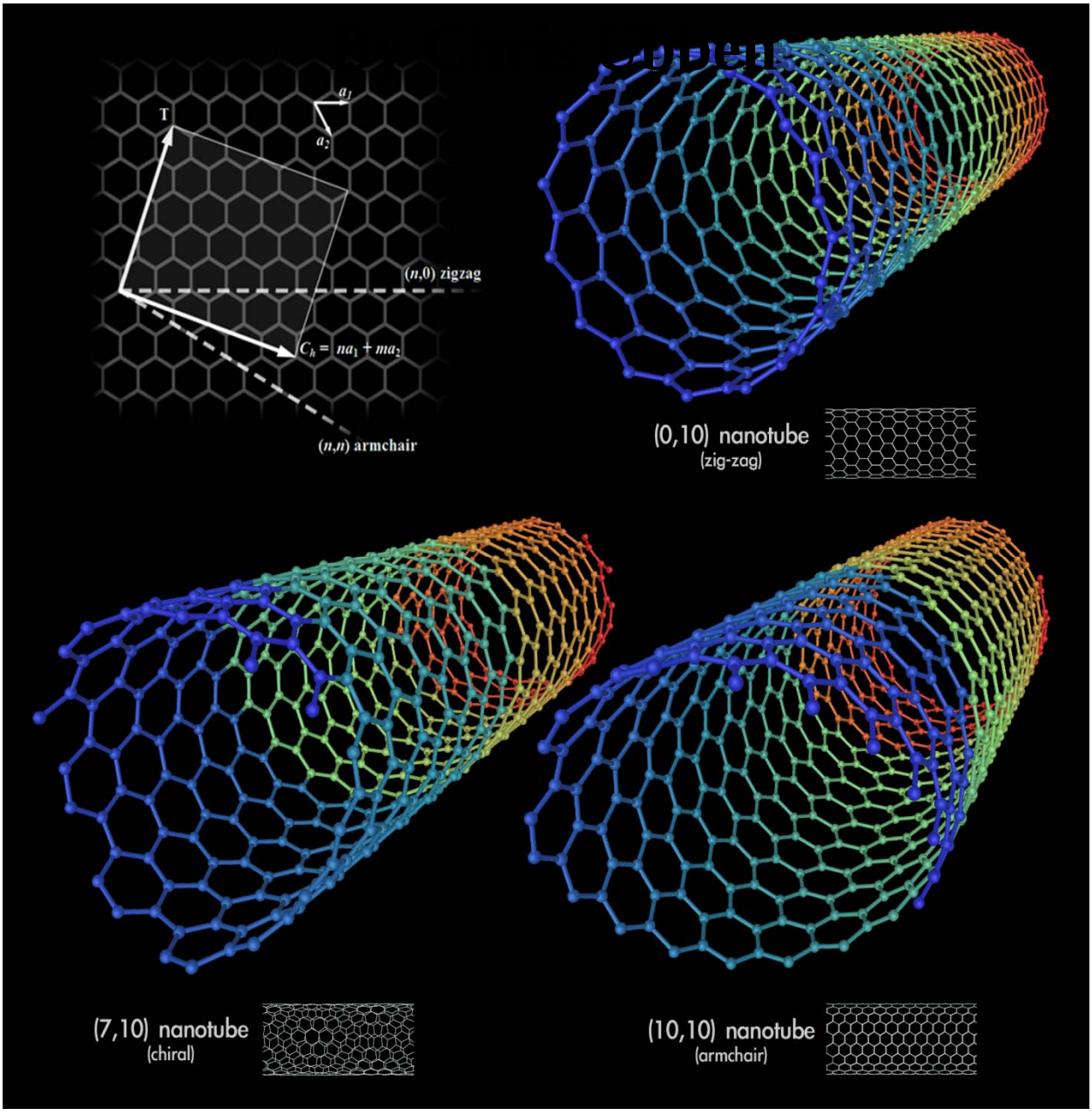
Current Progress Made in the Advancement of Carbon Nanotubes



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Current Progress Made in the Advancement of Carbon Nanotubes

1. Brown, Alan S. "positive reinforcement. " *Mechanical Engineering* 132.3 (2010): 36-39. Platinum Periodicals, ProQuest. Web. 17 Jan. 2011. <http://proquest.umi.com/pqdweb?index=0&did=1980866531&SrchMode=1&sid=7&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1294628687&clientId=23199>.

Summary

This article describes a few ways carbon nanotubes are used in technology today along with some future uses as well. The main theme of this article is based around a 54 foot long ship hull that is being finished just south of Seattle this year. This hull will be made with sheets of carbon fiber that cooked with an epoxy resin. This is all standard procedure, but what is out of the ordinary is that the epoxy consists of almost 0.5 percent carbon nanotubes. Although this does not seem like much, this will go on record as one of the largest nanotube reinforced structures ever. The 0.5 percent of nanotubes in this hull allows the fully completed 54 foot boat to weigh a meager 8500 pounds and carry up to 15000 pounds of extra cargo such as fuel and work equipment. Its closest competitor which does not use the nanotubes is only 34 feet long, weighs 17000 pounds and can only carry 5000 pounds of extra equipment. Carbon nanotubes have also proved to be more economical. The carbon fiber hull costs about $10-$12 per pound, but being reinforced by the nanotubes, they have the strength of an intermediate modulus fiber hull, which costs about $60 per pound. There are also plans in the future to use the nanotubes to stiffen the wings of UAV's which will make them 30 percent more efficient. Nanotube tests are also being conducted for the use in automobile panels because of their lightweight and flexibility. When a car with nanotube panels gets into a crash it will be damaged in the same way a car is now, except for now it will not splinter off and

possibly injure someone. It will be much like tempered glass.

Reflection

This article was interesting to me because it gave me a practical real world example of how carbon nanotubes are used in the today. Nanotubes are a technology that is still being researched and developed, which means most uses are only theorized and not actually achieved. What I found very interesting, was the level of enhancements that could be made to the boat hull, in comparison to the amount of nanotubes used. I was surprised that only 0.5 percent of the hull being nanotubes would be enough to allow the boat to weigh only 8500 pounds and still be able to support 3 times as much weight. The article describes how difficult it is to create an epoxy using the nanotubes because they get so tangled and clogged in the solution. This led me to consider what if we could create a solution that allowed them to all flow in the same direction? That would mean we could have infinitely strong and efficient materials. Would we be able to create a super composite that would surpass diamonds in strength?

Reliability

This article was published in March of 2010 and covers the current advances in Nanotube reinforcement in technology today. The article is covering technologies that are used today, and current research for future nanotube technologies. This means that an old article would have irrelevant information. Being only 10 months old this article is very reliable because the information it contains will be very relevant. This article was also published in Mechanical Engineering Magazine which is also closely connected to the American Society of Mechanical Engineering. Published since 1880, Mechanical Engineering is very widely known and reviewed by many. This also shows the article's reliability because it was published in a scholarly popular magazine and would not have been published if the information was inaccurate. The author of this article also plays a role in the reliability of the writing. Being the associate editor of Mechanical Engineering, the author, Alan S. Brown has written and edited numerous engineering articles that involve cutting edge technology or future advances. His background in this field makes him a very reliable author for an article on carbon nanotube technology.

2. Livermore, Carol. "carbon SUPER-SPRINGS. " *Mechanical Engineering* 132.3 (2010): 30-35. Platinum Periodicals, ProQuest. Web. 17 Jan. 2011. <http://proquest.umi.com/pqdweb?index=2&did=1980866521&SrchMode=1&sid=1&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1295296056&clientId=23199>.

Summary

This article is a description and analysis of the progress made for creating a "Super-spring" using current advancements in carbon nanotube technology. The author, Carol Livermore compares and contrasts the energy capabilities of both springs and electrochemical batteries. The article states that traditional springs can release their stored energy much more quickly and efficiently than batteries but batteries are much more commonly used for storing energy. This is because springs are powerful, but even a high performance steel spring can only store one one-hundredth of the energy capabilities of common electrochemical batteries. The article goes on to state that nanotechnology, specifically carbon nanotubes, may be the solution of both problems. The nanotubes have been tested to have a yield strain of 6 percent which means it is projected to store about 60 percent more energy than batteries while still retaining the qualities of a spring. This was a low level test, and engineers believe they can improve this storage capability to around 10,000 times the storage of batteries today. There is a catch to this incredible discovery, and that catch is that nanotubes are much too small for practical use as a storage device today. Amazing progress is being made in growing both larger and more pure nanotube structures. In the future they may be able to be grown to a practical size, but as of now using carbon nanotubes for storing energy is a dream to work forward to.

Reflection

I found this source particularly interesting because it applies to the world today. As the effects of fossil fuels are becoming clear, the world is struggling to advance the efficiency of new energy technologies. I thought this was interesting because it made me imagine a world that used springs for energy storage instead of batteries. I enjoy weird scenarios, and ideas that have not been thought of. These carbon nanotubes could possibly change the world in a way that hasn't been done in a very long time. What frustrates me about these nanotubes is how much potential they contain, but we have no way of harnessing their power. I hope to see in the future a way of growing these tubes more efficiently and in larger sizes. Scientists are only scratching the surface of the nanotube word and once we figure out their secrets we could be living in a Sifi-like world.

Reliability

This article was also published in March of 2010, meaning it is a very current article. The majority of the article is a description of the potential of carbon nanotubes and how testing is being conducted to allow us to use the nanotubes to our advantage later on. Since this is analyzing progress and stating what is to be seen in the future, the currency of the article plays a huge factor in its reliability. It has only been about 10 months since the publishing of this article giving a pretty good indication that this source is reliable. The organization that published this article is Mechanical Engineering. They are an official part of the American Society of Mechanical Engineering, making them a very credible organization. They have also been published since 1880, which means they are very well known and reviewed by many. The fact that they are popular and have been around for over a century indicates that they publish only accurate articles. The author, Dr. Carol Livermore is an associate professor at MIT in the department of mechanical engineering. Having a doctorate degree, and being an associate professor at one of the highest ranked universities for engineering and technology, Carol Livermore would be a very reliable source for this article.

3. Anonymous. "Three-Dimensional Shapes." The Science Teacher 77.9 (2010): 16-17. Platinum Periodicals, ProQuest. Web. 17 Jan. 2011. <http://proquest.umi.com/pqdweb?index=1&did=2224243411&SrchMode=1&sid=1&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1295320295&clientId=23199>.

Summary

This article describes the newest step in the advancement of transforming carbon nanotubes. The engineers at the University of Michigan have found a way to manipulate vertical carbon nanotube columns and transform them by twisting and bending them. The article describes the process called capillary forming, which bends or twists the nanotubes into various shapes. Nanotubes grow vertical and uniform, which is not ideal for a situation that calls for a non-vertical shape. This bending that the University of Michigan has made is created through boiling acetate. The nanotubes are placed on a wafer of silicon and held over a beaker of boiling acetate. The acetate boils up and condenses into the nanotubes, where it then evaporates out. While the acetate is in the nanotube, it travels up through the spaces and creates the capillary effect. This capillary effect deforms the tube and bends it or twists it in very specific ways. They then figure out which tubes will bend which ways and they rearrange the new tubes into positions to make specific shapes. They are able to take half column tubes, bend them together, and make them resemble the shapes of flowers. Although this is not a life changing ability, this means we are one step closer to arranging complex structure on a nanometer scale.

Reflection

This is interesting to me because it shows the steps that need to be taken to achieve a goal. This is a great real world example because new technologies aren't created in a day. As lame as this step seems at first, it is actually an amazing achievement. Until now we have not been able to manipulate nanotubes into 3D shapes, nanotubes have strictly been a 2D material. With this ability, we can now start thinking about applications for nanotube manipulation. They can become molds for some new nanotechnology, or

later used for specific metals or ropes. The applications for this technology are endless. The article states that these new bent tubes could be used to create “probes that could interact with specific cells, novel microfluidic devices, and lightweight materials for aircraft and spacecraft.” With this new ability to shape the carbon nanotubes, we are one step closer to creating complex designs with them, which will take us only one step away from our ultimate goal; working nanorobotics.

Reliability

This article was published December of 2010. Being only a month ago, this is a very current article. The currency of this article is not necessarily crucial for the relevance of the information, because the article is mainly describing how these new 3D shapes are obtained. This information will still be relevant in a few years because it still will be an accurate description of how to bend the carbon nanotubes. Even though the information is not dependent on the date, the currency of the article does validate the information in the article, confirming its reliability. This article was published and reviewed by the National Science Teacher Association. This association has been around since 1944 and is the world’s largest association of people committed to excellence and innovation in science teaching and learning for all. This publication takes pride in publishing accurate work, and its popularity and age indicate that it is a very reliable organization. The author is anonymous which takes away from the reliability of the article, but the data and procedure both come from the University of Michigan. The University of Michigan is a very accurate and reliable source. This all means this article is overall a reliable source.

4. Hersam, Mark C. "Nanotubes sorted using DNA." Nature 460.7252 (2009): 186-187. Platinum Periodicals, ProQuest. Web. 18 Jan. 2011. <http://proquest.umi.com/pqdweb?index=1&did=1796558231&SrchMode=1&sid=2&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1295397547&clientId=23199>.

Summary

This article describes the newest way of sorting carbon-nanotubes by binding them to specific DNA sequences. These DNA sequences are used to disperse random sized and shaped carbon-nanotubes into water. They then use chromatography and spectroscopy to determine if the DNA has formed complexes with a specific type of nanotubes. This is a very slow and tedious job because there is close to an infinite number of DNA sequences the scientists can test. The number of sequences possible was stated in the article as $4^{100}(10^{60})$. These DNA sequences allow the nanotubes to be sorted very specifically by size and shape, meaning the next step is to actually sort out the specified nanotubes into one congruent tube. They have also found that the shorter the sequence is, the more specific the nanotube it picks. This sorting stage is important because nanotubes are grown in very large quantities, meaning each batch creates a variety of shapes and sizes which is less than ideal for commercial use. To sell the nanotubes commercially, they must be grown consistently the same. This method of sorting is impractical because of the price of DNA, but it allows refined researching on specific tubes.

Reflection

This interests me because it is a very odd way of solving a very complex problem. DNA is something that I wouldn't expect be used to sort these complex nanotube structures. This surprised me and got me wondering about the research that could be conducted with these sorted structures. What tests could be conducted that could not be conducted on a mixed sample? What would the results be? It also interested me how many different sequences could be made from the DNA and it didn't discourage any of the scientists. With a number that large I would have given up before I had even started. The idea that

they stuck with it and decreased the number slowly until they got down to the very basic elements inspired me. The progress of the whole process intrigued me too. They only have tested 350 samples out of an infinite number of sequences which means they have not even broken the surface, but they have already found 20 sequences that specifically select one type of nanotube. That's a good amount for only 350 samples.

Reliability

The article was published July 9th, 2009. Although this is about 2 years old, it still retains good information on the sorting abilities of DNA. The date does not diminish the information in this article. What makes this article very reliable is who published it. This article was published on Nature. Nature is world famous for publishing well renowned high impact science articles. Nature was founded in 1869 and is a main part of Scientific America, which is the oldest continuously published science magazine in the US. This is important to the reliability because nature is known to only publish accurate relevant information. Nature is extremely wide known and have many people reviewing all the work published. The author, Mark C. Hersam is a professor of materials science and engineering with a Ph. D. in electrical engineering. Being a professor of material science and engineering gives him a lot of reliability when it comes to carbon nanotubes and DNA sorting. The Ph. D. he has earned also gives him credibility, making this a very reliable source.

5. Martin, Holly. "Measuring Excitement for Carbon Nanotubes." *Research.gov*. National Science Foundation , 10 Feb. 2009. Web. 18 Jan. 2011. <http://www.research.gov/researchportal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_news&_nfls=false&LatestNews_1_nodePath=/News/Common/Measuring_Excitement_for_Carbon_Nanotubes.html>.

Summary

This article begins by stating the exceptional properties of the carbon nanotubes. It describes the incredible structural, chemical, optical, and electrical properties. It describes carbon nanotubes to be 50 times stronger than steel while still being incredibly small and light. They also conduct heat very well, but their electrical uses are what are interesting to the rest of the world. What is interesting about the nanotubes is that they can be either metallic or semiconducting. The twist of the nanotube is what decides that factor. The chiral shape is what they test in this article. To study these twisted nanotubes, they shot extremely fast pulses of laser light into the tubes and measured the way the energy got distributed. What they noticed is that the light created an exciton in the carbon, and the size of the exciton the tube creates determines how the exciton reacts within the tube. They then measured the size of each of these exciton by measuring how many can fit in the nanotube at once. They then found that each exciton was the same size and exactly the width of the nanotube it passes through. That means the exciton can only move up and down the tube instead of side to side like they originally presumed.

Reflection

This article interested me at first because it took a very complicated situation and explained it in terms that I could follow along with. That is what initially caught my attention. As I read, what interested

me was how the tube created exactly the same exciton every time, and every exciton was exactly the width of the tube. That got me to think about why that happens. Why is it so exact every time, and how can we use this to our advantage in the future? This led me back to the first part of the article where it states that nanotubes could end up taking over most of our technology today. It says that they could be more efficient and save more energy in household appliances. That interested me because that's the kind of discovery I imagine myself discovering someday.

Reliability

The article was published on February 10th, 2009. The information in this article is information that was found through experimentation and very relevant. Although it is a year old the data that was in the article could be used again and time did not hinder the articles reliability at all. A second source of reliability comes from the publisher of the article. It was published by the National Science Foundation. The National Science Foundation supports over 200,000 scientists and labs over almost every continent. Being this popular in the science community, the articles published through the National Science Foundation are thoroughly reviewed and found to be very accurate. This enhances the reliability of my article. The author, Holly Martin is an assistant professor at Mississippi State University conducting biomedical research. Being an assistant professor at a very renowned university gives significant credibility for the article. This combination shows that the article is very reliable.