STUDY OF CONVERSION OF ATMOSPHERIC CARBON DIOXIDEINTONANOTUBEFORUSEIN BATTERIES AS AN ANODE

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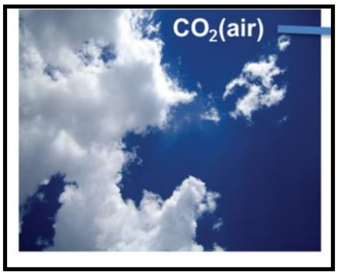
ABSTRACT

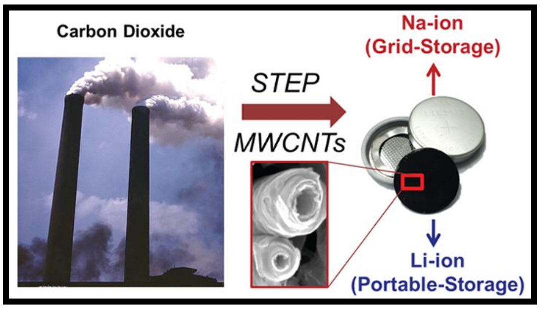
Nowadays the CO2 is increasing rapidly in air as a result of burning of fossil fuels, it causes increase in global warming that have triggered global efforts to reduce this level of CO2 So there is need to convert this environment available CO2 gas in the nanotube using solar thermal electrochemical process which uses molten litigated carbonate and low cost steal electrodes. This low cost CO2 derived CNTs can be used as high performance energy storage device in lithium ion and sodium ion batteries which gives optimised storage capacity over 370 mah/g (lithium) and 130 mah/g (sodium) with no capacity fade under durability tests up to 200 and 600 cycles, respectively. This paper shows that this environment pollutant can be used as source for making CNTS



Key words*:*supercritical CO2,CO2 reduction, solar thermal electrochemical process, carbon nanotubes, Battery anode

I. INTRODUCTION

Continues economic growth has contributed to today's ever increasing demand for energy. And absolutely result of this is an increase in the use of fuels, the fuel includes coal oil and natural gas that have become the essential source from the industrial revolution But due to more use of fossil fuel has increased the emission of carbon dioxide and other gases CO2is a major essential greenhouse gas [1]Over the past century the atmospheric CO2level has been increased 39% from 280ppm during pre-industrial time [2] Which increased global warming effect from past few decades. So this paper is mainly focused on the conversion of CO2into nanotube to balance the greenhouse gas. carbon dioxide gas capture and storage is considered as a crucial process for controlling CO2emission, this issue can be resolved by



finding new technology that can easily capture CO2and will convert it into high value product, carbon capturing from CO2 and convert it into nanotube is a newly emerging technology, so it needs to be update further. Nanotube is nothing but allotropes of carbon with a nanostructure that can have length to diameter ration more than 1000000. Nanotubes have various novel properties that make them suitable for highvalue applications. Their unique surface area, stiffness, strength and resilience made it suitable in the field of pharmacy.[3]
There aremainly two types of nanotubes, single wall nanotube (SWNT) and multiwall nanotube (MWNT)Typically the CNTS are made through vapour deposition, in which carbon rod is heated to until it turns into gas and cooled to make Nano fibre and nanotubes, which is complex and high energy process.[3] Now researchershave developed an electrochemical process that captureCO2from surrounding atmosphere.The new technique of making nanotube from CO2gas is based on the solar thermal electrochemical process. The element constituents of CO2, the most important greenhouse gas consists of carbon and oxygen which are the building block for various new technologies. The carbon nanotube made from the atmospheric CO2can be used as anode in the lithium and sodium ion batteries which gives more output than earlier anode which also boosts the battery performance. [4-5-6] this new approach describes that it is a way to remove some of the part of the most abundant greenhouse gas this will be larger fight against the climate change.

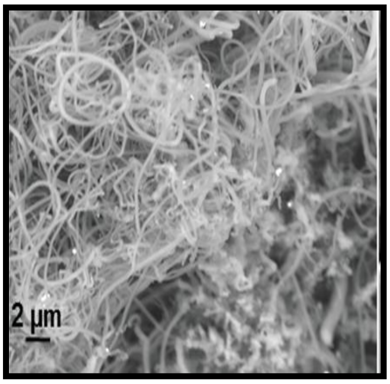
II. LITERATURE REVIEW

Carbon nanotube was discovered in 1991 by Lijima,carbon nanotubes have wide applications due to lot of superior properties like excellent mechanical, high electrical conductivity.CNTs are classified as single walled carbon nanotubes and multiwall carbon nanotubes the structure of SWNTs is defined as three patterns which include zigzag armchair and chiral. On the basis of SWNTs structure two models of the MWNTs were proposed by former researchers: Russian Dolls model and parchment model [7]Applications of CNTs: Firstly it was used to make good conducting composites because of their high aspect ratio and high conductivity. Another typical application for CNTs is used to make low density structure materials. Carbon nanotubes possess a high young modulus, about 1TPa that's why they are used to reinforce composites. [8]For the kyto protocol in 1997,163 countries have agreed to reduce emission and have been making an effort for making carbon capture and conversion of carbon into useful product[9].A Nobelprize winner Goeppert, A.and two co-authors, M. Prakash, Surya G. K., &Olah, G. A. (2012). Published a summary of the state of fossil fuels and alternative energy sources, including their availability and limitations. Direct air capture is also preferred to flue gas capture when looking at the composition of the captured CO2: emissions coming directly from the smokestacks of power stations and industrial buildings carry high concentrations of NOx and SOx in addition to CO2.[10]In research by Klaus Lackner (2009), sodium hydroxide was initially considered as a liquid sorbent, but it was quickly realized that extracting carbon dioxide from such filters would require overcoming a very large bonding energy, which ultimately defeats the purpose of CO2capture and sequestration [11]STEP- In 2010, S.L designed the solar thermal electrochemical carbon capture process and together with B.W conducted and analysed the electrolysis and solar experiments this a very efficient method for carbon capturing.[12]In 2012 stuartlicht, baochen cui, bahuiWangprovided experimental validation of theory using electrolysis of molten lithium eutectic alkali carbonates at high (~50%) solar efficiency and high rate, and delineated the materials required to use the

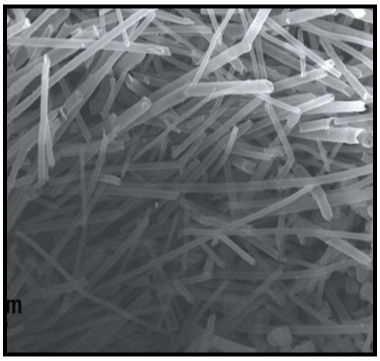
STEP carbon to decrease atmospheric CO_2 to pre-industrial levels in ten years.[13]In 2015, jiawenren,Jasonlau, Metthewlafler, and stuartlicht, founded theminimum energy needed to convert the carbon dioxide to carbon by electrolysis in carbonate melts.by this the CO_2 in the atmosphere can be mitigate by producing solid carbon. Electrolytes without lithium carbonate but containing calcium and barium carbonate can also be employed as reaction media for successful carbon deposition.[14]In 1928, indian physicist, Dr.C.V.Raman discovered the Raman effectThe Raman spectroscopy is based on the Raman effect. In 1960, Raman spectroscopy has been practically used because of invention of laser system. Now this technique has been used for the analysis of the graphitization of carbon nanotubes. [15]Application of carbon nanotubes for lithium ion battery anodes-lithium ion batteries are energy storage device based on conversion and energy storage. With the discovery of highly reversible low voltage Li-intercalation carbonaceous materials, Sony realised the commercialization of $Li_xC_6/Li_{1-x}CoO_2$ cells in 1991 However, the capacity of LIBs based on graphite as an anode material can be theoretically limited, since lithiumIons can only combine with every second carbon hexagon in the graphite sheets. The intercalation of lithium into graphite involves one lithium atom per six carbon atoms, *i.e.*, LiC_6, leading to a limitedSpecific capacity of 372 mAh/g and an observed capacity of 280–330 mAh/g, depending on the type of
Graphite used.[16]

III. METHODOLOGY

In this study, the method is based on the solar thermal electrochemical process (STEP),which is designed to capture greenhouse gas carbon dioxide and conversion of it into a useful carbon element. This process uses low cost galvanized steel cathode, nickel anode and molten carbonate electrolytes that are heated and powered using concentrated photovoltaic (CPV) cells that convert sunlight into electricity at 39% efficiency. STEP is shown to work effectively with or without solar powered operation to electrolytically split water, carbon dioxide, or metal oxides carbon,produce STEP ammonia and STEP organic [12]and produce STEP iron or cement.CNTs aremade by DC electrolysis from abundantCO_2 dissolved in 750 °C molten Li_2CO_3 with, or without,added Li_2O. A Ni crucible serves as both container andanode, and immersed 10 cm^2 galvanized steelacts as the cathode. First an initial low current (0.001 Afor 0.5 h) is supplied to grow Ni nucleation sites on the cathode,CNTs are grown on an immersed 10 cm^2 galvanized steelcathode at 1 A for 1 h. Two types of nanostructures areFormed, straight CNTs that are generated in electrolyte withoutadded Li_2O, and tangled CNTs that are grown when 4 m Li_2Ohas been added to the electrolyte.



Tangled Nanotube



Straight Nanotube

By controlling diffusion conditions during electrolyticsplitting of CO2 in molten lithium carbonate forms eitherfilled CNF or hollow CNT nanostructures, and control of oxideand transition metal concentration forms tangled or straightfibres. By this process, longer CNTs can also be formed by pulsing the formation current for 9 min on (at 1 A)and 1 min off. The tangled CNTs are generated in highelectrolytic oxide DC conditions.

Raman spectroscopy analysis was also examined to evaluate degree of graphitization of formed nanotubes, which shows the intensity ratio is an important factor for evaluate the graphitization & total relative ratio of defective carbon. These nanotubes can be used as an anode for the lithium and sodium ion batteries. The research showed that the battery with nanotube anode gives stable storage performance, which is 3.5 times greater than graphite electrodes, & it also showed no fatigue after continues charging and discharging up to 2.5 months.[16]

IV. FUTURE SCOPE

In this review it has been shown that carbon dioxide which is a global pollutant with adverse environmental impact could be successfully used as carbon source for the synthesis of the nanotubes by using the solar thermal electrochemical process. The step could be coupled to a natural gas powered electrical generator. The generator would provide the electricity, heat and a concentrated source of carbon dioxide that would boost the performance of STEP process. In future by exploring furtherthis technique the end result could be a fossil fuel electrical power plant with zero net CO2 emissions. And unlike methanol, combining batteries with solar cell provides renewable power with zero greenhouse emission, which is required to put an end to the current carbon cycle that threatens future global sustainability. This method will not only produce the good battery but also develops the value of pollutant CO2 captured from atmosphere. In addition to anode in batteries the CNTs can also be used in other applications such as carbon composites, sports equipment's and car truck airplane bodies.

V. CONCLUSION

Here we conclude that the conversion of atmospheric CO2intostraight and tangled CNT materials for use in both lithium-ion and sodium-ion batteries using the STEPProcess is easy and low cost method. These nanotubes show high performance and durability, and gave a boost to performance of battery. By making electrode of carbon nanotube, battery gave more storage capacity. The production of CNTs by electrolysis provides a low-cost pathway for CNTs and hence gives an economically practical trajectory toward the conversion of CO_2 into battery materials.

REFERENCES

[1] Emission databases for global atmospheric research EDGAR, Europeancommission.

[2] IPCC forth assessment report climate change 2007(AR4) from IPCC website.

[3] http://en.wikipedia.org/www/carbon%nanotube

[4] Leung, D. Y. C.; Caramanna, G.Maroto-Valer, M. M. An Overview of Current Status of Carbon Dioxide Capture and Storage.

[5] Dunn, B.; Kamath, H.; Tarascon, J. M. Electrical Energy Storagefor the Grid: A Battery of Choices. Science 2011, 334, 928−935..

[6] Xiong, Z.; Yun, Y. S.; Jin, H. J. Applications of Carbon Nanotubesfor Lithium Ion Battery Anodes. Materials 2013, 6, 1138−1158.

[7] S lijima, Helical microtubules of graphite carbon, Nature (London), 1991.

[8] J.Robertson, applications of CNTs today 7 (2004).

[9] United states environmental protection agency. Opportunities to reduce greenhouse gas emissions through materials and land management practices; office of solid waste and emergency response, Washington,DC,USA, September 2009.

[10] Goeppert, A., Czaun, M., Prakash, S. G. K., &Olah, G. A. (2012). Air as the renewable carbon source of The future: an overview of CO2 capture from the atmosphere. Energy & Environmental Science.

[11] Lackner, K. S. (2009). Capture of carbon dioxide from ambient air.

[12] Licht, S.; Wang, B. H.; Ghosh, S.; Ayub, H.; Jiang, D. L.; Ganley, J. A New Solar Carbon Capture Process: Solar Thermal Electrochemical Photo (STEP) Carbon Capture.

[13] Licht, S. Efficient Solar-Driven Synthesis, Carbon Capture, and Desalinization, STEP: Solar Thermal Electrochemical Production of Fuels, Metals, Bleach.

[14] Ren, J. W.; Lau, J.; Lefler, M.; Licht, S. The Minimum Electrolytic Energy Needed To Convert Carbon Dioxide to Carbon by Electrolysis in Carbonate Melts.

[15] Raman study on electrochemical Li intercalation into graphite. J. Electrochem. Soc. 1995.

[16] Lahiri, I.; Oh, S. W.; Hwang, J. Y.; Cho, S.; Sun, Y. K.; Banerjee, R.; Choi, W. High Capacity and Excellent Stability of Lithium Ion Battery Anode Using Interface-Controlled Binder-Free Multiwall Carbon Nanotubes Grown on Copper. ACS Nano 2010.