTs, due to the fact the bond power of a C-C double bond (146 KJ/mol) is a lot greater than that of a C-C Single bond (83 KJ/mol). CNTs actually have a notably better younger's modulus than maximum materials [8]. Numerous conformations of nanotubes exist – SWNTs, MWNTs; which have concentric shells, doughnut-fashioned torus (or nanotorus), and fullerite. Due to uncommon homes of fullerenes, their manufacturing and purification are nevertheless too complicated and high priced for mass manufacturing (fig.9).

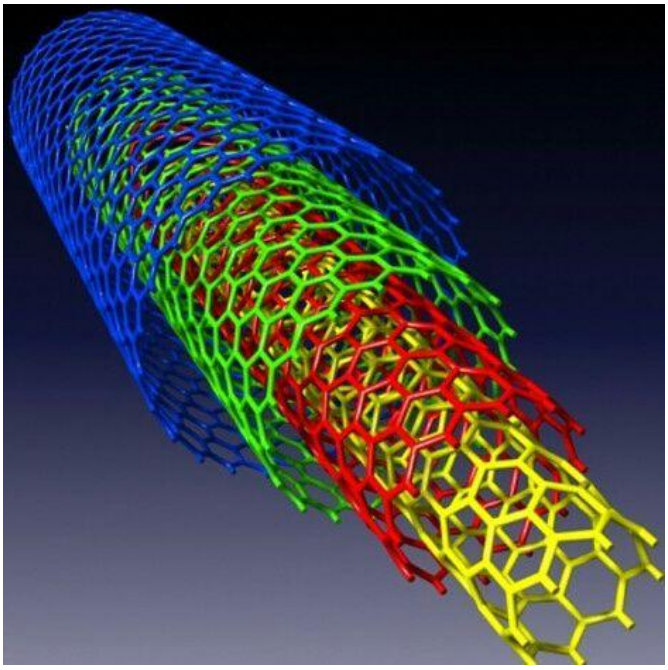

**Figure. 9. MWNTs more Strong than Steel**

## V. APPLICATIONS IN AIRCRAFT

**1. Resistance to lightning strike and much less Pollution-**

Buckypaper can be used to reduce the impact of lightning strike within the plane (fig.10). Copper and Aluminium are used only due to its low weight and rate distribution capability. But there may be a danger of Damage to aircraft because of lightning. Aligned Buckypaper will distribute all the charge [9]. It's going to also lessen the pollutants (fig.11).

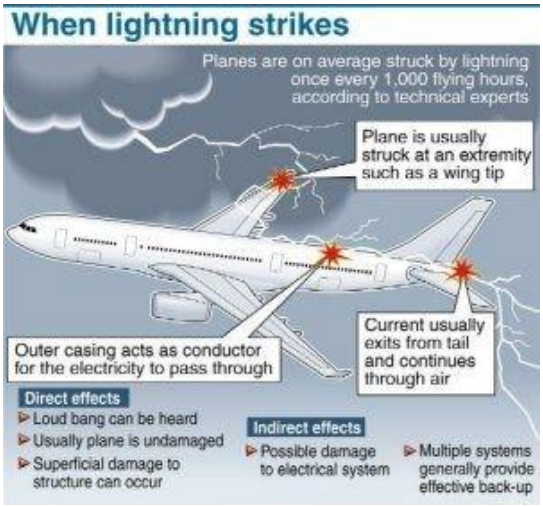


**Figure.10. Lightning Strike impact on Airplane**

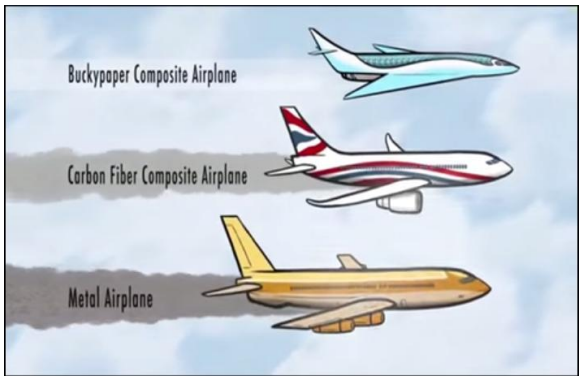


**Figure. 11. Pollution Rate Comparison**

**2. Weight reduction and Electrical benefits-**

Buckypaper weighs handiest 15 percent as much as copper and most effective thin strips are required [10]. Nanotubes showcase unrivalled strength, flexibility, particular electric Specifications, making the maximum conductive fibre known, can feature as semiconductors, and are the most effective thermal conductors. It uses for ElectroMagnetic Interference Shielding and lightning-strike protection on aircraft [11].

**3. Fire Retardancy-** Covering material with a thin layer of Buckypaper substantially improves its fireplace resistance because of the green reflection of warmth by way of the dense, compact layer of carbon nanotubes or carbon fibres [12]. If exposed to an electric powered charge having buckytubes in proper alignment then, buckypaper also can be used to illuminate PC and TV monitors. It could be more strength-effective, lighter, and could permit for a greater uniform degree of brightness than modern-day Cathode Ray Tube (CRT) and liquid-crystal display (LCD) Era. High electrical Resistance makes it secure from the lightning Strike (Fig.12). This results in Fire Retardant behavior which proves to be useful in this application.

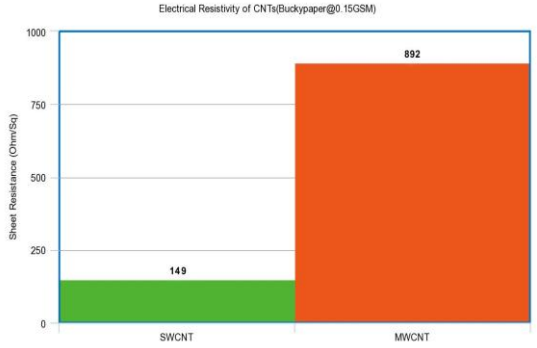


**Figure.12. Comparison of Electrical Resistivity of CNT materials**

**4. Effieciency booster-**

Buckypaper aircrafts are most efficient,even more than carbon nanofibre planes (fig.13). This is because of reduced overall weight of aircraft. Buckypaper composites improve structural integrity. Buckypaper allows wireless data transfer through composite material.

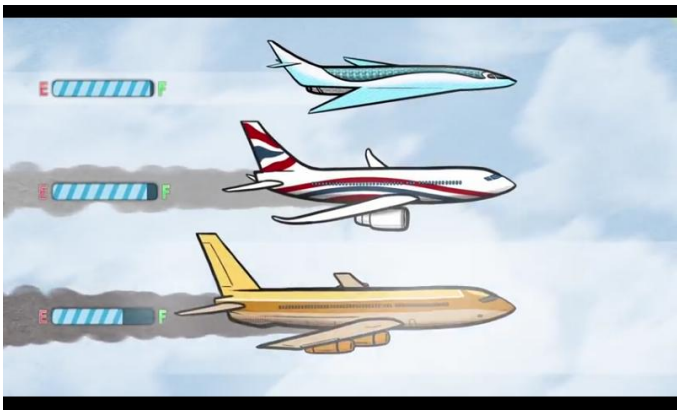


**Figure.13. Efficiency Comparison**

## VI. CONCLUSION

In this paper, Synthesis of CNTs and Manufacturing of buckypaper, Numerous specific properties of buckypaper which can be altered by specific alignment or pattern like EMI shielding, Strength, Electro conductivity, Heat Dissipation ,Heat Retardancy and their applications were reviewed. Buckypaper has large number of applications, where its usage in Aircrafts is one of them. Using Buckypaper in Aircrafts resulted in Resistance from lightning strike which ensures its safety even in bad weather conditions, Decrement in Pollution which leads to be a good contribution for Environment, Reduction in Weight of the Aircraft which increases its Performance as well as Efficiency, Electrical benefits making it secure and capability of storing charge which can be used further. Therefore, Buckypaper would emerge as price saving and most powerful aircraft Material in Future.

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