Carbon Nanotubes in Aircraft Paneling: An Important Nano-Technology Innovation

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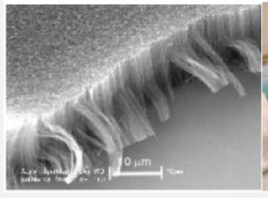
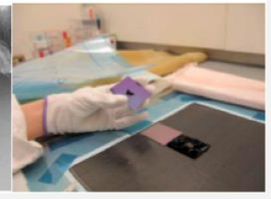
Background of Composite Materials

A composite is a material made of different materials with differing properties, and when these different materials are put together, they form a unique material with characteristics that are different from those of its singular components. Composite are usually referred to as materials in which a homogenous matrix component is reinforced with a stronger component that is generally fibrous. The fibers used in these modern composites are much stronger and more rigid than customary bulk materials, such as graphite or stone, and there are many factors that can lead to this incredible strength. Treatment of these fibers allows for the avoiding of internal or surface flaws that would weaken the material otherwise. These are some of the more common factors that allow for the high strength and stiffness of the fibers in composite materials, but it really depends on what kind of fiber it is, such as glass or carbon.

Enhancement of Composites with CNTs

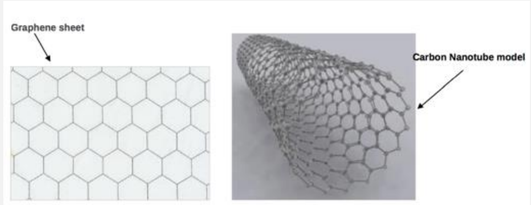
Implementation of CNTs into carbon fiber composites has shown to increase their strength and conductivity. An engineering team at MIT placed CNTs in between the layers of a carbon fiber composite laminate. The implemented CNTs act as stitches that hold they layers of the composite laminate together without damaging the carbon fibers. Aircraft-related in-plane strength tests on the composite laminate showed an increase in critical bearing strength of 30%, an increase in compression ultimate strength of 10%, and an increase in energy required for breaking of 40%.





Carbon Nanotubes

Carbon nanotubes are rolled up, one atom thick sheets of graphene. They are incredibly small and light, with radii in the .6 nanometer domain and lengths in the 1 to 2 micrometer domain. Despite their small size, they are still exceptionally strong due to the strong bonds between the in-plane carbon atoms. CNTs can also have high electrical and thermal conductivities depending on the bonding geometry around the tube circumference. In recent years, engineers and scientists have found use for CNTs in many different industries, but the application that has become most prevalent is structural reinforcement.



Commercial Sector

For airlines, fuel is almost always the greatest expense, accounting for about 36.7% of all operating costs. This great fuel cost comes from the fact that it takes an incredible amount of work to get planes that weigh upwards of 500,000 kilograms off the ground. By reducing the weight without compromising structural integrity or design, there is tremendous potential for savings. A rule-of-thumb is that a 1% weight reduction corresponds to around a 0.75% reduction in fuel consumption

Military Sector

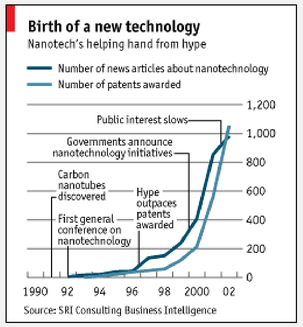
One area where CNTs may see the most use is in the testing and development of smaller unmanned aerial vehicles, or UAVs. "The combination of low cost per vehicle and low barriers to experimental development, have led to a plethora of technologies being designed, built, and tested on small UAV platforms" [17]. Because they have such low costs but also receive tremendous stresses and strains during fight, they are a perfect vehicle to test new experimental materials on.

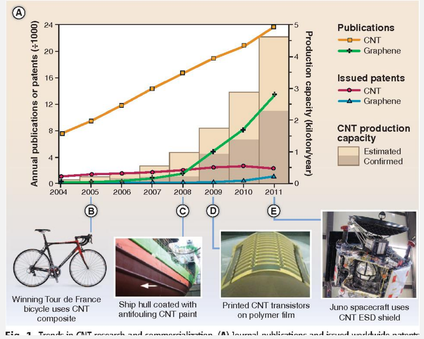
Future of Aircraft Materials

As air travel becomes increasingly popular, manufacturers, airlines, and airports must find ways to increase the number of flights and their fuel efficiency. This must be done using methods that minimize emissions as to continue to meet guidelines set by the Environmental Protection Agency (EPA) and the International Civil Aviation Organization (ICAO). One current innovation, carbon nanotubes, aims to not only meet but exceed the expectations for what is demanded of aircraft.

Trends

Because of the incredible properties displayed by CNTs, they have been dubbed the "wonder material" Because of CNTs current cost and the difficulty with working on such a small scale, few have dared spend time or money on research. To date, there have been very few largescale and industrially adopted projects involving carbon nanotubes in materials, but that may be changing In 2006, a bike made of CNT carbon fiber composites won the Tour de France, and, in 2013, a computer made from CNT based transistors was created.





Ethics

Costs

Another important issue to consider is the availability of flight. It's expensive to fly with the average round-trip ticket costing about $379, and any new technology should not make it prohibitively expensive for the majority if the population. CNTs are more expensive than current materials, they promise to bring down the cost of flights over time by dramatically lower the costs of operating aircraft.

Health

When discussing ethics and safety of CNTs it is necessary to mention workplace hazards. Most of the discussion surrounds the safety and environmental issues of the implementation of new technology, but the workers creating the new materials are also at risk. Because of their incredibly small size, CNTs can affect the body if inhaled or ingested.

Environment

Approximately 30% of greenhouse gases produced from the production of electricity is due to fossil fuels. Adding carbon nanotube reinforced paneling would virtually eliminate that contribution. Because they are so light they will dramatically reduce the weight of airplanes thus increasing the fuel efficiency