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Nano Car - The Era of Nanotechnology

Arushi Gupta, Prof. Sukhwinder Singh (Mentor)
Electronics and Electrical Communication Department, PEC University of Technology, Chandigarh, India

Abstract: One of the most appreciated advancements in the field of Nanotechnology is the introduction of Fullerene leading to the development of the molecule Nanocar. The concept, working and further evolvement of this molecule (Nanocar) into an actual car have been discussed in this document. Nanocar is not just one of the smallest cars in the world but is an emission free, noiseless and the smallest four wheel drive car that runs on electricity. This car-like m olecule is fuelled by electrons and might pave the way for applications requiring artificial transporters operating at nanoscale. The discovery of this molecule (Nanocar) was a sensation and to build such a device (the car) was probabl y one of the dreams of nanotechnology.

Keywords: Bucky Ball, Chassis, Fullerenes, Nanocar, Nanometer, Nanotechnology.

Introduction

Nanotechnology is the science of describing matter on an atomic, molecular, and supramolecular scale. It can be defined as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers, with size being the common trait fo r the broad range of research and applications in the real world. From a broader perspective, it is the engineering of construc ting tiny machines at the molecular scale and fabricating them and the materials used to make them, which ultimately result in efficient and high performance products. It is fundamentally based on two approaches: bottom-up and top-down. Atomic Force Microscope (AFM) and Scanning Tunneling Microscope (STM) are two of the earliest instruments used that launche d nanotechnology. Vast amount of developments have taken place in fields like electronics, medicine, chemistry, physics et c. which have proved to be of extensive use making our lives simpler. Examples of these applications are seen our day to d ay life. Some of which include microwaves, TVs, personal computers, solar cells etc. One of the fascinating advances is the discovery of water droplets rolling down an inclined plane due to the super-hydrophobicity provided by the nanostructures. Developments in Nanotechnology have been possible by means of biomimetic principles. However, the recent advances ar e ultimately based on the mechanical engineering principles, namely a manufacturing technology based on the mechanical f unctionality of components like gears, bearings and motors, which enable programmable and positional assembly of the spe cific atoms. One such advancement is the Nanocar which is main topic of focus in this paper.

Development of Nanocar

The molecule Nanocar was first designed in 2005 by a group of researchers headed by Professor James Tour at Rice Univer sity. Even though the original nanocar does not contain a molecular motor, it was primarily designed to explain how fullere nes move about on metal surfaces. The molecule, measuring just 4x3 nanometers which is slightly wider a strand of DNA a nd about 20,000 times smaller than the width of a strand of human hair, consists of an H-shaped chassis with spherical fulle rene groups (composed of sixty carbon atoms each) attached at the four corners to act as Bucky ball wheels that rotate on in dependent axles in the same direction when zapped with a beam of electrons.

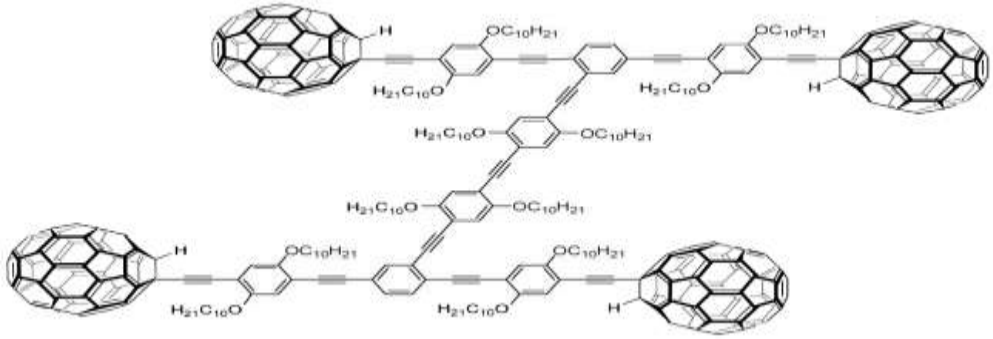

Figure 1. Chemical structure of nanocar

The Concept

It was found that the nanocars moved about on a metal surface by rolling of the wheels in a direction perpendicular to the a xles, rather than sliding about like a car on ice. When dispersed on a gold surface, the molecules attach themselves to the su rface via their fullerene groups and are detected via scanning tunneling microscopy. Upon heating the surface to 200 °C the molecules move forward and back, precisely due to the conformational changes in the rotor induced by inelastic electron tu nneling. The nanocar is able to roll about because the fullerene wheel is fitted to the alkyne axle through a carbon-carbon si ngle bond. The hydrogen on the neighboring carbon is no great obstacle to free rotation. When the temperature is high enou gh, the four carbon-carbon bonds rotate and the car rolls about. Occasionally the direction of movement changes as the mol ecule pivots, the trajectory being linear preferentially [9].

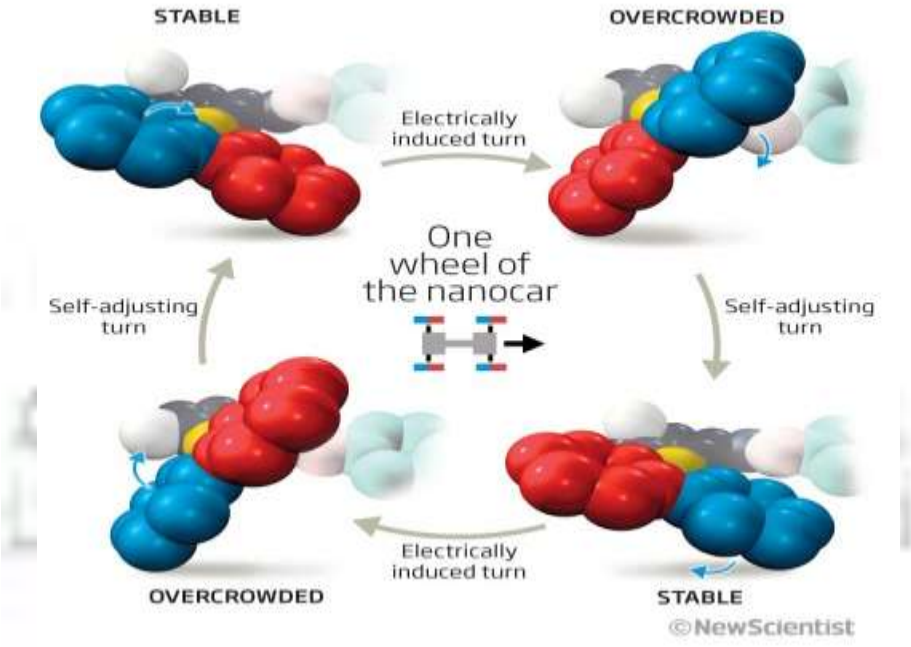

Figure 2. A wheel of the Nanocar

Design of a Nanocar - The Car

The Nanocar consists of three basic components that include spherical fullerene wheels, freely rotating alkyne axles, and a molecular chassis. The Nanocar body is constructed of lightweight, state-of-the-art materials called carbon nanotubes. Elect rostatic regenerative disc brakes and rack and pinion steering, which is attached to the steering arms by means of tie rods, ar e used in this car. It is observed that its wheels design is similar to a bicycle tire. The wheel's rim and hubs are Bucky disks and the spokes are made of nanotubes covered with adipose stem cells to increase aerodynamic efficiency. The cars main c hassis, solar array and other additional frameworks have been fabricated and tested using perfect materials in laboratories [6].Even though there is no reverse gear, the car can be parked very easily due to the cars' wheelbase which is less than 5nm. The car was found to be stable on the parked surface if the temperature was below 170 deg. C.

A basic and simple version of the automobile was created by the scientists at the Rice University and the first one being test ed in October 2005. Further improved versions of the car were launched later in 2006 and are shown in the figure below. Th e main difference between a nanocar (2005) and a motorized nanocar (2006) is that thenanocar has C_{60} wheels, a chassis, an d axles, whereas the motorized nanocar has carborane (boron cluster) wheels, a chassis, axles, and a motor that can rotate w ith 365 nm light [7].

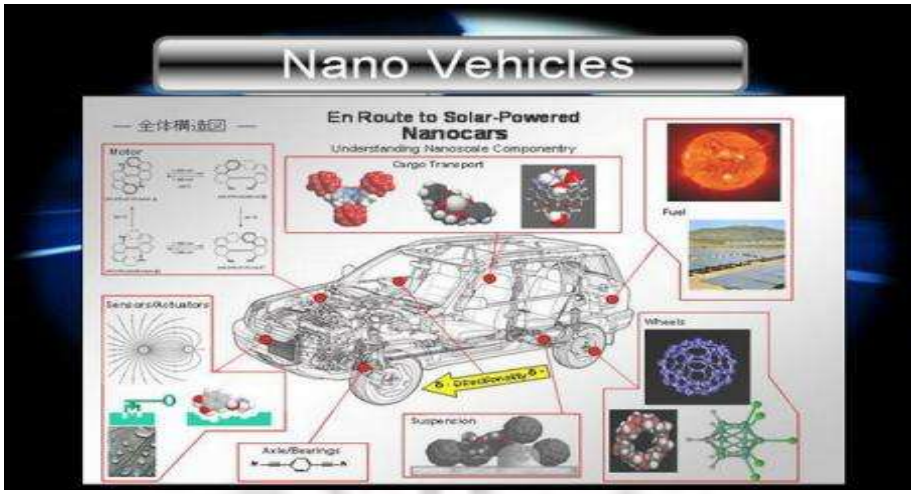

Figure 3. Components of a Nanocar

Furthermore, scientists have built a super small new version of the nanocar called the nanodragster (knows as the smallest h ot rod). The front wheels are smaller and are on a shorter axle while the back wheels are bigger and are on a longer axle. Du e to this, the car can reach a speed up to nine nanomiles, or 0.014 millimeters, per hour, which is relatively fast considering the minute size.

Working of the Nanocar

Based on the concept of rolling of the nanocar molecule on a metal surface, it was observed and proven that it acted just lik e a car. It runs using solar cells mounted on the vehicle. This means that the car has a light sensitive motor that helps to pro pel the car further. The collected energy is delivered to the car's nano-batteries or to its electrostatic motor when the car is r unning. Its motor weighs less than 5 ng (nanograms = 1 billionth of a gram). The speed and directional control of the car is affected using an on-board neural-net. Gear changing is done electronically in the electrostatic motor; the two connected by a nanochain for high efficiency, strength and longevity [6].In addition to this, due to the molecular design of the car, its whe els can only turn in one direction, having a radius of 4m.

Conclusion

The Nanocar is a fully functioning automobile that is one billionth the size of a regular automobile. However, every technol ogy has its implications on the society. The rising concerns about the toxicity and the environmental impact of nanomaterial s, and their effects on global economics have left the governments confused about the regulation of the technology. For exa mple, inhaling the nanoparticles and nanofibres which are used in making these products are harmful for the humans. More over, the car has other disadvantages to it too. Manual gearing, lack of power steering and prone to damage of the front half of the car due to its small size are few other drawbacks. Regardless of this, the growing use of the Nanocars has proven to be a success in this field. The worlds cheapest and one of the smallest cars is definitely making business with Tata Nano T wist being the most recent one in the Indian market.

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